
EKU

Ignition Potential of Common Fuels by Residential Electric Range Cooktops

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Potential Ignition Sources from Residential Electric Cooktops

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DEDICATION

This thesis is dedicated to my wife Robyn and our two children Landen and Kaelyn for their support during all those late nights spent working on fulfilling my life goals. To my parents Rick and Teresa for all those years of encouragement and reinsuring me that I could do whatever I put my mind to.

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Abstract

A study was conducted to evaluate the competency of several types of electric cooktop ranges igniting a variety of common kitchen items. Four types of electric cooktop ranges were tested including a ceramic-glass cooktop range, an electric coil cooktop range, an electric coil cooktop range with cast iron plate installed, and an electric coil cooktop range which had both a cast iron plate and a temperature-limiting control sensor installed. The last type of cooktop will be referred to as the temperature-limiting or temperature control sensor cooktop throughout this report. The latest research was reviewed to select a representative sample of fuels commonly noted as the first fuel ignited in kitchen fires. The nine selected fuels included cardboard (pizza box), a cotton dish towel, a roll of paper towels, a pan of canola oil, a pan of vegetable oil, a nylon short turn spatula (cooking utensil), a kitchen appliance (toaster), a plastic storage container, and a pan of corn oil.

The study evaluated the potential for testing for each range in the high, medium, and low settings on the large (8" diameter) and the small (6" diameter) heating elements resulting in a potential of 54 tests per burner technology type. Not all test were conducted based on results from the individual test on the next higher setting. An additional eight tests were completed to examine the repeatability of results. The replicate tests were conducted with the high setting for each heating element diameter. Cardboard was selected as the fuel for the replicate tests. A variety of data was collected for each test including video photography, infrared video photography, still photography, and thermocouple data. The heat sources were characterized using thin skin calorimeters.

The high setting for all three cooktop types, excluding the temperature-limiting sensor cooktops, tested at both the 6-inch and 8-inch diameter heating element resulted in the ignition of 45 of 54 tests. The temperature-limiting sensor cooktop did not ignite any of the fuels on any setting. Table 45 quickly illustrates, as logic would suggest, that the potential for ignition is greatest when the cooktop is set to the high setting. The ceramic glass cooktop resulted in a 72% ignition on the high setting while both the electric coil cooktop and cast iron plate cooktop resulted in a 94% ignition on the high setting. Although not all fuels ignited at the high setting, it was noted that the potential for ignition was possible due to the quick consumption of mass, smoldering combustion

(cellulosic fuels), and increased volume of vaporization/pyrolysis products. The high setting for all three cooktop types showed the maximum potential for ignition based on the total heat output produced by the 6-inch diameter and 8-inch diameter heating elements. No fuels ignited at the high setting for the temperature-limiting sensor cooktop.

The medium setting for all three cooktop types for both diameter heating elements resulted in few instances of flaming combustion of the fuels. Approximately half of the fuels tested on the ceramic-glass cooktop ignited at the medium setting, while it was more difficult to ignite fuels on the electric coil and cast iron plate cooktops. Although only select fuels ignited on the different electric range types tested at the medium-setting, it was noted that a majority of the fuels did demonstrate the potential of reaching flaming combustion through evidence of smoldering combustion and significant loss of mass for those cooktops without the temperature-limiting sensor. The medium setting for all three ranges demonstrated moderate potential for ignition based on the total heat output produced by the 6-inch diameter and 8 inch diameter heating elements. No fuels ignited at the medium setting for the temperature-limiting sensor cooktop.

The low setting for all four cooktop types tested for both the 6-inch and the 8-inch diameter heating element resulted in no flaming ignition. All tests conducted using the three different electric range types for both the 6-inch and 8-inch diameter heating elements demonstrated no potential for ignition of any of the fuels tested. Based on the research conducted it can be concluded that the low setting for all three electric range types has minor-to-no potential for ignition of the fuels tested. This study has validated a number of configurations of electric cooktop ranges in a variety of ignition scenarios. The competency of aforementioned cooktops as an ignition source given a number of common household fuels has been reported on in extensive detail within the body of this report.

Disclaimer

Certain commercial software, equipment, instruments, or materials may have been used in the preparation of contributing information to this report. Identification in this report is not intended to imply recommendation or endorsement by Eastern Kentucky University, nor is it the intent to imply that such software, equipment, instruments or materials are necessarily the best available for the purpose. The products are intended solely as a means to best describe the experiments for reproducibility purposes.

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CHAPTER ONE
INTRODUCTION

The objective of this study was to evaluate the potential for ignition of commonly found household kitchen items using four different types of residential kitchen ranges. The four different types of kitchen ranges that were evaluated consist of a ceramic-glass cooktop range, an electric coil cooktop range, an electric coil cooktop range with a cast iron cover plate, and an electric coil cooktop range with a temperature control sensor. Common residential kitchen items were selected as the fuels for this series of tests based on the statistics of first fuels ignited in kitchen range fires, including these eight common household fuel items (Ahrens, 2011):

1. Cardboard (Pizza box)
2. Dish Towel
3. Paper Towel
4. Canola Oil
5. Vegetable Oil
6. Cooking Utensil (Nylon Short Turner)
7. Kitchen Appliance (Toaster)
8. Storage Container
9. Corn Oil

All nine fuels were tested using each of the cooktop technologies. The six-inch and eight-inch diameter heating elements were used for each range and both heating elements were used to test all nine fuels. Each test was conducted using the high, medium, and low settings for each heating element. This resulted in a test matrix of 54 ignition tests for each range.

Each test was documented using a systematic arrangement of thermocouples to record the temperature of the fuel (external and internal) and the heating element during the heating process. A thermal imaging camera and video camera also recorded each test.

CHAPTER TWO
BACKGROUND

This report is a continued effort to promote technology and enhance life safety that started from the Vision 20/20, Kitchen Fire Prevention Technologies Workshop that took place in 2010. The purpose of the workshop was to explore technological pre-ignition interventions for cooktop kitchen fires. This report is a continued effort to explore some of the different cooktop technologies that are currently available. The following sections are included as a brief literature review of the statistics of cooking fires, common fuels associated with cooking fires, ignition scenario studies, and studies regarding a temperature controlled sensor plate. This report used a temperature controlled sensor plate called the Safe-T element manufactured by Pioneering Technology. The statistics were reviewed to identify the most common fuels, ignition sources, and causes of cooking fires. This information was then used to help create the experimental setup for this study.

2.1 Cooking Fires

The U.S. continues to combat the loss and damage created every year by fire. In 2010, there were 1,331,500 fires reported in the United States. These fires result in 3,120 civilian deaths, 17,720 civilian injuries, and $11.6 billion in property damage. Although there has been a continued decrease in deaths annually by fire, the average for deaths on an annual basis reflects a consistent 3000 plus deaths yearly (Karter, 2011). Despite the improvements in the last four decades, the participants in Vision 20/20 felt strongly that the U.S. fire service needed to embrace and value prevention strategies as part of their core, and not focus nearly most of their time and resources on emergency response, which occurs after the fact.(Vision 20/20, CRR)

The majority of fire deaths occur in residential structure fires, 85% of civilian fire deaths in 2010 occurred in homes[1] (Karter, 2011). The leading cause of fires in

residential structures since 1990 has been cooking. Between 2005-2009 it was found that unattended cooking was the greatest cause of cooking fires (Karter, 2011).

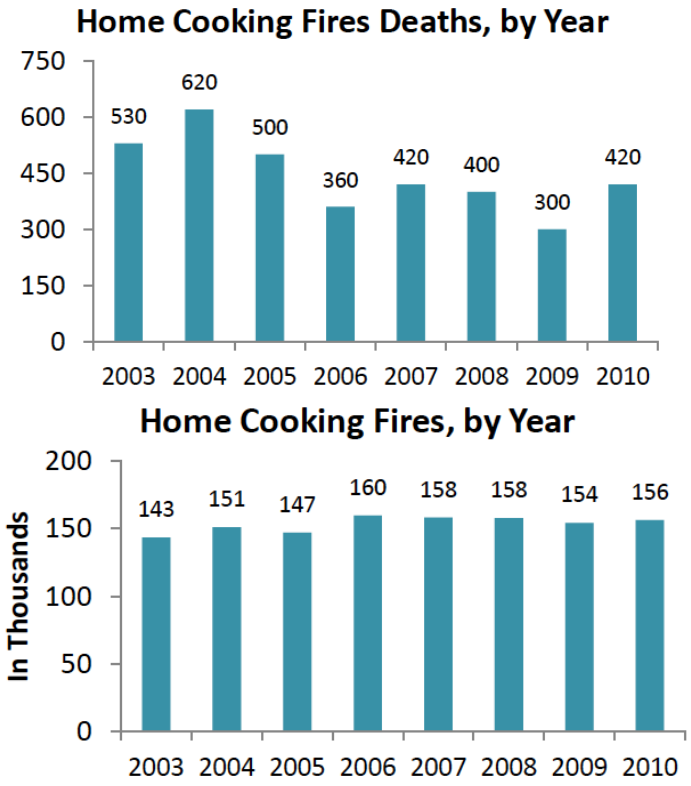


Figure 1: Statistics regarding home cooking fires.

Source: Karter, M. (2011). Fire Loss in the U.S. During 2010. NFPA: Quincy, MA

According to NFPA, homes included one and two-family homes, apartments and other multi-family housing. To truly evaluate the cause of cooking fires, it is important to analyze these fires by evaluating the common ignition source(s), the material first ignited, and what elements or circumstances brought those elements together to cause the fire.

2.1.1 First Material Ignited in Cooking Fires

FEMA (2005) concluded that cooking materials, including food were the most common first material ignited in cooking fires. It was found that oil, fats, and grease are the first material ignited in 41% of cooking fires. Other foods, starch, and flour account for the second most common material ignited (21%), followed by plastics (10%) such as casings or cooking utensils (FEMA, 2005). A survey completed by CPSC between 1994

and 1996 found that the material being heated or cooked was the first material ignited in 71% of fires, followed by cabinets (5.2%) (Smith, Monticone, & Gillum, 1999). A similar problem was found in the United Kingdom, where a study found that 84.9% of fires with an electric range resulted from the ignition of material being heated or cooked, followed by the appliance being accidentally turned on (2.95%) (Hogg, 1963). Solutions to the fire problems our communities face demand an integrated approach that balances emergency response capabilities with other proactive measures that work together (integrate) to reduce risks.(Vision 20/20, CRR)

2.1.2 Common Ignition Sources in Cooking Fires

In 1998, the vast majority (72.1%) of cooking fires involve the range or cooktop, followed by the oven at 17.3% (Babrauskas, 2003). Between 2005-2009, the range or cooktop remained the greatest fire threat in cooking fires (58%). It is apparent the range or cooktop has been the consistent ignition source for cooking fires (Ahrens, 2011). It was also found that electric ranges have been shown to have a higher risk for cooking fires (Ahrens, 2011).

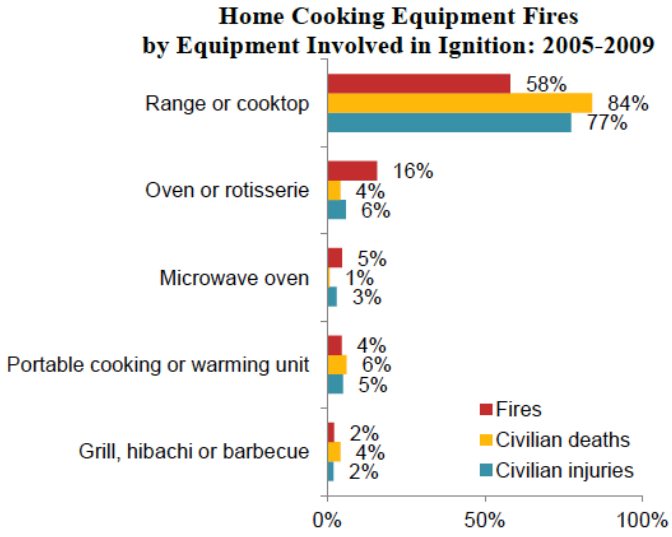


Figure 2: Home Cooking Equipment Fires.

Source: Ahrens, M. (2011). *Home Fires Involving Cooking Equipment.* NFPA: Quincy, MA.

2.1.3 Causes of Cooking Fires

A study completed in the UK revealed that that 97% of fires involving cooking equipment was caused by misuse (Hogg, 1963). A more recent study completed by CPSC (1999) found that the greatest action or event leading to cooking fires was (1) unattended cooktops [57.7%], (2) other misuse [11%], (3) mechanical/electrical failure [10%], (4) combustible material too close [9.3%], (5) accidentally turned on [5%].

There have been several studies completed to evaluate cooking fire ignition scenarios. However, the majority of these studies have been primarily focused on ignition properties of various oil and fat products. These studies are referenced when discussing the specific fuels used for this research in Section 3.2 of this report.

2.2 Electric Ranges

An Electric Range is a common household kitchen appliance that is used to cook food using electricity. At this time no detailed research studies could be found that evaluated electric ranges as ignition sources for fires. Several small studies had been completed to evaluate the ignition of corn oil when placed in a saucepan on an electric coil cooktop in comparison to a previous test with a gas burner (Fire Findings, 1997). The 1997 study evaluated the time to ignition and temperature of the oil at the time of ignition. The major findings of this study are that the electric range could easily ignite the oil as did the gas range burner had, and that it took 28 minutes for ignition with an oil temperature of 379^{o}C. In 2000, the same researchers evaluated the rate of temperature rise and whether the larger diameter heating elements would achieve higher temperatures prior to ignition. It was found that the larger diameter heating elements recorded a peak temperature of ~732^{o}C in five minutes, while the smaller heating elements reached ~500^{o}C in four minutes (Fire Findings, 2000).

2.3 Cooking Fire Mitigation Technology Studies: Safe-T-Element

A number of performance tests have been conducted on the Safe-T-element, which is an electronically controlled cast iron plate product designed to help prevent cooking fires. Testing was conducted by UL in 2005 to determine the ability of the device to actually prevent fires from occurring as well as to cook food effectively. The study included multiple types of utensils with 100mL of oil. Results indicated a

significant reduction in the ignition of oil, but with significant increases in the time it took to cook water, pasta, fries, and bacon (Underwriters, 2005). Based on these results, enhancements were made to the Safe-T-element in order to try to reduce overall cook times. New studies were conducted in 2010 by the Canadian Standards Association (CSA) by OnSpex Consumer Produce Evaluation (Tech. Report Number 30013030). These studies were compared the overall cooking performance of the Safe-T-element as compared to that of an electric coil and glass-ceramic stovetop. Results indicated that the Safe-T-element was slower than a standard electric burner by approximately 10-20% for most cooking procedures. Overall, cook times were increased approximately 30 seconds to two minutes. However, compared to the glass-ceramic stove, the Safe-T-element was equivalent or faster in various cooking procedures.

Furthermore, testing of deep-fat frying foods demonstrated longer cook times for the Safe-T-element, taking approximately 50% longer than the electric coils and 25% longer than the glass-ceramic stovetop. It is noted that research has shown that deep-fat frying of foods is the most dangerous type of cooking and the USFA recommends that deep-fat frying of foods should not be conducted on any stovetop technology. Overall, the appearance and consistency of the cooked food from all three devices appeared similar (Onspex, 2010)

CHAPTER THREE

METHODOLGY

The general methodology for this research was to select kitchen ranges of different cooktop technology to serve as the heat source for analyzing the potential ignition of a variety of common kitchen items. This section will discuss the heat sources and fuels selected for this research. Additional information can be found in Appendices A and H.

3.1 Heat Source

The objective of this study was to evaluate the potential for ignition of commonly found household kitchen items using four different types of residential kitchen ranges. The four different types of kitchen ranges that were evaluated consist of a glass-ceramic

cooktop range, an electric coil cooktop range, an electric coil cooktop range with a cast iron cover plate, and an Electric coil cooktop range with a temperature control sensor. Thermocouple data and heat flux gauges were used to characterize the temperature and heat output for the six-inch and eight-inch elements for each range.

The model and manufacturer of the ranges used for this research was selected in an attempt to find an electric coil cooktop range and glass-ceramic cooktop range that was similar in element configurations and size, price, energy output, and manufacturer. The General Electric (GE) electric range was the most similar to these requirements and was selected for this research. Both the electrical coil cooktop range and ceramic-glass cooktop range have six- and eight-inch diameter elements.

3.1.1 Ranges

The following section will provide general information regarding the electric ranges selected and used for this study. Additional specifications for the ranges are listed in Appendix A.

The GE electric coil cooktop range has four heating elements two eight-inch diameter elements and two six-inch diameter elements. The model number for the electric coil cooktop range is GE JBP23DRWW. This model is a 30" free-standing electric range with approximate dimensions 46.88 inch by 29.88 inch x 27.75 inch (HxWxD). The six-inch diameter element has a maximum output of 1500 watts and the eight-inch diameter element has a maximum output of 2600 watts. Six of these ranges were purchased and used for this study, three were used without any modifications and the other three had a Safe-T-element installed over the electric coil (Figures 3-4).

The ceramic-glass cooktop range was also manufactured by GE and has two six-inch diameter heating elements and two eight-inch diameter heating elements. The model number for the ceramic-glass cooktop range is GE JBS55DMWW. This model is a 30" free-standing range with approximate dimensions 46.88 inch by 29.88 inch x 27.75 inch (HxWxD). The six-inch diameter element has a maximum output of 1500 watts and the eight-inch diameter element has a maximum output of 2000 watts respectively. Three of these ranges were purchased and used for this study (Figures 3-4

Figure 3: (left) Electric Coil Cooktop Range - GE Model JBP23DRWW; (right) Electric Ceramic-Glass Cooktop Range - GE Model JBS55DMWW

The selection of these specific freestanding ranges was made because they satisfied most of the similarity requirements for this study. The dimensions, element size and configuration, manufacturer, and overall layout are identical. The one difference between the two ranges was the wattage output of the 8-inch diameter heating element.

The two six-inch diameter elements are identical in wattage, but the maximum output for the eight-inch diameter elements differed by 600 watts. Despite the difference in output for the eight-inch diameter heating element, these two ranges were still selected, because they were the closest matching set of ranges that were identified on the market. All test ranges operated on electric power supplies of 240 Volts.

In summary, the nine units being tested and compared to each other include (Figure 4):

- (3) Electric coil cooktop range manufactured by GE (Model: JBP23DRWW)
- (3) Electric ceramic-glass cooktop range manufactured by GE (Model: JBS55DMWW)
- (3)Electric coil cooktop range manufactured by GE (Model: JBP23DRWW) with a cast iron plate installed on top of both the 6 inch and 8 inch heating elements.
- (3) Electric coil cooktop range manufactured by GE (Model: JBP23DRWW) with temperature sensor technology attached to a cast iron plate that controls the maximum temperature output. The temperature sensor technology is a Safe-T element installed from Pioneering technology. Certified electricians installed these elements after being certified on the installation of the Safe-T-element by Pioneering technology.

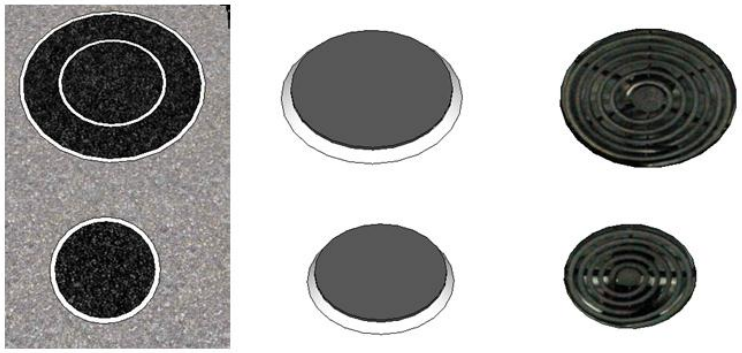


Figure 4: Four types of cooktop elements (left) ceramic-glass, (center) cast iron plate & temperature control sensor over coil, (right) coil element

3.1.2 Safe-T-element

The Safe-T-element is manufactured by Pioneering technology from Ontario, Canada (http://www.pioneeringtech.com/safe-t-element). The product brochure for the Safe-T-element lists the following functions and details about their product (Figure 5): "Each Safe-T-element® is an electronically controlled solid cover plate that is installed

on top of your existing stovetop burner. A patented control unit inside the stove controls the temperature of the plate cover allowing it to only reach a maximum of 350°C/662°F.

When the plate reaches a temperature of 350°C/662°F, it automatically shuts the stove off and conversely as it cools to just below 350°C/662°F the stovetop is turned on again. In this way the burner plate maintains a temperature of 350°C/662°F, more than enough for efficient and effective cooking, while not allowing household materials to ignite" (Pioneering Technology, 2012).

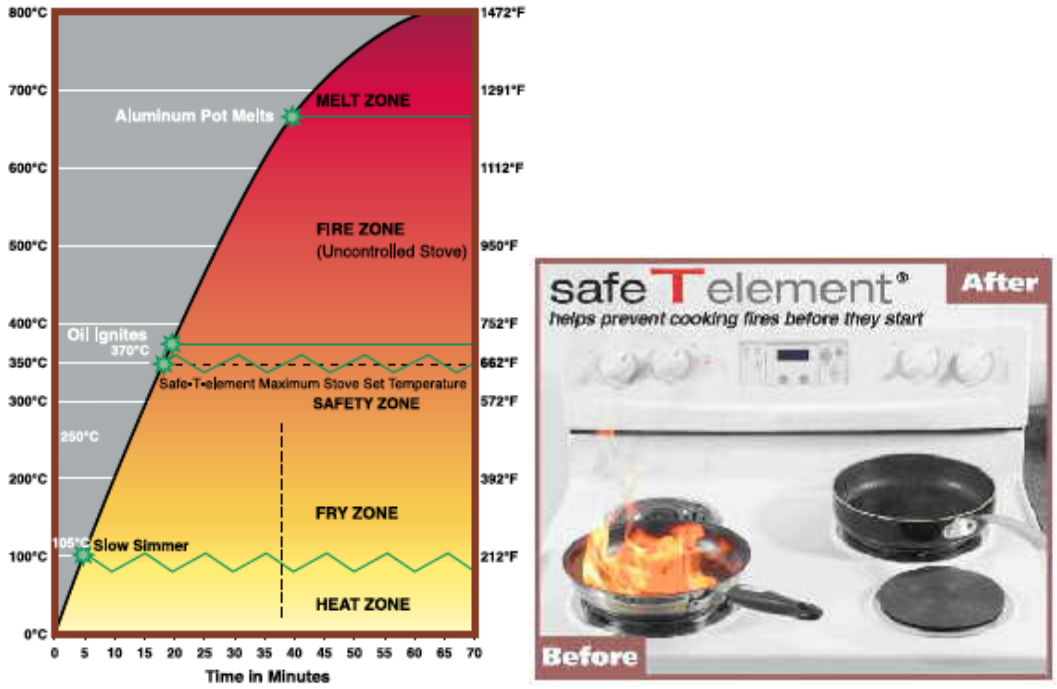


Figure 5: Time / Temperature Curve and Photograph of Safe-T-Element installed (source: product brochure for Safe-T-element) Source: Pioneering Technology. (2012). Safe-T-Element Product Brochure. Retrieved June 20, 2012, from:

Source: ***http://www.pioneeringtech.com/sites/default/files/STE-sellsheet-web%20%281%29.pdf.***

The Safe-T-element can be pre-installed on new ranges or retrofitted on existing ranges. Two service technicians from Pioneering technology traveled to EKU to train two certified electricians on how to install the Safe-T-element to the electric coil cooktops. This included a hands-on course, classroom instruction, and an online exam.

Both certified electricians sat through the course and completed the certification exam to become certified on installing the Safe-T-element. A Safe-T-element was installed onto the Electric coil cooktop range manufactured by GE (Model: JBP23DRWW) by these electricians. Both the six-inch diameter element and the eight-inch diameter element were installed.

3.2 Fuels

Common residential kitchen items were selected as the fuels for this series of tests based on the statistics of first fuels ignited in kitchen range fires, resulting in the selection of these nine common household fuel items (Ahrens, 2011):

1. Cardboard (Pizza box)
2. Dish Towel
3. Paper Towel
4. Canola Oil
5. Vegetable Oil
6. Cooking Utensil (Nylon Short Turner Spatula)
7. Kitchen Appliance (Toaster)
8. Storage Container
9. Corn Oil

The solid fuels in this research included corrugated paper (cardboard), cotton (dish towel), paper (paper towel), polypropylene (plastic toaster), nylon (spatula), and polyethylene (storage container). The solid fuels were placed directly on the heating element. As such, literature was reviewed to identify hot surface ignition temperatures to best characterize the fuels. However, there are limited studies available for hot surface ignition of the selected fuels. Therefore, this report lists the available autoignition temperatures (AIT) for each fuel as a means to characterize the solid fuels.

The liquid fuels in this research included canola oil, vegetable oil, and corn oil. One hundred and ten milliliters of the canola oil and vegetable oil fuels were placed in a one-quart, stainless steel saucepan (5.5 inch diameter) and then the pan was placed on the heating element. Twenty five milliliters of the corn oil was placed in an aluminum alloy

skillet (9 inch diameter) and then placed on the heating element. The appropriate ignition scenario for the liquid fuels is autoignition of the fuels, as there was no external ignition source present. Therefore, the AIT for each liquid fuel is listed below to characterize the liquid fuels.

The fuels are listed in this section according to the numerical order used above and will be the numerical order used to describe each test throughout the rest of this report. Additional information and photographs of the fuels can be found in Appendix H.

3.2.1 Corrugated Paper (Cardboard Pizza Box)

The cardboard material or corrugated paper was obtained from a commercial pizzeria (Little Caesars Pizza). Corrugated paper has been experimentally determined to have an ignition temperature of approximately 370^{o}C (Ohlemiller & Villa, 1991). The cardboard box was cut into six- and eight-inch diameter circles to fit directly on top of the six- and eight-inch elements. These cardboard box circles were placed directly on the element (Figure 6).

Figure 6: Orientation of corrugated paper (cardboard pizza box) fuel on heating element.

3.2.2 Cotton (Dish Towel)

The dish towel selected for this research was purchased from Walmart and is a Mainstays kitchen towel. It is fifteen inches wide and twenty-five inches long and is primarily constructed of cotton. Cotton has a reported AIT of approximately 250^{o}C (Babrauskas, 2003). The towel was folded over four times and centered directly on top of the element (Figure 7).

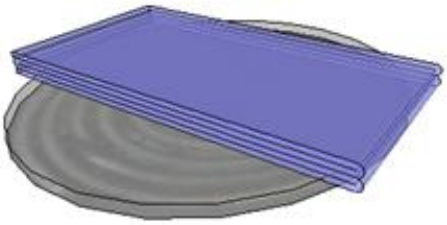


Figure 7: Orientation of dish towel on heating element

3.2.3 Paper (Paper Towel)

Sparkle brand paper towels were selected for the third fuel. Mowrer (2003) performed experiments to identify the minimum heat flux required for ignition of paper towels and found that paper towel was ignited at 30.6 kW/m^2. Babrauskas (2003) lists a range of measured AIT of various paper products between 123-240^{o}C. The full roll of paper towels, without any plastic covering, was centered horizontally on top of the element, lying flat extending across the heating element left to right in relation to the front of the range (Figure 8).

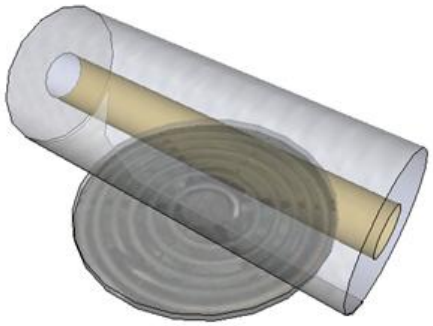


Figure 8: Orientation of paper towel roll on heating element

3.2.4 Canola oil

The fourth fuel used with this research was canola oil. Specifically, Land O' Lakes-all natural butter with canola oil was used. Babrauskas (2003) reports an AIT for canola oil ranging between 315-447^{o}C. A more recent study performed on the autoignition of cooking oils listed the AIT for canola oil as 424 ^{o}C (Buda-Ortins & Sunderland, 2010). A half-cup (~115 grams) of canola oil was placed into the stainless steel saucepan for each test (Figure 9).

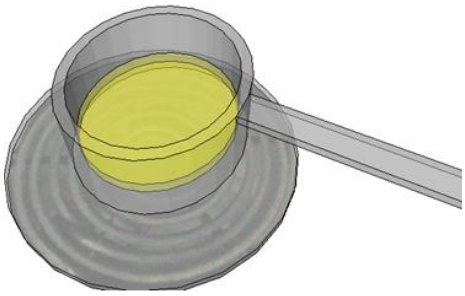


Figure 9: Orientation of saucepan with canola oil on heating element

3.2.5 Vegetable oil

Vegetable oil was the fifth fuel used in this research. The vegetable oil was purchased at Walmart and was the "Great Value" brand. The AIT for vegetable oil is listed as 406^{o}C (Buda-Ortins & Sunderland, 2010). A half-cup (~112 grams) of vegetable oil was placed into the saucepan for each test (Figure 10).

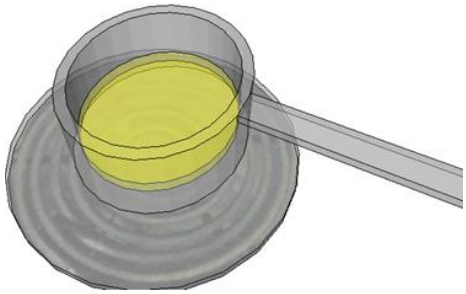


Figure 10: Orientation of saucepan with vegetable oil on heating element

3.2.6 Nylon (Short Turner Spatula-Cooking Utensil)

The cooking utensil used for this study was a Farberware-professional short turner spatula. It is constructed from Nylon. Nylon has a recorded AIT of approximately 328-500^{o}C (Babrauskas, 2003). Hot surface ignition temperatures for nylon based floor coverings have been reported as high as 660 ^{o}C (Babrauskas, 2003). The nylon spatula was placed directly on the heating element with the handle and base of the spatula in direct contact with the heating element (Figure 11).

Figure 11: Orientation of spatula on heating element

3.2.7 Polypropylene (Toaster-Kitchen Appliance)

The kitchen appliance selected for this research was a 2-slice toaster manufactured by Rival, Model 16041. The top and side panels of the appliance housing are constructed of plastic (polypropylene), while the base of the toaster and the internal mechanisms are constructed of metal. Babrauskas reports an AIT ranging between (325-440^{o}C). The toaster was centered in the upright position directly on the burner (Figure 12).

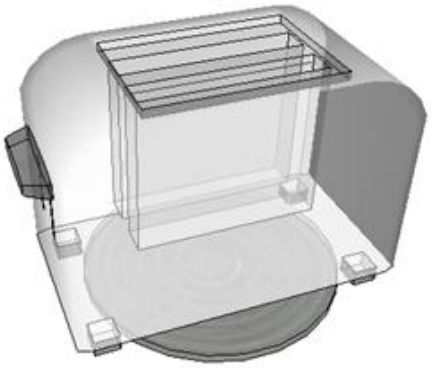


Figure 12: Orientation of toaster on heating element

3.2.8 Polyethylene (Food Storage Container)

The food storage container is a Takealongs® brand manufactured by Rubbermaid. The storage container has a square base approximately 5.5 inches in width and is constructed of low density polyethylene (LDPE) plastic. Babrauskas reports that polyethylene material has a recorded AIT between 349-457^{o}C (Babrauskas, 2003). The storage container was centered directly on the heating element (Figure 13).

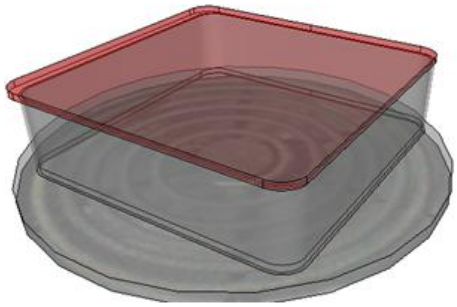


Figure 13: Orientation of food storage container on heating element

3.2.9 Corn oil

Corn oil was the ninth fuel used in this research. The corn oil was purchased at Walmart and was the "Great Value" brand. The AIT for corn oil is listed as 309^{o}C (Babrauskas, 2003). Twenty five milliliters (~ 21 grams) of corn oil was placed into the 9 inch diameter skillet for each test (Figure 14).

Figure 14: Orientation of skillet with corn oil on heating element

Table 1: Weight of fuels tested for both 6 and 8 inch heating elements

Fuel	Size	Total Weight/Volume of Fuel Tested	AIT
Cardboard (pizza box)	6"	10 grams	370 C
Cardboard (pizza box)	8"	16 grams	370 C
Cloth(dish towel)	6"	27 grams (four layers)	250 C
Cloth(dish towel)	8"	44 grams (four layers)	250 C
Paper (paper towel)	6"&	194 grams (same for both	123-240

	8”	heating elements)	C
Canola Oil	6”& 8”	114 grams (110 milliliters)	315-447 C
Vegetable Oil	6”& 8”	114 grams (110 milliliters)	406 C
Nylon	6”& 8”	46 grams (same for both heating elements)	328-500C
Polypropylene (Toaster)	6”& 8”	719 grams (same for both heating elements)	325-440 C
Polyethylene (Food Storage Container)	6”& 8”	46 grams (same for both heating elements)	349-456 C
Corn Oil	6”& 8”	21 grams (25 milliliters)	309C

3.3 Experimental Design

The following discussion outlines the experimental design utilized for this research, including the test facility, instrumentation, and test matrix. All nine fuels were tested using each type of cooktop. The six-inch and eight-inch diameter heating elements were used for each range and both heating elements were used to test all nine fuels. Each test was conducted using the high, medium, and low settings for each heating element. This resulted in a test matrix of 54 ignition tests for each type of cooktop.

Each test was documented using a systematic arrangement of thermocouples to record the temperature of the fuel (external and internal) and the heating element during the heating process. A thermal imaging camera and video camera also recorded each test.

The test were conducted using only the heating elements located on the left side of each type of cooktop technology. After completing each test the individual heating element was cleaned in a nondestructive manor to remove any residue from previous testing material. In the event that a heating element could not be cleaned without causing damage to the heating element it was then replaced with a heating element(s) from the same model and size from additional cooktop technologies purchased for the research testing.

3.3.1 Test Facility

All tests were conducted utilizing Eastern Kentucky University's Ashland Fire and Safety Laboratory located in Richmond, KY. The testing took place in the sprinkler flow room that is constructed of concrete walls and bar joist ceiling. The sprinkler flow room measurements are 34 feet wide (10.36 meters) X 31 feet 6 inches deep (9.6 meters) X 15 feet 6 inches high (4.72 meters). The room is constructed to enable small-scale tests and is equipped with a smoke ventilation system, as well as automatic and manual fire suppression systems. The ventilation system was only used to vent smoke after the tests were completed and was not in operation during any of the tests. During the testing the sprinkler flow room maintained an average of 78 degrees Fahrenheit (22 C) with 65 percent humidity. A backdrop was used to increase the effectiveness of the video and photographs taken throughout the tests (Figure 15).

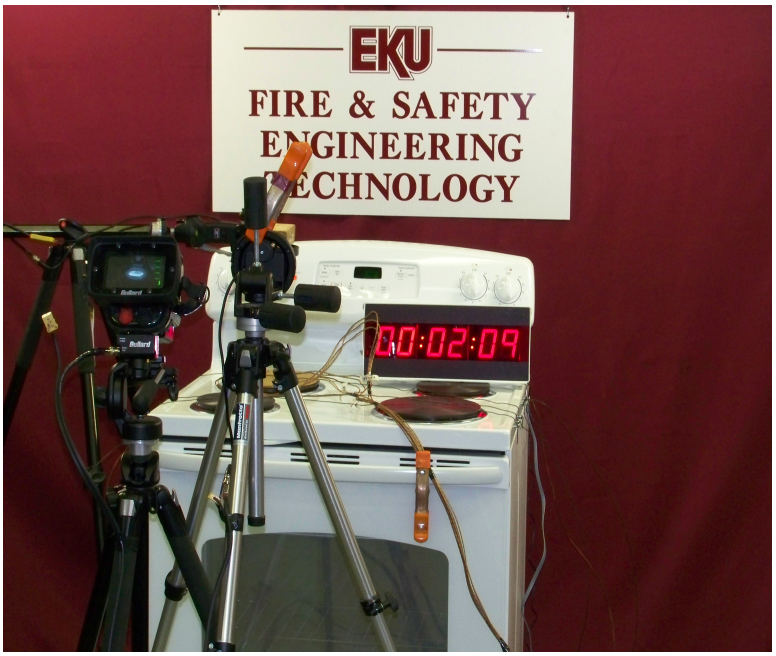


Figure 15: Experimental setup

3.3.2 Test Matrix

All nine fuels were tested using each type of cooktop. The six-inch and eight-inch diameter heating elements were used for each cooktop and both heating elements were used to test all nine fuels. Each test was conducted using the high, medium, and low settings for each heating element. This resulted in a test matrix of 54 ignition tests for each range. In order to organize this information each test was provided a unique alpha-numeric code as generated by the following setup: cooktop type | fuel | element diameter | temperature setting. The acronyms used for the cooktop types include ceramic-glass (CG), electric coil (EC), cast iron plate (IP), and the temperature control sensor (TS). The fuels will be listed in numerical order according to section 3.2 and repeated here: (1) cardboard (pizza box); (2) cotton (dish towel); (3) paper (paper towel); (4) canola oil; (5) vegetable oil; (6) nylon short turner spatula; (7) polypropylene (toaster); (8) polyethylene (storage container); (9)corn oil. The heating elements were listed according to their respective diameters, either given the number 6 or 8. The first letter of the temperature setting was used to identify the setting: 'H' for High, 'M' for Medium, and 'L' for Low. Finally, an additional repeatability test was performed for all four cooktop technologies for both the six-inch and eight-inch diameter heating elements on the high setting using

the cardboard fuel only. The additional tests were conducted to help determine if fuels shown similarity in test results using the same test parameters. The repeatability tests are identified with an asterisk at the end of the unique alpha-numeric code.

Each value in the test identification heading is separated by a period, for example if the ceramic-glass cooktop was used for corrugated paper on the six-inch diameter heating element with a setting of high, the following test identification number was used ***CG.1.6.H***. Table 1 provides a complete listing of the tests completed with the ceramic-glass cooktop range. Table 2 provides a complete listing of the tests completed with the electrical coil cooktop range. Table 3 provides a complete listing of the tests completed with the coil cooktop with the cast iron plate installed. Table 4 provides a complete listing of the tests completed with the coil cooktop with the thermostat operated plate installed.

Table 2: Ceramic-Glass Cooktop Range Test Matrix

Test Id	Cooktop Type	Fuel	Diameter	Setting
CG.1.6.L	Ceramic-Glass	Cardboard	6”	Low
CG.1.6.M	Ceramic-Glass	Cardboard	6”	Medium
CG.1.6.H	Ceramic-Glass	Cardboard	6”	High
CG.1.8.L	Ceramic-Glass	Cardboard	8”	Low
CG.1.8.M	Ceramic-Glass	Cardboard	8”	Medium
CG.1.8.H	Ceramic-Glass	Cardboard	8”	High
CG.1.6.H.*	Ceramic-Glass	Cardboard	6”	High
CG.1.8.H.*	Ceramic-Glass	Cardboard	8”	High
CG.2.6.L	Ceramic-Glass	Dish Towel	6”	Low
CG.2.6.M	Ceramic-Glass	Dish Towel	6”	Medium
CG.2.6.H	Ceramic-Glass	Dish Towel	6”	High
CG.2.8.L	Ceramic-Glass	Dish Towel	8”	Low
CG.2.8.M	Ceramic-Glass	Dish Towel	8”	Medium
CG.2.8.H	Ceramic-Glass	Dish Towel	8”	High
CG.3.6.L	Ceramic-Glass	Paper Towel	6”	Low
CG.3.6.M	Ceramic-Glass	Paper Towel	6”	Medium
CG.3.6.H	Ceramic-Glass	Paper Towel	6”	High
CG.3.8.L	Ceramic-Glass	Paper Towel	8”	Low
CG.3.8.M	Ceramic-Glass	Paper Towel	8”	Medium
CG.3.8.H	Ceramic-Glass	Paper Towel	8”	High
CG.4.6.L	Ceramic-Glass	Canola Oil	6”	Low
CG.4.6.M	Ceramic-Glass	Canola Oil	6”	Medium
CG.4.6.H	Ceramic-Glass	Canola Oil	6”	High

CG.4.8.L	Ceramic-Glass	Canola Oil	8”	Low
CG.4.8.M	Ceramic-Glass	Canola Oil	8”	Medium
CG.4.8.H	Ceramic-Glass	Canola Oil	8”	High
CG.5.6.L	Ceramic-Glass	Vegetable Oil	6”	Low
CG.5.6.M	Ceramic-Glass	Vegetable Oil	6”	Medium
CG.5.6.H	Ceramic-Glass	Vegetable Oil	6”	High
CG.5.8.L	Ceramic-Glass	Vegetable Oil	8”	Low
CG.5.8.M	Ceramic-Glass	Vegetable Oil	8”	Medium
CG.5.8.H	Ceramic-Glass	Vegetable Oil	8”	High
CG.6.6.L	Ceramic-Glass	Nylon spatula	6”	Low
CG.6.6.M	Ceramic-Glass	Nylon spatula	6”	Medium
CG.6.6.H	Ceramic-Glass	Nylon spatula	6”	High
CG.6.8.L	Ceramic-Glass	Nylon spatula	8”	Low
CG.6.8.M	Ceramic-Glass	Nylon spatula	8”	Medium
CG.6.8.H	Ceramic-Glass	Nylon spatula	8”	High
CG.7.6.L	Ceramic-Glass	Polypropylene	6”	Low
CG.7.6.M	Ceramic-Glass	Polypropylene	6”	Medium
CG.7.6.H	Ceramic-Glass	Polypropylene	6”	High
CG.7.8.L	Ceramic-Glass	Polypropylene	8”	Low
CG.7.8.M	Ceramic-Glass	Polypropylene	8”	Medium
CG.7.8.H	Ceramic-Glass	Polypropylene	8”	High
CG.8.6.L	Ceramic-Glass	Polyethylene	6”	Low
CG.8.6.M	Ceramic-Glass	Polyethylene	6”	Medium
CG.8.6.H	Ceramic-Glass	Polyethylene	6”	High
CG.8.8.L	Ceramic-Glass	Polyethylene	8”	Low
CG.8.8.M	Ceramic-Glass	Polyethylene	8”	Medium
CG.8.8.H	Ceramic-Glass	Polyethylene	8”	High
CG.9.6.L	Ceramic-Glass	Corn Oil	6”	Low
CG.9.6.M	Ceramic-Glass	Corn Oil	6”	Medium
CG.9.6.H	Ceramic-Glass	Corn Oil	6”	High
CG.9.8.L	Ceramic-Glass	Corn Oil	8”	Low
CG.9.8.M	Ceramic-Glass	Corn Oil	8”	Medium
CG.9.8.H	Ceramic-Glass	Corn Oil	8”	High

Table 3: Electric Coil Cooktop Test Matrix

Test Id	Cooktop Type	Fuel	Diameter	Setting
EC.1.6.L	Electric Coil	Cardboard	6”	Low
EC.1.6.M	Electric Coil	Cardboard	6”	Medium
EC.1.6.H	Electric Coil	Cardboard	6”	High
EC.1.8.L	Electric Coil	Cardboard	8”	Low
EC.1.8.M	Electric Coil	Cardboard	8”	Medium

EC.1.8.H	Electric Coil	Cardboard	8”	High
EC.1.6.H.*	Electric Coil	Cardboard	6”	High
EC.1.8.H.*	Electric Coil	Cardboard	8”	High
EC.2.6.L	Electric Coil	Dish Towel	6”	Low
EC.2.6.M	Electric Coil	Dish Towel	6”	Medium
EC.2.6.H	Electric Coil	Dish Towel	6”	High
EC.2.8.L	Electric Coil	Dish Towel	8”	Low
EC.2.8.M	Electric Coil	Dish Towel	8”	Medium
EC.2.8.H	Electric Coil	Dish Towel	8”	High
EC.3.6.L	Electric Coil	Paper Towel	6”	Low
EC.3.6.M	Electric Coil	Paper Towel	6”	Medium
EC.3.6.H	Electric Coil	Paper Towel	6”	High
EC.3.8.L	Electric Coil	Paper Towel	8”	Low
EC.3.8.M	Electric Coil	Paper Towel	8”	Medium
EC.3.8.H	Electric Coil	Paper Towel	8”	High
EC.4.6.L	Electric Coil	Canola Oil	6”	Low
EC.4.6.M	Electric Coil	Canola Oil	6”	Medium
EC.4.6.H	Electric Coil	Canola Oil	6”	High
EC.4.8.L	Electric Coil	Canola Oil	8”	Low
EC.4.8.M	Electric Coil	Canola Oil	8”	Medium
EC.4.8.H	Electric Coil	Canola Oil	8”	High
EC.5.6.L	Electric Coil	Vegetable Oil	6”	Low
EC.5.6.M	Electric Coil	Vegetable Oil	6”	Medium
EC.5.6.H	Electric Coil	Vegetable Oil	6”	High
EC.5.8.L	Electric Coil	Vegetable Oil	8”	Low
EC.5.8.M	Electric Coil	Vegetable Oil	8”	Medium
EC.5.8.H	Electric Coil	Vegetable Oil	8”	High
EC.6.6.L	Electric Coil	Nylon spatula	6”	Low
EC.6.6.M	Electric Coil	Nylon spatula	6”	Medium
EC.6.6.H	Electric Coil	Nylon spatula	6”	High
EC.6.8.L	Electric Coil	Nylon spatula	8”	Low
EC.6.8.M	Electric Coil	Nylon spatula	8”	Medium
EC.6.8.H	Electric Coil	Nylon spatula	8”	High
EC.7.6.L	Electric Coil	Polypropylene	6”	Low
EC.7.6.M	Electric Coil	Polypropylene	6”	Medium
EC.7.6.H	Electric Coil	Polypropylene	6”	High
EC.7.8.L	Electric Coil	Polypropylene	8”	Low
EC.7.8.M	Electric Coil	Polypropylene	8”	Medium
EC.7.8.H	Electric Coil	Polypropylene	8”	High
EC.8.6.L	Electric Coil	Polyethylene	6”	Low
EC.8.6.M	Electric Coil	Polyethylene	6”	Medium
EC.8.6.H	Electric Coil	Polyethylene	6”	High
EC.8.8.L	Electric Coil	Polyethylene	8”	Low
EC.8.8.M	Electric Coil	Polyethylene	8”	Medium
EC.8.8.H	Electric Coil	Polyethylene	8”	High

EC.9.6.L	Electric Coil	Corn Oil	6”	Low
EC.9.6.M	Electric Coil	Corn Oil	6”	Medium
EC.9.6.H	Electric Coil	Corn Oil	6”	High
EC.9.8.L	Electric Coil	Corn Oil	8”	Low
EC.9.8.M	Electric Coil	Corn Oil	8”	Medium
EC.9.8.H	Electric Coil	Corn Oil	8”	High

Table 4: Cast Iron Plate- Coil Cooktop Test Matrix

Test Id	Cooktop Type	Fuel	Diameter	Setting
IP.1.6.L	Cast Iron Plate	Cardboard	6”	Low
IP.1.6.M	Cast Iron Plate	Cardboard	6”	Medium
IP.1.6.H	Cast Iron Plate	Cardboard	6”	High
IP.1.8.L	Cast Iron Plate	Cardboard	8”	Low
IP.1.8.M	Cast Iron Plate	Cardboard	8”	Medium
IP.1.8.H	Cast Iron Plate	Cardboard	8”	High
IP.1.6.H.*	Cast Iron Plate	Cardboard	6”	High
IP.1.8.H.*	Cast Iron Plate	Cardboard	8”	High
IP.2.6.L	Cast Iron Plate	Dish Towel	6”	Low
IP.2.6.M	Cast Iron Plate	Dish Towel	6”	Medium
IP.2.6.H	Cast Iron Plate	Dish Towel	6”	High
IP.2.8.L	Cast Iron Plate	Dish Towel	8”	Low
IP.2.8.M	Cast Iron Plate	Dish Towel	8”	Medium
IP.2.8.H	Cast Iron Plate	Dish Towel	8”	High
IP.3.6.L	Cast Iron Plate	Paper Towel	6”	Low
IP.3.6.M	Cast Iron Plate	Paper Towel	6”	Medium
IP.3.6.H	Cast Iron Plate	Paper Towel	6”	High
IP.3.8.L	Cast Iron Plate	Paper Towel	8”	Low
IP.3.8.M	Cast Iron Plate	Paper Towel	8”	Medium
IP.3.8.H	Cast Iron Plate	Paper Towel	8”	High
IP.4.6.L	Cast Iron Plate	Canola Oil	6”	Low
IP.4.6.M	Cast Iron Plate	Canola Oil	6”	Medium
IP.4.6.H	Cast Iron Plate	Canola Oil	6”	High
IP.4.8.L	Cast Iron Plate	Canola Oil	8”	Low
IP.4.8.M	Cast Iron Plate	Canola Oil	8”	Medium
IP.4.8.H	Cast Iron Plate	Canola Oil	8”	High
IP.5.6.L	Cast Iron Plate	Vegetable Oil	6”	Low
IP.5.6.M	Cast Iron Plate	Vegetable Oil	6”	Medium
IP.5.6.H	Cast Iron Plate	Vegetable Oil	6”	High
IP.5.8.L	Cast Iron Plate	Vegetable Oil	8”	Low
IP.5.8.M	Cast Iron Plate	Vegetable Oil	8”	Medium
IP.5.8.H	Cast Iron Plate	Vegetable Oil	8”	High
IP.6.6.L	Cast Iron Plate	Nylon spatula	6”	Low
IP.6.6.M	Cast Iron Plate	Nylon spatula	6”	Medium

IP.6.6.H	Cast Iron Plate	Nylon spatula	6”	High
IP.6.8.L	Cast Iron Plate	Nylon spatula	8”	Low
IP.6.8.M	Cast Iron Plate	Nylon spatula	8”	Medium
IP.6.8.H	Cast Iron Plate	Nylon spatula	8”	High
IP.7.6.L	Cast Iron Plate	Polypropylene	6”	Low
IP.7.6.M	Cast Iron Plate	Polypropylene	6”	Medium
IP.7.6.H	Cast Iron Plate	Polypropylene	6”	High
IP.7.8.L	Cast Iron Plate	Polypropylene	8”	Low
IP.7.8.M	Cast Iron Plate	Polypropylene	8”	Medium
IP.7.8.H	Cast Iron Plate	Polypropylene	8”	High
IP.8.6.L	Cast Iron Plate	Polyethylene	6”	Low
IP.8.6.M	Cast Iron Plate	Polyethylene	6”	Medium
IP.8.6.H	Cast Iron Plate	Polyethylene	6”	High
IP.8.8.L	Cast Iron Plate	Polyethylene	8”	Low
IP.8.8.M	Cast Iron Plate	Polyethylene	8”	Medium
IP.8.8.H	Cast Iron Plate	Polyethylene	8”	High
IP.9.6.L	Cast Iron Plate	Corn Oil	6”	Low
IP.9.6.M	Cast Iron Plate	Corn Oil	6”	Medium
IP.9.6.H	Cast Iron Plate	Corn Oil	6”	High
IP.9.8.L	Cast Iron Plate	Corn Oil	8”	Low
IP.9.8.M	Cast Iron Plate	Corn Oil	8”	Medium
IP.9.8.H	Cast Iron Plate	Corn Oil	8”	High

Table 5: Thermostat Operated Plate- Coil Cooktop Test Matrix

Test Id	Cooktop Type	Fuel	Diameter	Setting
TS.1.6.L	Temp-Sensor	Cardboard	6”	Low
TS.1.6.M	Temp Sensor	Cardboard	6”	Medium
TS.1.6.H	Temp Sensor	Cardboard	6”	High
TS.1.8.L	Temp Sensor	Cardboard	8”	Low
TS.1.8.M	Temp Sensor	Cardboard	8”	Medium
TS.1.8.H	Temp Sensor	Cardboard	8”	High
TS.1.6.H.*	Temp Sensor	Cardboard	6”	High
TS.1.8.H.*	Temp Sensor	Cardboard	8”	High
TS.2.6.L	Temp Sensor	Dish Towel	6”	Low
TS.2.6.M	Temp Sensor	Dish Towel	6”	Medium
TS.2.6.H	Temp Sensor	Dish Towel	6”	High
TS.2.8.L	Temp Sensor	Dish Towel	8”	Low
TS.2.8.M	Temp Sensor	Dish Towel	8”	Medium
TS.2.8.H	Temp Sensor	Dish Towel	8”	High
TS.3.6.L	Temp Sensor	Paper Towel	6”	Low
TS.3.6.M	Temp Sensor	Paper Towel	6”	Medium
TS.3.6.H	Temp Sensor	Paper Towel	6”	High
TS.3.8.L	Temp Sensor	Paper Towel	8”	Low

TS.3.8.M	Temp Sensor	Paper Towel	8”	Medium
TS.3.8.H	Temp Sensor	Paper Towel	8”	High
TS4.6.L	Temp Sensor	Canola Oil	6”	Low
TS.4.6.M	Temp Sensor	Canola Oil	6”	Medium
TS.4.6.H	Temp Sensor	Canola Oil	6”	High
TS.4.8.L	Temp Sensor	Canola Oil	8”	Low
TS.4.8.M	Temp Sensor	Canola Oil	8”	Medium
TS.4.8.H	Temp Sensor	Canola Oil	8”	High
TS.5.6.L	Temp Sensor	Vegetable Oil	6”	Low
TS.5.6.M	Temp Sensor	Vegetable Oil	6”	Medium
TS.5.6.H	Temp Sensor	Vegetable Oil	6”	High
TS.5.8.L	Temp Sensor	Vegetable Oil	8”	Low
TS.5.8.M	Temp Sensor	Vegetable Oil	8”	Medium
TS.5.8.H	Temp Sensor	Vegetable Oil	8”	High
TS.6.6.L	Temp Sensor	Nylon spatula	6”	Low
TS.6.6.M	Temp Sensor	Nylon spatula	6”	Medium
TS.6.6.H	Temp Sensor	Nylon spatula	6”	High
TS.6.8.L	Temp Sensor	Nylon spatula	8”	Low
TS.6.8.M	Temp Sensor	Nylon spatula	8”	Medium
TS.6.8.H	Temp Sensor	Nylon spatula	8”	High
TS.7.6.L	Temp Sensor	Polypropylene	6”	Low
TS.7.6.M	Temp Sensor	Polypropylene	6”	Medium
TS.7.6.H	Temp Sensor	Polypropylene	6”	High
TS.7.8.L	Temp Sensor	Polypropylene	8”	Low
TS.7.8.M	Temp Sensor	Polypropylene	8”	Medium
TS.7.8.H	Temp Sensor	Polypropylene	8”	High
TS.8.6.L	Temp Sensor	Polyethylene	6”	Low
TS.8.6.M	Temp Sensor	Polyethylene	6”	Medium
TS.8.6.H	Temp Sensor	Polyethylene	6”	High
TS.8.8.L	Temp Sensor	Polyethylene	8”	Low
TS.8.8.M	Temp Sensor	Polyethylene	8”	Medium
TS.8.8.H	Temp Sensor	Polyethylene	8”	High
TS.9.6.L	Temp Sensor	Corn Oil	6”	Low
TS.9.6.M	Temp Sensor	Corn Oil	6”	Medium
TS.9.6.H	Temp Sensor	Corn Oil	6”	High
TS.9.8.L	Temp Sensor	Corn Oil	8”	Low
TS.9.8.M	Temp Sensor	Corn Oil	8”	Medium
TS.9.8.H	Temp Sensor	Corn Oil	8”	High

3.3.3 Instrumentation

Instrumentation used in experiments is described in this section. The specific thermocouple locations for each test varied based on the fuels evaluated and will be specifically addressed in the thermocouple section. In addition to the instrumentation recorded during the ignition tests, preliminary tests were completed in an attempt to characterize the heat output for each heating element, which included rate of rise temperature measurements and heat flux.

Systematic arrangements of thermocouples were used to record changes in temperature during each test at a cycle rate of 3 seconds. Specifications regarding the thermocouples used during these test can be found in below (Table 6).

Table 6: Thermocouple Specifications

Type	K
Minimum temperature (C)	-73 (C)
Maximum temperature (C)	900 (C)
Gauge	20 gauge
OD	0.060 inch x 0.106 inch
Inner insulation	Glass Braid
Outer insulation	Glass Braid
Wire	Solid
Error limit	+/- 2% reading from -200 to -110 C ; from +/- 2.2 C from -110 to 285 C; +/- 0.75% reading from 285 to 1250 C.

3.3.3.1 Thermocouple placement

Thermocouples were used to characterize the temperature between the heating element and the fuel, as well as within each fuel. All thermocouples were constructed of bare bead TCs that were 20Ga Type K with glass insulation. The first three thermocouples for all solid fuels (TC0, TC1, and TC2) were located against the heating element beneath the fuel, with the nylon spatula being the only exception. The first three thermocouples for all fuels tested in pans (TC0, TC1 and TC2) were located on the outside edge of the pan and against the heating element The remaining thermocouples varied within the fuels dependent on the fuel configuration and are discussed in sections 3.3.3.1.1 – 3.3.3.1.8 (Figures 16-24).

3.3.3.1.1 Cardboard

The first three thermocouples were placed beneath the fuel and against the heating element (TC0, TC1, TC2). The next row of thermocouples (TC3-TC5) was placed in the center of the cardboard box above the locations of TC0, TC1, and TC2. The last row of thermocouples (TC6-TC8) was placed on the top of the corrugated paper (Figure 16).

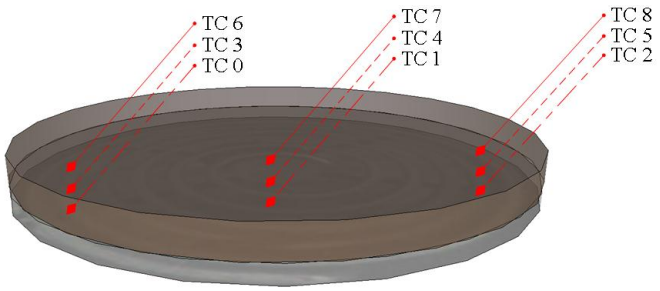


Figure 16: TC placement for corrugated paper (cardboard box): (left) isometric view; (right) elevation view

3.3.3.1.2 Dish Towel

The first three thermocouples were placed beneath the fuel and against the heating element (TC0, TC1, TC2). The next row of thermocouples (TC3-TC5) was placed near the center of the dish towel above TC0, TC1, and TC2. The last row of thermocouples (TC6-TC8) was placed along the top of the dish towel (Figure 17).

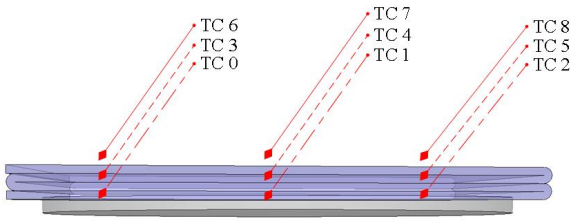


Figure 17: TC placement for dish towel (cotton)

3.3.3.1.3 Paper Towel

The first three thermocouples were placed beneath the fuel and against the heating element (TC0, TC1, TC2). The next row of thermocouples (TC3-TC5) was placed in the

center of the cardboard cylinder inside the paper towel roll. The last row of thermocouples (TC6-TC8) was placed along the top of the paper towel roll (Figure 18).

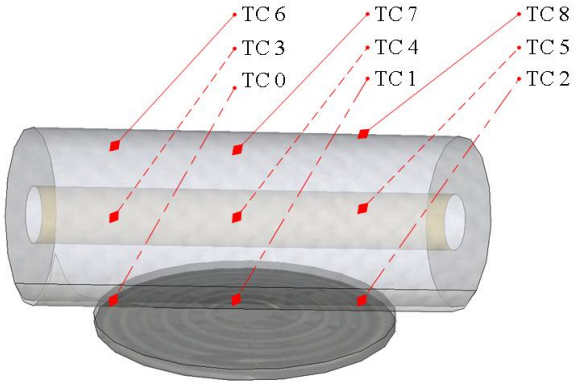


Figure 18: TC placement for paper towel roll

3.3.3.1.4 Canola Oil

The first three thermocouples were placed on the outside edge of the pan and against the heating element (TC0, TC1, TC2). The next row of thermocouples (TC3-TC5) was placed near the center of the saucepan. The last row of thermocouples (TC6-TC8) was placed above the liquid level of the fuel (Figure 19).

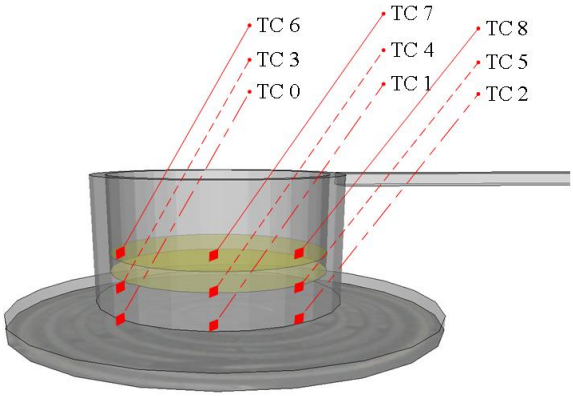


Figure 19: TC placement for canola oil

3.3.3.1.5 Vegetable Oil

The first three thermocouples were placed on the outside edge of the pan and against the heating element (TC0, TC1, TC2). The next row of thermocouples (TC3-TC5) was placed near the center of the saucepan. The last row of thermocouples (TC6-TC8) was placed above the liquid level of the fuel (Figure 20).

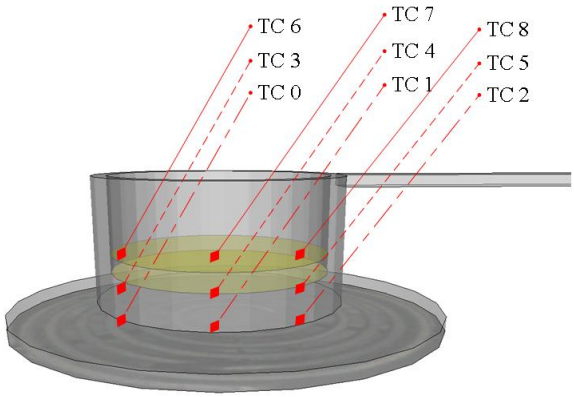


Figure 20: TC placement for vegetable oil

3.3.3.1.6 Nylon Spatula

The first thermocouple (TC0) was placed beneath the spatula end against the heating element. The second thermocouple (TC1) was placed along the top of the spatula above TC0. The third thermocouple (TC2) was placed beneath the handle end against the heating element. The fourth thermocouple (TC3) was placed along the top of the handle above TC2 (Figure 21).

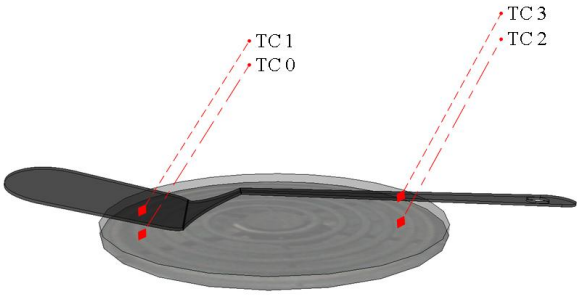


Figure 21: TC placement for nylon spatula

3.3.3.1.7 Toaster (Polypropylene)

The first three thermocouples were placed beneath the fuel and against the heating element (TC0, TC1, TC2). The next row of thermocouples (TC3-TC5) was placed near the center of the toaster. The last row of thermocouples (TC6-TC8) was placed along the top of the toaster (Figure 22).

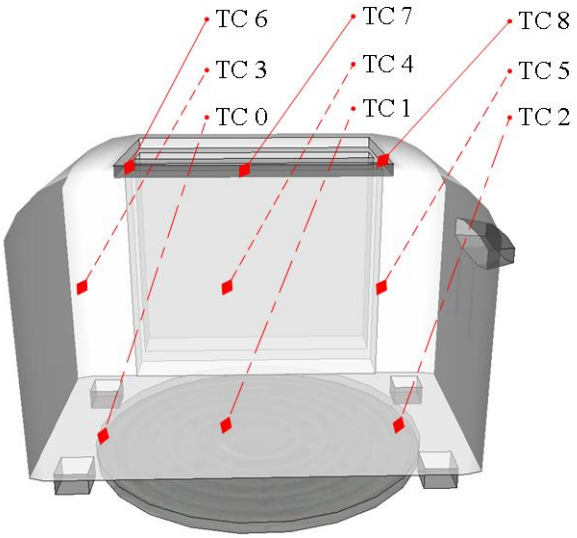


Figure 22: TC placement for toaster

3.3.3.1.8 Food Storage Container (Polyethylene)

The first three thermocouples were placed beneath the fuel and against the heating element (TC0, TC1, TC2). The next row of thermocouples (TC3-TC5) was placed in the center of the food storage container. The last row of thermocouples (TC6-TC8) was placed along the top of the food storage container (Figure 23).

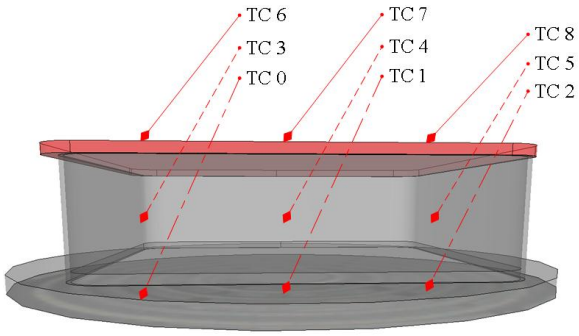


Figure 23: TC placement for food storage container

3.3.3.1.9 Corn Oil

The first three thermocouples were placed on the outside edge of the pan and against the heating element (TC0, TC1, TC2). The next row of thermocouples (TC3-TC5) was placed near the center of the skillet. The last row of thermocouples (TC6-TC8) was placed above the liquid level of the fuel (Figure 24).

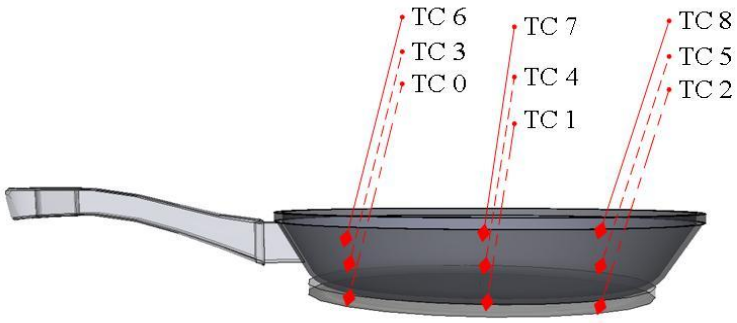


Figure 24: TC placement Corn Oil

3.3.3.2 Heat Flux Transducer

Heat flux transducers (radiometers) were used to help characterize the heat flux emitted from the heating element. Each heating element was evaluated at low, medium, and high settings with a heat flux transducer placed approximately 0.75 inch above the heating element. Convective and radiant heat transfer was measured with a water cooled, Schmidt-Boelter type heat flux transducer. One limitation of this method to characterize the heat output is that the transducer is water-cooled and therefore does not take into account conductive heat transfer. This introduces significant uncertainty with this measurement, as conduction heat transfer is a significant portion of the total heat flux in this scenario due to the hot surface and direct contact with the fuels. Nevertheless, it is one of the methods used in this study employed to evaluate the heat output from the heating elements. Due to time constraints, this portion of the study will be published later as part of the MS thesis work of Corey Hanks and will not be presented in this report.

3.3.3.3 Thin-Skin Calorimeters (TSC)

The heat output for each heating element for all ranges was recorded for the high, medium, and low settings using three thin-skin calorimeters (TSC). Thin-skin calorimeters (TSC) were used to measure the incident heat flux on a surface as outlined in ASTM E459-05 (Alston, 2004). TSC data was collected for each cooktop and was calibrated with a constant heat flux from a radiant heat source and its Schmidt-Boelter type heat flux transducer as a reference. The use of TSC enabled a more accurate analysis

of the heat output for the hot surface of each heating element. The TSC output units will be provided as a heat flux (kW/m^2). It was employed in this testing to ensure that conduction heat transfer would be accounted for in the total heat flux that each fuel would be exposed to during each ignition experiment. Three TSC measuring 2 inches x 2 inches were place directly on each diameter heating element (Figure 25). The results can be found in Appendix B.

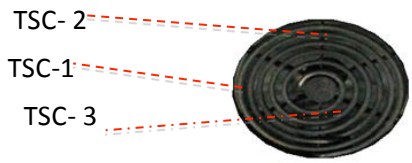


Figure 25: TSC location for total heat output measurements

3.3.3.4 Rate of Rise Temperature Measurements

The rate of temperature rise was recorded for each cooktop type, each heating element diameter, and temperature setting. Three thermocouples were placed directly on each diameter heating element and each cooktop type, so the maximum temperatures and rate of temperature rise could be recorded (Figure 26). The results can be found in Appendix C.

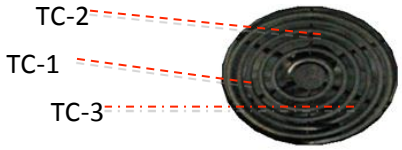


Figure 26: TC location for rate of rise temperature measurements

3.3.3.5 Videography and Photography

The events of each test were documented using video cameras. Two video cameras and an infrared (thermal imaging) camera were used for each test. All camera feeds were digitally recorded. One standard video camera and the Bullard IR T4MAX IR camera were placed in front of the cooktop and recorded each test. One standard video camera was placed directly above the range viewing the top of the fuel for each test (Figure 27). Additionally, photographs were taken before, during, and after each test.

Figure 27: Line of Sight for Test Videography

CHAPTER FOUR

RESEARCH FINDINGS

This section details the ignition results of each cooktop and fuel. There are a total of 54 tests for each cooktop (9 fuels, 3 settings, 2 heating element diameters), resulting in a total of 216 tests completed for this study. The organization of this section includes a summary of results for each test separated by the cooktop and then the fuel evaluated. Ignition was for purposes of these test was the presence of flaming combustion. Additional data can be found in the appendices.

4.1 Rate of Temperature Rise Results and Thin-Skin Calorimeter Results

Table 4 provides the maximum temperatures achieved by each cooktop type based on results from the highest temperature recorded by Thin Skin Calorimeter (TSC). As was expected, the cooktop with the cast iron plate installed consistently had a slower rate of temperature rise as compared to the other cooktop types (Figures 28-29). When the cast iron plate was installed, it took 13 minutes and 8 minutes more to reach its maximum temperature on the high setting with the respective 6-inch and 8-inch diameter heating elements. The temperature-limiting sensor reached substantially lower temperatures as designed. The values are provided as a range of temperatures based on the three-thermocouple locations (Figure 26). The full results of this analysis can be found in Appendix C

Table 7: Maximum Temperature Ranges Achieved by Heating Elements

Diameter	Setting	Ceramic-Glass Temp (°C)	Electric Coil Temp (°C)	Cast Iron Plate Temp (°C)	Temperature-Limiting Sensor Temp (°C)
6”	High	451-664	542-731	467-652	312-370
	Medium	405-567	338-465	302-423	314-353
	Low	150-211	28-102	63-78	67-70
8”	High	482-645	564-743	523-689	320-370
	Medium	390-529	370-441	289-382	312-350
	Low	141-186	42-147	54-65	105-107

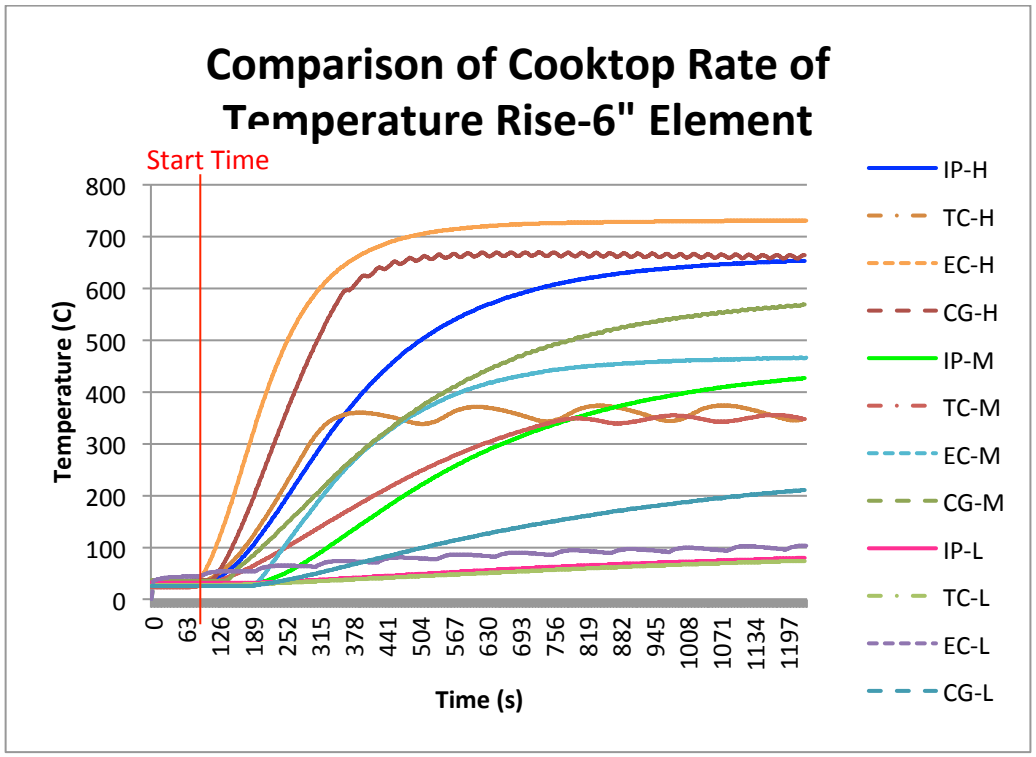


Figure 28: Rate of Temperature Rise-Cooktop Type Comparison (6" diameter heating element)

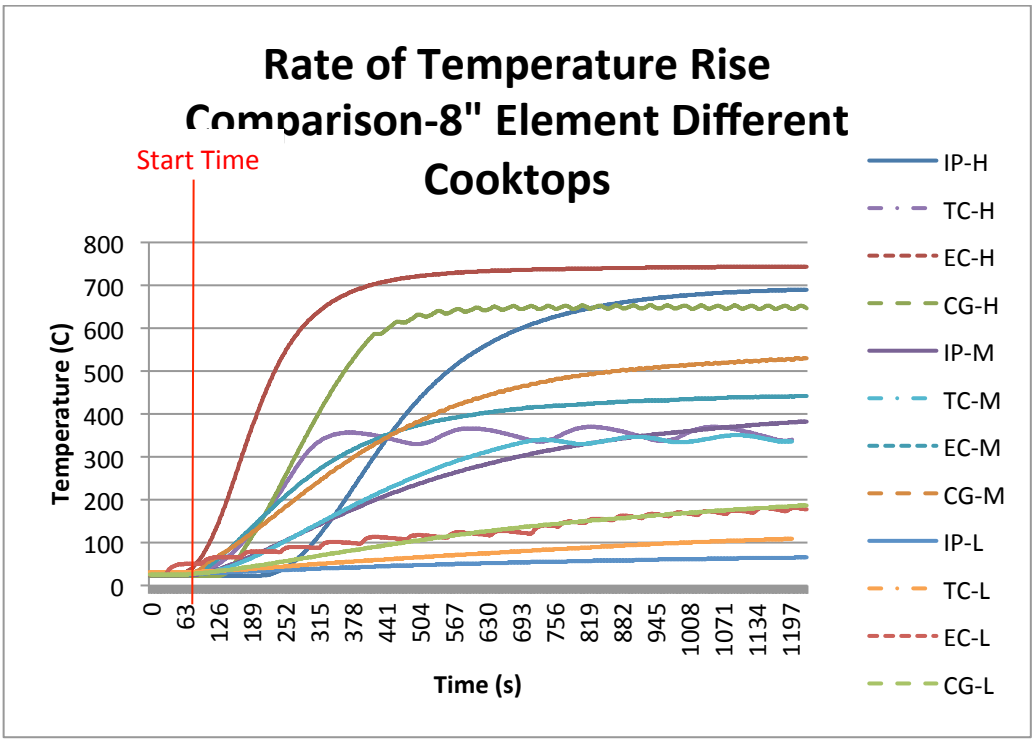


Figure 29: Rate of Temperature Rise-Cooktop Type Comparison (8" diameter heating element)

Three thin-skin calorimeters were employed in this testing to establish the incident heat flux from each heating element. The range of maximum incident heat fluxes achieved with each heating element is listed in table 8. The full results of this analysis can be found in Appendix B.

Table 8: Maximum Incident Heat Flux Ranges Achieved by Heating Elements

Diameter	Setting	Ceramic-Glass Heat Flux (kW/m^2)	Electric Coil Heat Flux (kW/m^2)	Cast Iron Plate Heat Flux (kW/m^2)	Temperature-Limiting Sensor Heat Flux (kW/m^2)
6”	High	27-62	35-72	25-50	13-22
	Medium	19-42	14-26	13-24	12-16
	Low	4-9	0.5-2.5	1.7-2.5	1.9-2.0
8”	High	25-60	39-79	32-63	13-22
	Medium	20-39	14-24	13-20	12-16
	Low	4-7	1.5-3.0	1.4-1.75	3.0-3.25

4.2 Ceramic-Glass Cooktop Range Results: Selected Observations

This section provides tables (Tables 9-17) that summarize the results for each ignition test, including the general conditions for the individual fuels that were evaluated with the ceramic-glass cooktop range. Below each table is a brief discussion regarding the selected observations witnessed during each test. The thermocouple data for each test can be found in Appendix D.

Table 9: Ignition Results of Ceramic-Glass cooktop and cardboard fuel

Test Id	Fuel	Diameter	Setting	Time (min:sec)	Ignition (Yes/No)	Time to Ignition (min:sec)
CG.1.6.L	Cardboard	6″	Low	25:00	No	
CG.1.6.M	Cardboard	6″	Medium	9:00	Yes	5:00
CG.1.6.H	Cardboard	6″	High	2:30	Yes	2:30
CG.1.6.H.*	Cardboard	6″	High	3:37	Yes	3:37
CG.1.8.L	Cardboard	8″	Low	25:00	No	
CG.1.8.M	Cardboard	8″	Medium	7:07	Yes	7:07
CG.1.8.H	Cardboard	8″	High	2:33	Yes	2:33
CG.1.8.H.*	Cardboard	8″	High	3:33	Yes	3:33

CG.1.6.H: The test conducted using the Electric Ceramic-Glass Cooktop Appliance with the corrugated paper (cardboard pizza box) using the 6-inch diameter heating element set to the high setting, resulted in flaming ignition in 2 minutes 30 seconds. At the time of ignition, the thermocouples located between the element and the fuel recorded the following temperatures: TC-0=364^{o}C, TC-1=318 ^{o}C, TC-2=300 ^{o}C.

CG.1.6.H.*: The repeat test conducted using the Electric Ceramic-Glass Cooktop Appliance with the corrugated paper (cardboard pizza box) using the 6-inch diameter heating element set to the high setting, resulted in flaming ignition in 3 minutes 37 seconds. At the time of ignition, the thermocouples located between the element and the fuel recorded the following temperatures. It is believed that the TC recordings were so high prior to ignition due to the fuel being consumed by smoldering combustion prior to ignition and ignition only occurred once the fuel began to break apart and oxygen was allowed to mix with fuel: TC-0=646^{o}C, TC-1=668^{o}C, TC-2=597 ^{o}C.

CG.1.6.M: The test conducted using the Electric Ceramic-Glass Cooktop Appliance with the corrugated paper (cardboard pizza box) using the 6-inch diameter heating element set

to the medium setting, resulted in flaming ignition in 5 minutes. At the time of ignition, the thermocouples located between the element and the fuel recorded the following temperatures: TC-0=315 ^{o}C, TC-1=304 ^{o}C, TC-2=357 ^{o}C.

CG.1.6.L: The test conducted using the Electric Ceramic-Glass Cooktop Appliance with the corrugated paper (cardboard pizza box) using the 6-inch diameter heating element set to the low setting after a 25-minute test resulted in no flaming ignition.

CG.1.8.H: The test conducted using the Electric Ceramic-Glass Cooktop Appliance with the corrugated paper (cardboard pizza box) using the 8-inch diameter heating element set to the high setting, resulted in flaming ignition in 2 minutes 33 seconds. At the time of ignition, the thermocouples located between the element and the fuel recorded the following temperatures: TC-0=518^{o}C, TC-1=488^{o}C, TC-2=378 ^{o}C.

CG.1.8.H.*: The repeat test conducted using the Electric Ceramic-Glass Cooktop Appliance with the corrugated paper (cardboard pizza box) using the 8-inch diameter heating element set to the high setting, resulted in flaming ignition in 3 minutes 33 seconds. At the time of ignition, the thermocouples located between the element and the fuel recorded the following temperatures. It is believed that the TC recordings were so high prior to ignition due to the fuel being consumed by smoldering combustion prior to ignition and ignition only occurred once the fuel began to break apart and oxygen was allowed to mix with fuel: TC-0=587^{o}C, TC-1=616^{o}C, TC-2=503 ^{o}C.

CG.1.8.M: The test conducted using the Electric Ceramic-Glass Cooktop Appliance with the corrugated paper (cardboard pizza box) using the 8-inch diameter heating element set to the medium setting, resulted in flaming ignition in 7 minutes 7 seconds. At the time of ignition, the thermocouples located between the element and the fuel recorded the following temperatures: TC-0=427 ^{o}C, TC-1=388^{o}C, TC-2=387^{o}C.

CG.1.8.L: The test conducted using the Electric Ceramic-Glass Cooktop Appliance with the corrugated paper (cardboard pizza box) using the 8-inch diameter heating element set to the low setting after a 25-minute test resulted in no flaming ignition.

Table 10: Ignition Results of Ceramic-Glass Cooktop and the dish towel

Test Id	Fuel	Diameter	Setting	Time (min:sec)	Ignition (Yes/No)	Time to Ignition (min:sec)
CG.2.6.L	Dish Towel	6"	Low	25:00	No	
CG.2.6.M	Dish Towel	6"	Medium	12:09	Yes	12:09
CG.2.6.H	Dish Towel	6"	High	2:30	Yes	2:30
CG.2.8.L	Dish Towel	8"	Low	25:00	No	
CG.2.8.M	Dish Towel	8"	Medium	12:00	Yes	12:00
CG.2.8.H	Dish Towel	8"	High	3:26	Yes	3:26

CG.2.6.H: The test conducted using the Electric Ceramic-Glass Cooktop Appliance with the cotton (dish towel) using the 6-inch diameter heating element set to the high setting, resulted in flaming ignition in 3 minutes 20 seconds. At the time of ignition, the thermocouples located between the element and the fuel recorded the following temperatures: TC-0=172^{o}C, TC-1=429 ^{o}C, TC-2=284^{o}C.

CG.2.6.M: The test conducted using the Electric Ceramic-Glass Cooktop Appliance with the cotton (dish towel) using the 6-inch diameter heating element set to the medium setting, resulted in flaming ignition in 12 minutes 9 seconds. At the time of ignition, the thermocouples located between the element and the fuel recorded the following temperatures: TC-0=305^{o}C, TC-1=284^{o}C, TC-2=442^{o}C.

CG.2.6.L: The test conducted using the Electric Ceramic-Glass Cooktop Appliance with the cotton (dish towel) using the 6-inch diameter heating element set to the low setting after a 25-minute test resulted in no flaming ignition.

CG.2.8.H: The test conducted using the Electric Ceramic-Glass Cooktop Appliance with the cotton (dish towel), using the 8-inch diameter heating element set to the high setting, resulted in flaming ignition in 3 minutes 26 seconds. At the time of ignition, the thermocouples located between the element and the fuel recorded the following temperatures: TC-0=500^{o}C, TC-1=288 ^{o}C, TC-2=419^{o}C.

CG.2.8.M: The test conducted using the Electric Ceramic-Glass Cooktop Appliance with the cotton (dish towel), using the 8-inch diameter heating element, set to the medium setting, resulted in flaming ignition in 12 minutes. At the time of ignition, the

thermocouples located between the element and the fuel recorded the following temperatures: TC-0=309^{o}C, TC-1=255^{o}C, TC-2=239^{o}C.

CG.2.8.L: The test conducted using the Electric Ceramic-Glass Cooktop Appliance with the cotton (dish towel) using the 8-inch diameter heating element set to the low setting after a 25-minute test resulted in no flaming ignition.

Table11: Ignition Results of Ceramic-Glass Cooktop and Paper Towel

Test Id	Fuel	Diameter	Setting	Time (min:sec)	Ignition (Yes/No)	Time to Ignition (min:sec)
CG.3.6.L	Paper Towel	6″	Low	30:00	No	
CG.3.6.M	Paper Towel	6″	Medium	18:57	Yes	18:57
CG.3.6.H	Paper Towel	6″	High	2:36	Yes	2:36
CG.3.8.L	Paper Towel	8″	Low	35:00	No	
CG.3.8.M	Paper Towel	8″	Medium	10:24	Yes	10:24
CG.3.8.H	Paper Towel	8″	High	2:30	Yes	2:30

CG.3.6.H: The test conducted using the Electric Ceramic-Glass Cooktop Appliance with the paper (paper towel) using the 6-inch diameter heating element set to the high setting, resulted in flaming ignition in 2 minutes 36 seconds. At the time of ignition, the thermocouples located between the element and the fuel recorded the following temperatures: TC-0=432^{o}C, TC-1= 363^{o}C, TC-2=359^{o}C

CG.3.6.M: The test conducted using the Electric Ceramic-Glass Cooktop Appliance with the paper (paper towel) using the 6-inch diameter heating element set to the medium setting, resulted in flaming ignition in 18 minutes 57 seconds. At the time of ignition, the thermocouples located between the element and the fuel recorded the following temperatures: TC-0=526^{o}C, TC-1= 379^{o}C, TC-2=416^{o}C.

CG.3.6.L: The test conducted using the Electric Ceramic-Glass Cooktop Appliance with the paper (paper towel) using the 6-inch diameter heating element set to the low setting after a 30-minute test resulted in no flaming ignition.

CG.3.8.H: The test conducted using the Electric Ceramic-Glass Cooktop Appliance with the paper (paper towel) using the 8-inch diameter heating element set to the high setting, resulted in flaming ignition in 2 minutes 30 seconds. At the time of ignition, the

thermocouples located between the element and the fuel recorded the following temperatures: TC-0=432^{o}C, TC-1= 363^{o}C, TC-2=359^{o}C.

CG.3.8.M: The test conducted using the Electric Ceramic-Glass Cooktop Appliance with the paper (paper towel) using the 8 inch diameter heating element set to the medium setting, resulted in flaming ignition in 10 minutes 24 seconds. At the time of ignition, the thermocouples located between the element and the fuel recorded the following temperatures: TC-0=524^{o}C, TC-1= 477^{o}C, TC-2=461^{o}C.

G.3.8.L: The test conducted using the Electric Ceramic-Glass Cooktop Appliance with the paper (paper towel) using the 8-inch diameter heating element set to the low setting after a 30-minute test resulted in no flaming ignition. Smoldering combustion was noticed on the fuel's surface.

Table 12: Ignition Results of Ceramic-Glass Cooktop and Canola Oil

Test Id	Fuel	Diameter	Setting	Time (min:sec)	Ignition (Yes/No)	Time to Ignition (min:sec)
CG.4.6.L	Canola Oil	6″	Low	No test	No	
CG.4.6.M	Canola Oil	6″	Medium	22:16	Yes	22:16
CG.4.6.H	Canola Oil	6″	High	12:02	Yes	12:02
CG.4.8.L	Canola Oil	8″	Low	No test	No	
CG.4.8.M	Canola Oil	8″	Medium	25:00	No	
CG.4.8.H	Canola Oil	8″	High	11:26	Yes	11:26

CG.4.6.H: The test conducted using the Electric Ceramic-Glass Cooktop Appliance with the canola oil using the 6-inch diameter heating element set to the high setting resulted in ignition in 12 minutes and 2 seconds.

CG.4.6.M: The test conducted using the Electric Ceramic-Glass Cooktop Appliance with the canola oil using the 6-inch diameter heating element set to the medium setting resulted in ignition in 22 minutes and 16 seconds.

CG.4.6.L: No test conducted. The test was not conducted using the Electric Ceramic-Glass Cooktop Appliance with canola oil using the 6-inch diameter heating element set to the low setting based on the low energy output data collected from the rate of rise test.

CG.4.8.H: The test conducted using the Electric Ceramic-Glass Cooktop Appliance with the canola oil using the 8-inch diameter heating element set to the high setting resulted in ignition in 11 minutes and 26 seconds.

CG.4.8.M: The test conducted using the Electric Ceramic-Glass Cooktop Appliance with the canola oil using the 8-inch diameter heating element set to the medium setting resulted in no ignition after a 25 minute test.

CG.4.8.L: No test conducted. The test was not conducted using the Electric Ceramic-Glass Cooktop Appliance with canola oil using the 8-inch diameter heating element set to the low setting based on the low energy output data collected from the rate of rise test.

Table 13: Ignition Results of Ceramic-Glass Cooktop and Vegetable Oil

Test Id	Fuel	Diameter	Setting	Time (min:sec)	Ignition (Yes/No)	Time to Ignition (min:sec)
CG.5.6.L	Vegetable Oil	6″	Low	No test	No	
CG.5.6.M	Vegetable Oil	6″	Medium	21:29	Yes	21:29
CG.5.6.H	Vegetable Oil	6″	High	11:32	Yes	11:32
CG.5.8.L	Vegetable Oil	8″	Low	No test	No	
CG.5.8.M	Vegetable Oil	8″	Medium	25:00	No	
CG.5.8.H	Vegetable Oil	8″	High	10:26	Yes	10:26

CG.5.6.H: The test conducted using the Electric Ceramic-Glass Cooktop Appliance with the vegetable oil using the 6-inch diameter heating element set to the high setting resulted in ignition in 11 minutes and 32 seconds.

CG.5.6.M: The test conducted using the Electric Ceramic-Glass Cooktop Appliance with the vegetable oil using the 6-inch diameter heating element set to the medium setting resulted in ignition in 21 minutes and 29 seconds.

CG.5.6.L: No test conducted. The test was not conducted using the Electric Ceramic-Glass Cooktop Appliance with vegetable oil using the 6-inch diameter heating element set to the low setting based on the low energy output data collected from the rate of rise test.

CG.5.8.H: The test conducted using the Electric Ceramic-Glass Cooktop Appliance with the vegetable oil using the 8-inch diameter heating element set to the high setting resulted in ignition in 10 minutes and 26 seconds.

CG.5.8.M: The test conducted using the Electric Ceramic-Glass Cooktop Appliance with the vegetable oil using the 8-inch diameter heating element set to the medium setting resulted no flaming ignition after a 25 minute test was conducted.

CG.5.8.L: No test conducted. The test was not conducted using the Electric Ceramic-Glass Cooktop Appliance with vegetable oil using the 8-inch diameter heating element set to the low setting based on the low energy output data collected from the rate of rise test.

Table 54: Ignition Results of Ceramic-Glass Cooktop and Nylon Spatula

Test Id	Fuel	Diameter	Setting	Time (min:sec)	Ignition (Yes/No)	Time to Ignition (min:sec)
CG.6.6.L	Nylon spatula	6”	Low	No Test	No	
CG.6.6.M	Nylon spatula	6”	Medium	15:00	No	
CG.6.6.H	Nylon spatula	6”	High	8:34	Yes	8:34
CG.6.8.L	Nylon spatula	8”	Low	No Test	No	
CG.6.8.M	Nylon spatula	8”	Medium	15:00	No	
CG.6.8.H	Nylon spatula	8”	High	15:00	No	

CG.6.6.H: The test conducted using the Electric Ceramic-Glass Cooktop Appliance with the nylon (short turner spatula-cooking utensil) using the 6-inch diameter heating element set to the high setting, resulted in flaming ignition in 8 minutes 34 seconds. At the time of ignition, the thermocouples located between the element and the fuel recorded the following temperatures: TC-0=249^{o}C, TC-2= 172^{o}C.

CG.6.6.M: The test conducted using the Electric Ceramic-Glass Cooktop Appliance with the nylon (short turner spatula-cooking utensil) using the 6-inch diameter heating element set to the medium setting after a 15-minute test resulted in no flaming ignition.

CG.6.6.L: No test conducted. The test was not conducted because the fuel did not show the potential of ignition on the next higher setting.

CG.6.8.H: The test conducted using the Electric Ceramic-Glass Cooktop Appliance with the nylon (short turner spatula-cooking utensil) using the 8-inch diameter heating element set to the high setting after a 15-minute test resulted in no flaming ignition.

CG.6.8.M: The test conducted using the Electric Ceramic-Glass Cooktop Appliance with the nylon (short turner spatula-cooking utensil) using the 8-inch diameter heating element set to the high setting after a 15-minute test resulted in no flaming ignition.

CG.6.8.L: No test conducted. The test was not conducted because the fuel did not show the potential of ignition on the next higher setting.

Table 15: Ignition Results of Ceramic-Glass Cooktop and Toaster

Test Id	Fuel	Diameter	Setting	Time (min:sec)	Ignition (Yes/No)	Time to Ignition (min:sec)
CG.7.6.L	Toaster	6″	Low	No test	No	
CG.7.6.M	Toaster	6″	Medium	20:00	No	
CG.7.6.H	Toaster	6″	High	2:49	Yes	2:49
CG.7.8.L	Toaster	8″	Low	No test	No	
CG.7.8.M	Toaster	8″	Medium	20:00	No	
CG.7.8.H	Toaster	8″	High	7:48	Yes	7:48

CG.7.6.H: The test conducted using the Electric Ceramic-Glass Cooktop Appliance with the polypropylene (toaster-kitchen appliance) using the 6-inch diameter heating element set to the high setting, resulted in flaming ignition in 2 minutes 49 seconds. At the time of ignition, the thermocouples located between the element and the fuel recorded the following temperatures: TC-0=67^{o}C, TC-1=131^{o}C TC-2= 309^{o}C.

CG.7.6.M: The test conducted using the Electric Ceramic-Glass Cooktop Appliance with the polypropylene (toaster-kitchen appliance) using the 6-inch diameter heating element set to the medium setting after a 20-minute test resulted in no flaming ignition.

CG.7.6.L: No test conducted. The test was not conducted because the fuel did not show the potential of ignition on the next higher setting.

CG.7.8.H: The test conducted using the Electric Ceramic-Glass Cooktop Appliance with the polypropylene (toaster-kitchen appliance) using the 8-inch diameter heating element

set to the high setting, resulted in flaming ignition in 7 minutes 48 seconds. At the time of ignition, the thermocouples located between the element and the fuel recorded the following temperatures: TC-0=336^{o}C, TC-1=209^{o}C TC-2=23^{o}C.

CG.7.8.M: The test conducted using the Electric Ceramic-Glass Cooktop Appliance with the polypropylene (toaster-kitchen appliance) using the 8-inch diameter heating element set to the medium setting after a 20-minute test resulted in no flaming ignition.

CG.7.8.L: No test conducted. The test was not conducted because the fuel did not show the potential of ignition on the next higher setting.

Table 16: Ignition Results of Ceramic-Glass Cooktop and Food Storage Container

Test Id	Fuel	Diameter	Setting	Time (min:sec)	Ignition (Yes/No)	Time to Ignition (min:sec)
CG.8.6.L	Food Storage Container (Polyethylene)	6”	Low	No test	No	
CG.8.6.M	Food Storage Container (Polyethylene)	6”	Medium	No test	No	
CG.8.6.H	Food Storage Container (Polyethylene)	6”	High	6:30	No	
CG.8.8.L	Food Storage Container (Polyethylene)	8”	Low	No test	No	
CG.8.8.M	Food Storage Container (Polyethylene)	8”	Medium	6:30	No	
CG.8.8.H	Food Storage Container (Polyethylene)	8”	High	7:00	No	

CG.8.6.H: The test conducted using the Electric Ceramic-Glass Cooktop Appliance with Polyethylene (Food Storage Container) using the 6-inch diameter heating element set to the high setting after a 6 minute and 30 second test resulted in no flaming ignition. The test was stopped when all the fuel was consumed.

CG.8.6.M: No test conducted. The test was not conducted because the fuel did not show the potential of ignition on the next higher setting. The test was stopped when all the fuel was consumed.

CG.8.6.L: No test conducted. The test was not conducted because the fuel did not show the potential of ignition on the next higher setting.

CG.8.8.H: The test conducted using the Electric Ceramic-Glass Cooktop Appliance with Polyethylene (Food Storage Container) using the 8-inch diameter heating element set to the high setting after a 7-minute test resulted in no flaming ignition. The test was stopped when all the fuel was consumed.

CG.8.8.M: The test conducted using the Electric Ceramic-Glass Cooktop Appliance with Polyethylene (Food Storage Container) using the 8-inch diameter heating element set to the high setting after a 6 minute and 30 second test resulted in no flaming ignition.

CG.8.8.L: No test conducted. The test was not conducted because the fuel did not show the potential of ignition on the next higher setting.

Table 17: Ignition Results of Ceramic-Glass Cooktop and Corn Oil

Test Id	Fuel	Diameter	Setting	Time (min:sec)	Ignition (Yes/No)	Time to Ignition (min:sec)
CG.9.6.L	Corn Oil	6”	Low	No Test	No	
CG.9.6.M	Corn Oil	6”	Medium	25:00	No	
CG.9.6.H	Corn Oil	6”	High	25:00	No	
CG.9.8.L	Corn Oil	8”	Low	No Test	No	
CG.9.8.M	Corn Oil	8”	Medium	25:00	No	
CG.9.8.H	Corn Oil	8”	High	25:00	No	

CG.9.6.H: The test conducted using the Electric Ceramic-Glass Cooktop Appliance with Corn Oil using the 6-inch diameter element set to the high setting after a 25-minute test resulted in no flaming ignition. The test resulted in no significant smoke release or sign of ignition.

CG.9.6.M: The test conducted using the Electric Ceramic-Glass Cooktop Appliance with Corn Oil using the 6-inch diameter element set to the medium setting after a 25-minute test resulted in no flaming ignition. The test resulted in no significant smoke release or sign of ignition.

CG.9.6.L: No test conducted. The test was not conducted because the fuel did not show the potential of ignition on the next higher setting.

CG.9.8.H: The test conducted using the Electric Ceramic-Glass Cooktop Appliance with Corn Oil using the 8-inch diameter heating element set to the high setting after a 25-minute test resulted in no flaming ignition. The test resulted in no significant smoke release or sign of ignition.

CG.9.8.M: The test conducted using the Electric Ceramic-Glass Cooktop Appliance with Corn Oil using the 8-inch diameter heating element set to the medium setting after a 25-minute test resulted in no flaming ignition. The test resulted in no significant smoke release or sign of ignition.

CG.9.8.L: No test conducted. The test was not conducted because the fuel did not show the potential of ignition on the next higher setting.

4.3 Electric Coil Cooktop Range Results: Selected Observations

This section provides tables (Tables 18-26) that summarize the results for each ignition test, including the general conditions for the individual fuels that were evaluated with the electric coil cooktop. Below each table is a brief discussion regarding the selected observations witnessed during each test. The thermocouple data for each test can be found in Appendix E.

Table 18: Ignition Results of Coil Cooktop and Cardboard

Test Id	Fuel	Diameter	Setting	Time (min:sec)	Ignition (Yes/No)	Time to Ignition (min:sec)
EC.1.6.L	Cardboard	6”	Low	25:00	No	
EC.1.6.M	Cardboard	6”	Medium	6:30	No	
EC.1.6.H	Cardboard	6”	High	1:39	Yes	1:39
EC.1.6.H.*	Cardboard	6”	High	1:36	Yes	1:36
EC.1.8.L	Cardboard	8”	Low	25:00	No	
EC.1.8.M	Cardboard	8”	Medium	4:32	Yes	4:32
EC.1.8.H	Cardboard	8”	High	1:24	Yes	1:24
EC.1.8.H.*	Cardboard	8”	High	1:20	Yes	1:20

EC.1.6.H: The test conducted using the Electric Coil Cooktop Appliance with the corrugated paper (cardboard pizza box) using the 6-inch diameter heating element set to

the high setting, resulted in flaming ignition in 1 minutes 39 seconds. At the time of ignition, the thermocouples located between the element and the fuel recorded the following temperatures: TC-0=448^{o}C, TC-1=289^{o}C, TC-2=318^{o}C.

EC.1.6.H.*: The repeat test conducted using the Electric Coil Cooktop Appliance with the corrugated paper (cardboard pizza box) using the 6-inch diameter heating element set to the high setting, resulted in flaming ignition in 1 minutes 36 seconds. At the time of ignition, the thermocouples located between the element and the fuel recorded the following temperatures: TC-0=361^{o}C, TC-1=344^{o}C, TC-2=307^{o}C.

EC.1.6.M: The test conducted using the Electric Coil Cooktop Appliance with the corrugated paper (cardboard pizza box) using the 6-inch diameter heating element set to the medium setting after a 6 minute and 30 second test resulted in no flaming ignition. The test was stopped after corrugated paper fuel mass was consumed.

EC.1.6.L: The test conducted using the Electric Coil Cooktop Appliance with the corrugated paper (cardboard pizza box) using the 6-inch diameter heating element set to the low setting after a 25-minute test resulted in no flaming ignition.

EC.1.8.H: The test conducted using the Electric Coil Cooktop Appliance with the corrugated paper (cardboard pizza box) using the 8 inch diameter heating element set to the high setting, resulted in flaming ignition in 1 minutes 24 seconds. At the time of ignition, the thermocouples located between the element and the fuel recorded the following temperatures: TC-0=407^{o}C, TC-1=292^{o}C, TC-2=265^{o}C.

EC.1.8.H.*: The repeat test conducted using the Electric Coil Cooktop Appliance with the corrugated paper (cardboard pizza box) using the 8 inch diameter heating element set to the high setting, resulted in flaming ignition in 1 minutes 20 seconds. At the time of ignition, the thermocouples located between the element and the fuel recorded the following temperatures: TC-0=390^{o}C, TC-1=253^{o}C, TC-2=296^{o}C.

EC.1.8.M: The test conducted using the Electric Coil Cooktop Appliance with the corrugated paper (cardboard pizza box) using the 8-inch diameter heating element set to the medium setting, resulted in flaming ignition in 4 minutes 32 seconds. At the time of

ignition, the thermocouples located between the element and the fuel recorded the following temperatures: TC-0=272°C, TC-1=231°C, TC-2=153°C.

EC.1.8.L: The test conducted using the Electric Coil Cooktop Appliance with the corrugated paper (cardboard pizza box) using the 8-inch diameter heating element set to the low setting after a 25-minute test resulted in no flaming ignition.

Table 19: Ignition Results of Coil Cooktop and Dish Towel

Test Id	Fuel	Diameter	Setting	Time (min:sec)	Ignition (Yes/No)	Time to Ignition (min:sec)
EC.2.6.L	Dish Towel	6″	Low	25:00	No	
EC.2.6.M	Dish Towel	6″	Medium	6:15	Yes	6:15
EC.2.6.H	Dish Towel	6″	High	1:52	Yes	1:52
EC.2.8.L	Dish Towel	8″	Low	25:00	No	
EC.2.8.M	Dish Towel	8″	Medium	5:32	Yes	5:32
EC.2.8.H	Dish Towel	8″	High	1:20	Yes	1:20

EC.2.6.H: The test conducted using the Electric Coil Cooktop Appliance with the cotton (dish towel) using the 6-inch diameter heating element set to the high setting, resulted in flaming ignition in 1 minute 52 seconds. At the time of ignition, the thermocouples located between the element and the fuel recorded the following temperatures: TC-0=377°C, TC-1=315°C, TC-2=363°C.

EC.2.6.M: The test conducted using the Electric Coil Cooktop Appliance with the cotton (dish towel) using the 6-inch diameter heating element set to the medium setting, resulted in flaming ignition in 6 minutes 15 seconds. At the time of ignition, the thermocouples located between the element and the fuel recorded the following temperatures: TC-0=62°C, TC-1=187°C, TC-2=159°C.

EC.2.6.L: The test conducted using the Electric Coil Cooktop Appliance with the cotton (dish towel) using the 6-inch diameter heating element set to the low setting after a 25-minute test resulted in no flaming ignition.

EC.2.8.H: The test conducted using the Electric Coil Cooktop Appliance with the cotton (dish towel), using the 8-inch diameter heating element set to the high setting, resulted in flaming ignition in 1 minute 20 seconds. At the time of ignition, the thermocouples

located between the element and the fuel recorded the following temperatures: TC-0=359°C, TC-1=111°C, TC-2=150°C.

EC.2.8.M: The test conducted using the Electric Coil Cooktop Appliance with the cotton (dish towel), using the 8-inch diameter heating element, set to the medium setting, resulted in flaming ignition in 5 minutes and 32 seconds. At the time of ignition, the thermocouples located between the element and the fuel recorded the following temperatures: TC-0=246°C, TC-1=387°C, TC-2=341°C.

EC.2.8.L: The test conducted using the Electric Coil Cooktop Appliance with the cotton (dish towel) using the 8-inch diameter heating element set to the low setting after a 25-minute test resulted in no flaming ignition.

Table 20: Ignition Results of Coil Cooktop and Paper Towel

Test Id	Fuel	Diameter	Setting	Time (min:sec)	Ignition (Yes/No)	Time to Ignition (min:sec)
EC.3.6.L	Paper Towel	6″	Low	25:00	No	
EC.3.6.M	Paper Towel	6″	Medium	15:00	No	
EC.3.6.H	Paper Towel	6″	High	1:29	Yes	1:29
EC.3.8.L	Paper Towel	8″	Low	35:00	No	
EC.3.8.M	Paper Towel	8″	Medium	15:00	No	
EC.3.8.H	Paper Towel	8″	High	1:36	Yes	1:36

EC.3.6.H: The test conducted using the Electric Coil Cooktop Appliance with the paper (paper towel) using the 6-inch diameter heating element set to the high setting, resulted in flaming ignition in 1 minute 29 seconds.

EC.3.6.M: The test conducted using the Electric Coil Cooktop Appliance with the paper (paper towel) using the 6-inch diameter heating element set to the medium setting after a 15-minute test resulted in no flaming ignition. The test was stopped after paper fuel mass was consumed and temperatures began to decrease in thermocouples.

EC.3.6.L: The test conducted using the Electric Coil Cooktop Appliance with the paper (paper towel) using the 6-inch diameter heating element set to the low setting after a 25-minute test resulted in no flaming ignition.

EC.3.8.H: The test conducted using the Electric Coil Cooktop Appliance with the paper (paper towel) using the 8-inch diameter heating element set to the high setting, resulted in flaming ignition in 1 minute 36 seconds.

EC.3.8.M: The test conducted using the Electric Coil Cooktop Appliance with the paper (paper towel) using the 8-inch diameter heating element set to the medium setting after a 15-minute test resulted in no flaming ignition. The test was stopped after paper fuel mass was consumed and temperatures began to decrease in thermocouples.

EC.3.8.L: The test conducted using the Electric Coil Cooktop Appliance with the paper (paper towel) using the 8-inch diameter heating element set to the low setting after a 25-minute test resulted in no flaming ignition.

Table 21: Ignition Results of Coil Cooktop and Canola Oil

Test Id	Fuel	Diameter	Setting	Time (min:sec)	Ignition (Yes/No)	Time to Ignition (min:sec)
EC.4.6.L	Canola Oil	6″	Low	No test	No	
EC.4.6.M	Canola Oil	6″	Medium	25:00	No	
EC.4.6.H	Canola Oil	6″	High	11:32	Yes	11:32
EC.4.8.L	Canola Oil	8″	Low	No Test	No	
EC.4.8.M	Canola Oil	8″	Medium	25:00	No	
EC.4.8.H	Canola Oil	8″	High	9:19	Yes	9:19

EC.4.6.H: The test conducted using the Electric Coil Cooktop Appliance with the canola oil using the 6-inch diameter heating element set to the high setting, resulted in flaming ignition in 11 minute 32 seconds.

EC.4.6.M: The test conducted using the Electric Coil Cooktop Appliance with the canola oil using the 6-inch diameter heating element set to the medium setting after a 25-minute test resulted in no flaming ignition.

EC.4.6.L: No test conducted. The test was not conducted using the Electric Coil Cooktop Appliance with canola oil using the 6-inch diameter heating element set to the low setting based on the low energy output data collected from the rate of rise test.

EC.4.8.H: The test conducted using the Electric Coil Cooktop Appliance with the canola oil using the 8-inch diameter heating element set to the high setting, resulted in flaming ignition in 9 minutes 19 seconds.

EC.4.8.M: The test conducted using the Electric Coil Cooktop Appliance with the canola oil using the 8-inch diameter heating element set to the medium setting after a 25-minute test resulted in no flaming ignition.

EC.4.8.L No test conducted. The test was not conducted using the Electric Coil Cooktop Appliance with canola oil using the 8-inch diameter heating element set to the low setting based on the low energy output data collected from the rate of rise test.

Table 22: Ignition Results of Coil Cooktop and Vegetable Oil

Test Id	Fuel	Diameter	Setting	Time (min:sec)	Ignition (Yes/No)	Time to Ignition (min:sec)
EC.5.6.L	Vegetable Oil	6”	Low	No test	No	
EC.5.6.M	Vegetable Oil	6”	Medium	25:00	No	
EC.5.6.H	Vegetable Oil	6”	High	8:32	Yes	8:32
EC.5.8.L	Vegetable Oil	8”	Low	No test	No	
EC.5.8.M	Vegetable Oil	8”	Medium	25:00	No	
EC.5.8.H	Vegetable Oil	8”	High	8:10	Yes	8:10

EC.5.6.H: The test conducted using the Electric Coil Cooktop Appliance with the vegetable oil using the 6 inch diameter heating element set to the high setting, resulted in flaming ignition in 8 minute 32 seconds.

EC.5.6.M: The test conducted using the Electric Coil Cooktop Appliance with the vegetable oil using the 6-inch diameter heating element set to the medium setting after a 25-minute test resulted in no flaming ignition.

EC.5.6.L: No test conducted. The test was not conducted using the Electric Coil Cooktop Appliance with vegetable oil using the 6-inch diameter heating element set to the low setting based on the low energy output data collected from the rate of rise test.

EC.5.8.H: The test conducted using the Electric Coil Cooktop Appliance with the vegetable oil using the 8-inch diameter heating element set to the high setting, resulted in flaming ignition in 8 minutes 10 seconds.

EC.5.8.M: The test conducted using the Electric Coil Cooktop Appliance with the vegetable oil using the 8-inch diameter heating element set to the medium setting after a 25-minute test resulted in no flaming ignition.

EC.5.8.L: No test conducted. The test was not conducted using the Electric Coil Cooktop Appliance with canola oil using the 8-inch diameter heating element set to the low setting based on the low energy output data collected from the rate of rise test.

Table 23: Ignition Results of Coil Cooktop and Nylon Spatula

Test Id	Fuel	Diameter	Setting	Time (min:sec)	Ignition (Yes/No)	Time to Ignition (min:sec)
EC.6.6.L	Nylon spatula	6”	Low	No Test	No	
EC.6.6.M	Nylon spatula	6”	Medium	15:00	No	
EC.6.6.H	Nylon spatula	6”	High	2:39	Yes	2:39
EC.6.8.L	Nylon spatula	8”	Low	No Test	No	
EC.6.8.M	Nylon spatula	8”	Medium	15:00	No	
EC.6.8.H	Nylon spatula	8”	High	2:07	Yes	2:07

EC.6.6.H: The test conducted using the Electric Coil Cooktop Appliance with the nylon (short turner spatula-cooking utensil) using the 6-inch diameter heating element set to the high setting, resulted in flaming ignition in 2 minutes 39 seconds. At the time of ignition, the thermocouples located between the element and the fuel recorded the following temperatures: TC-0=377^{o}C, TC-2=192^{o}C.

EC.6.6.M: The test conducted using the Electric Coil Cooktop Appliance with the nylon (short turner spatula-cooking utensil) using the 6-inch diameter heating element set to the medium setting after a 15-minute test resulted in no flaming ignition.

EC.6.6.L: No test conducted. The test was not conducted because the fuel did not show the potential of ignition on the next higher setting.

EC.6.8.H: The test conducted using the Electric Coil Cooktop Appliance with the nylon (short turner spatula-cooking utensil) using the 8-inch diameter heating element set to the high setting, resulted in flaming ignition in 2 minutes 7 seconds. At the time of ignition, the thermocouples located between the element and the fuel recorded the following temperatures: TC-0=103^{o}C, TC-2=273^{o}C.

EC.6.8.M: The test conducted using the Electric Coil Cooktop Appliance with the nylon (short turner spatula-cooking utensil) using the 8-inch diameter heating element set to the medium setting after a 15-minute test resulted in no flaming ignition.

EC.6.8.L: No test conducted. The test was not conducted because the fuel did not show the potential of ignition on the next higher setting.

Table 24: Ignition Results of Coil Cooktop and Toaster

Test Id	Fuel	Diameter	Setting	Time (min:sec)	Ignition (Yes/No)	Time to Ignition (min:sec)
EC.7.6.L	Toaster	6″	Low	No test	No	
EC.7.6.M	Toaster	6″	Medium	15:00	No	
EC.7.6.H	Toaster	6″	High	2:30	Yes	2:30
EC.7.8.L	Toaster	8″	Low	No test	No	
EC.7.8.M	Toaster	8″	Medium	15:00	No	
EC.7.8.H	Toaster	8″	High	2:00	Yes	2:00

EC.7.6.H: The test conducted using the Electric Coil Cooktop Appliance with the polypropylene (toaster-kitchen appliance) using the 6-inch diameter heating element set to the high setting, resulted in flaming ignition in 2 minutes 30 seconds. At the time of ignition, the thermocouples located between the element and the fuel recorded the following temperatures: TC-0=232^{o}C, TC-1=474^{o}C TC-2= 474^{o}C.

EC.7.6.M: The test conducted using the Electric Coil Cooktop Appliance with the polypropylene (toaster-kitchen appliance) using the 6-inch diameter heating element set to the medium setting after a 15-minute test resulted in no flaming ignition.

EC.7.6.L: No test conducted. The test was not conducted because the fuel did not show the potential of ignition on the next higher setting.

EC.7.8.H: The test conducted using the Electric Coil Cooktop Appliance with the polypropylene (toaster-kitchen appliance) using the 8-inch diameter heating element set to the high setting, resulted in flaming ignition in 2 minutes 0 seconds. At the time of ignition, the thermocouples located between the element and the fuel recorded the following temperatures: TC-0=350^{o}C, TC-1=345^{o}C TC-2=339^{o}C.

EC.7.8.M: The test conducted using the Electric Coil Cooktop Appliance with the polypropylene (toaster-kitchen appliance) using the 8-inch diameter heating element set to the medium setting after a 15-minute test resulted in no flaming ignition.

EC.7.8.L: No test conducted. The test was not conducted because the fuel did not show the potential of ignition on the next higher setting.

Table 25: Ignition Results of Coil Cooktop and Food Storage Container

Test Id	Fuel	Diameter	Setting	Time (min:sec)	Ignition (Yes/No)	Time to Ignition (min:sec)
EC.8.6.L	Food Storage Container (Polyethylene)	6”	Low	12:00	No	
EC.8.6.M	Food Storage Container (Polyethylene)	6”	Medium	12:00	No	
EC.8.6.H	Food Storage Container (Polyethylene)	6”	High	3:05	Yes	3:05
EC.8.8.L	Food Storage Container (Polyethylene)	8”	Low	12:00	No	
EC.8.8.M	Food Storage Container (Polyethylene)	8”	Medium	12:00	No	
EC.8.8.H	Food Storage Container (Polyethylene)	8”	High	1:36	Yes	1:36

EC.8.6.H: The test conducted using the Electric Coil Cooktop Appliance with Polyethylene (Food Storage Container) using the 6-inch diameter heating element set to the high setting, resulted in flaming ignition in 3 minutes 5 seconds. At the time of ignition, the thermocouples located between the element and the fuel recorded the following temperatures: TC-0=307^{o}C, TC-1=416^{o}C TC-2=314^{o}C.

EC.8.6.M: The test conducted using the Electric Coil Cooktop Appliance with Polyethylene (Food Storage Container) using the 6-inch diameter heating element set to

the medium setting after a 12-minute test resulted in no flaming ignition. The test was stopped after the fuel's mass was consumed and the temperature recorded by the thermocouples started to decrease.

EC.8.6.L: The test conducted using the Electric Coil Cooktop Appliance with Polyethylene (Food Storage Container) using the 6-inch diameter heating element set to the low setting after a 12-minute test resulted in no flaming ignition. Test resulted in minor melting to the bottom of polyethylene food storage container.

EC.8.8.H: The test conducted using the Electric Coil Cooktop Appliance with Polyethylene (Food Storage Container) using the 8-inch diameter heating element set to the high setting, resulted in flaming ignition in 1 minute 36 seconds. At the time of ignition, the thermocouples located between the element and the fuel recorded the following temperatures: TC-0=201^{o}C, TC-1=180^{o}C TC-2=261^{o}C.

EC.8.8.M: The test conducted using the Electric Coil Cooktop Appliance with Polyethylene (Food Storage Container) using the 8-inch diameter heating element set to the medium setting after a 12-minute test resulted in no flaming ignition. The test was stopped after the fuel's mass was consumed and the temperature recorded by the thermocouples started to decrease.

EC.8.8.L: The test conducted using the Electric Coil Cooktop Appliance with Polyethylene (Food Storage Container) using the 8-inch diameter heating element set to the low setting after a 12-minute test resulted in no flaming ignition. Test resulted in minor melting to the bottom of polyethylene food storage container.

Table 26: Ignition Results of Coil Cooktop and Corn Oil

Test Id	Fuel	Diameter	Setting	Time (min:sec)	Ignition (Yes/No)	Time to Ignition (min:sec)
EC.9.6.L	Corn Oil	6"	Low	No test	No	
EC.9.6.M	Corn Oil	6"	Medium	25:00	No	
EC.9.6.H	Corn Oil	6"	High	25:00	No	
EC.9.8.L	Corn Oil	8"	Low	No test	No	
EC.9.8.M	Corn Oil	8"	Medium	25:00	No	
EC.9.8.H	Corn Oil	8"	High	5:36	Yes	5:36

EC.9.6.H: The test conducted using the Electric Coil Cooktop Appliance with the corn oil using the 6 inch diameter heating element set to the high setting during a 25 minute test, resulted in no flaming ignition. The test conducted on the 6 inch heating element on the high setting shown potential for ignition.

EC.9.6.M: The test conducted using the Electric Coil Cooktop Appliance with the corn oil using the 6 inch diameter heating element set to the medium setting, resulted in no flaming ignition.

EC.9.6.L: No test conducted. The test was not conducted using the Electric Ceramic-Glass Cooktop Appliance with corn oil using the 6-inch diameter heating element set to the low setting based on the low energy output data collected from the rate of rise test.

EC.9.8.H: The test conducted using the Electric Coil Cooktop Appliance with the corn oil using the 8-inch diameter heating element set to the high setting, resulted in flaming ignition in 5 minutes 36 seconds.

EC.9.8.M: The test conducted using the Electric Coil Cooktop Appliance with the corn oil using the 8 inch diameter heating element set to the medium setting after a 25 minute test, resulted in no flaming ignition.

EC.9.8.L: No test conducted. The test was not conducted using the Electric Coil Cooktop Appliance with corn oil using the 8-inch diameter heating element set to the low setting based on the low energy output data collected from the rate of rise test.

4.4 Electric Coil Cooktop Range with Cast Iron Cover Plate Results: Selected Observations

This section provides tables (Tables 27-35) that summarize the results for each ignition test, including the general conditions for the individual fuels that were evaluated with the electric coil cooktop range with the cast iron cover plate installed on top of the electric coil. Below each table is a brief discussion regarding the selected observations witnessed during each test. The thermocouple data for each test can be found in Appendix F.

Table 27: Ignition Results of Cast Iron Cover Plate Cooktop and Cardboard

Test Id	Fuel	Diameter	Setting	Time (min:sec)	Ignition (Yes/No)	Time to Ignition (min:sec)
IP.1.6.L	Cardboard	6”	Low	20:00	No	
IP.1.6.M	Cardboard	6”	Medium	15:00	Yes	15:00
IP.1.6.H	Cardboard	6”	High	9:25	Yes	9:25
IP.1.6.H.*	Cardboard	6”	High	9:15	No	
IP.1.8.L	Cardboard	8”	Low	20:00	No	
IP.1.8.M	Cardboard	8”	Medium	20:30	Yes	20:30
IP.1.8.H	Cardboard	8”	High	5:10	Yes	5:10
IP.1.8.H.*	Cardboard	8”	High	8:30	No	

IP.1.6.H: The test conducted using the Electric Coil Cooktop Appliance and a cast iron cover plate with the corrugated paper (cardboard pizza box) using the 6-inch diameter heating element set to the high setting, resulted in flaming ignition in 9 minutes 25 seconds. At the time of ignition, the thermocouples located between the element and the fuel recorded the following temperatures: TC-0=560^{o}C, TC-1=437^{o}C, TC-2=292^{o}C.

IP.1.6.H.*: The repeat test conducted using the Electric Coil Cooktop Appliance and a cast iron cover plate with the corrugated paper (cardboard pizza box) using the 6-inch diameter heating element set to the high setting, resulted in no flaming ignition. The test was stopped after 9 minutes and 15 seconds due to the fuel being consumed by smoldering combustion and resulted in TC temperatures to begin to decrease. The fuel showed potential for flaming ignition and released significant smoke.

IP.1.6.M: The test conducted using the Electric Coil Cooktop Appliance and a cast iron cover plate with the corrugated paper (cardboard pizza box) using the 6-inch diameter heating element set to the medium setting resulted in ignition at 15 minutes.

IP.1.6.L: The test conducted using the Electric Coil Cooktop Appliance and a cast iron cover plate with the corrugated paper (cardboard pizza box) using the 6-inch diameter heating element set to the low setting after a 25-minute test resulted in no flaming ignition.

IP.1.8.H: The test conducted using the Electric Coil Cooktop Appliance and a cast iron cover plate with the corrugated paper (cardboard pizza box) using the 8-inch diameter

heating element set to the high setting, resulted in flaming ignition in 5 minutes 10 seconds. At the time of ignition, the thermocouples located between the element and the fuel recorded the following temperatures: TC-0=500^{o}C, TC-1=346^{o}C, TC-2=376^{o}C.

IP.1.8.H.*: The repeat test conducted using the Electric Coil Cooktop Appliance and a cast iron cover plate with the corrugated paper (cardboard pizza box) using the 8-inch diameter heating element set to the high setting, resulted in no flaming ignition. The test was stopped after 8 minutes and 30 seconds due to the fuel being consumed by smoldering combustion and resulted in TC temperatures to begin to decrease. The fuel showed potential for flaming ignition and released significant smoke.

IP.1.8.M: The test conducted using the Electric Coil Cooktop Appliance and a cast iron cover plate with the corrugated paper (cardboard pizza box) using the 8-inch diameter heating element set to the medium setting resulted in ignition at 20 minutes and 30 seconds.

IP.1.8.L: The test conducted using the Electric Coil Cooktop Appliance and a cast iron cover plate with the corrugated paper (cardboard pizza box) using the 8-inch diameter heating element set to the low setting after a 25-minute test resulted in no flaming ignition.

Table 28: Ignition Results of Cast Iron Cover Plate Cooktop and Dish Towel

Test Id	Fuel	Diameter	Setting	Time (min:sec)	Ignition (Yes/No)	Time to Ignition (min:sec)
IP.2.6.L	Dish Towel	6”	Low	25:00	No	
IP.2.6.M	Dish Towel	6”	Medium	25:00	No	
IP.2.6.H	Dish Towel	6”	High	5:46	Yes	5:46
IP.2.8.L	Dish Towel	8”	Low	25:00	No	
IP.2.8.M	Dish Towel	8”	Medium	25:00	No	
IP.2.8.H	Dish Towel	8”	High	6:55	Yes	6:55

IP.2.6.H: The test conducted using the Electric Coil Cooktop Appliance and a cast iron cover plate with the cotton (dish towel) using the 6-inch diameter heating element set to the high setting, resulted in flaming ignition in 1 minute 52 seconds. At the time of

ignition, the thermocouples located between the element and the fuel recorded the following temperatures: TC-0=360°C, TC-1=372°C, TC-2=330°C.

IP.2.6.M: The test conducted using the Electric Coil Cooktop Appliance and a cast iron cover plate with the cotton (dish towel) using the 6-inch diameter heating element set to the medium setting after a 25-minute test resulted in no flaming ignition.

IP.2.6.L: The test conducted using the Electric Coil Cooktop Appliance and a cast iron cover plate with the cotton (dish towel) using the 6-inch diameter heating element set to the low setting after a 25-minute test resulted in no flaming ignition.

IP.2.8.H: The test conducted using the Electric Coil Cooktop Appliance and a cast iron cover plate with the cotton (dish towel), using the 8-inch diameter heating element set to the high setting, resulted in flaming ignition in 6 minutes 55 seconds. At the time of ignition, the thermocouples located between the element and the fuel recorded the following temperatures: TC-0=500°C, TC-1=371°C, TC-2=354°C.

IP.2.8.M: The test conducted using the Electric Coil Cooktop Appliance and a cast iron cover plate with the cotton (dish towel) using the 8-inch diameter heating element set to the medium setting after a 25-minute test resulted in no flaming ignition.

IP.2.8.L: The test conducted using the Electric Coil Cooktop Appliance and a cast iron cover plate with the cotton (dish towel) using the 8-inch diameter heating element set to the low setting after a 25-minute test resulted in no flaming ignition.

Table 29: Ignition Results of Cast Iron Cover Plate Cooktop and Paper Towel

Test Id	Fuel	Diameter	Setting	Time (min:sec)	Ignition (Yes/No)	Time to Ignition (min:sec)
IP.3.6.L	Paper Towel	6”	Low	25:00	No	
IP.3.6.M	Paper Towel	6”	Medium	25:00	No	
IP.3.6.H	Paper Towel	6”	High	6:04	Yes	6:04
IP.3.8.L	Paper Towel	8”	Low	25:00	No	
IP.3.8.M	Paper Towel	8”	Medium	25:00	No	
IP.3.8.H	Paper Towel	8”	High	5:20	Yes	5:20

IP.3.6.H: The test conducted using the Electric Coil Cooktop Appliance and a cast iron cover plate with the paper (paper towel), using the 6-inch diameter heating element set to the high setting, resulted in flaming ignition in 6 minutes 4 seconds. At the time of ignition, the thermocouples located between the element and the fuel recorded the following temperatures: TC-0=535^{o}C, TC-1=374^{o}C, TC-2=27^{o}C. The low temperature recoded by TC-2 is most likely due to the fuel being consumed at this location prior to ignition.

IP.3.6.M: The test conducted using the Electric Coil Cooktop Appliance and a cast iron cover plate with the paper (paper towel) using the 6-inch diameter heating element set to the medium setting after a 25-minute test resulted in no flaming ignition. The test was stopped after the bottom portion of the fuel's mass was consumed and temperatures began to decrease.

IP.3.6.L: The test conducted using the Electric Coil Cooktop Appliance and a cast iron cover plate with the paper (paper towel) using the 6-inch diameter heating element set to the low setting after a 25-minute test resulted in no flaming ignition.

IP.3.8.H: The test conducted using the Electric Coil Cooktop Appliance and a cast iron cover plate with the paper (paper towel), using the 8-inch diameter heating element set to the high setting, resulted in flaming ignition in 5 minutes 20 seconds. At the time of ignition, the thermocouples located between the element and the fuel recorded the following temperatures: TC-0=554^{o}C, TC-1=417^{o}C, TC-2=203^{o}C.

IP.3.8.M: The test conducted using the Electric Coil Cooktop Appliance and a cast iron cover plate with the paper (paper towel) using the 8-inch diameter heating element set to the medium setting after a 25-minute test resulted in no flaming ignition. The test was stopped after the bottom portion of the fuel's mass was consumed and temperatures began to decrease.

IP.3.8.L: The test conducted using the Electric Coil Cooktop Appliance and a cast iron cover plate with the paper (paper towel) using the 8-inch diameter heating element set to the low setting after a 25-minute test resulted in no flaming ignition.

Table 30: Ignition Results of Cast Iron Cover Plate Cooktop and Canola Oil

Test Id	Fuel	Diameter	Setting	Time (min:sec)	Ignition (Yes/No)	Time to Ignition (min:sec)
IP.4.6.L	Canola Oil	6”	Low	No test	No	
IP.4.6.M	Canola Oil	6”	Medium	25:00	No	
IP.4.6.H	Canola Oil	6”	High	17:18	Yes	17:18
IP.4.8.L	Canola Oil	8”	Low	No test	No	
IP.4.8.M	Canola Oil	8”	Medium	25:00	No	
IP.4.8.H	Canola Oil	8”	High	13:31	Yes	13:31

IP.4.6.H: The test conducted using the Electric Coil Cooktop Appliance and a cast iron cover plate with the canola oil using the 6-inch diameter heating element set to the high setting, resulted in flaming ignition in 17 minutes 18 seconds.

IP.4.6.M: The test conducted using the Electric Coil Cooktop Appliance and a cast iron cover plate with the canola oil using the 6-inch diameter heating element set to the medium setting after a 25-minute test resulted in no flaming ignition.

IP.4.6.L: No test conducted. The test was not conducted using the Electric Coil Cooktop Appliance and a cast iron cover plate with canola oil using the 6-inch diameter heating element set to the low setting based on the low energy output data collected from the rate of rise test.

IP.4.8.H: The test conducted using the Electric Coil Cooktop Appliance and a cast iron cover plate with the canola oil using the 8-inch diameter heating element set to the high setting, resulted in flaming ignition in 13 minutes 31 seconds.

IP.4.8.M: The test conducted using the Electric Coil Cooktop Appliance and a cast iron cover plate with the canola oil using the 8-inch diameter heating element set to the medium setting after a 25-minute test resulted in no flaming ignition.

IP.4.8.L: No test conducted. The test was not conducted using the Electric Coil Cooktop Appliance and a cast iron plate with canola oil using the 8-inch diameter heating element set to the low setting based on the low energy output data collected from the rate of rise test.

Table 31: Ignition Results of Cast Iron Cover Plate Cooktop and Vegetable Oil

Test Id	Fuel	Diameter	Setting	Time (min:sec)	Ignition (Yes/No)	Time to Ignition (min:sec)
IP.5.6.L	Vegetable Oil	6”	Low	No test	No	
IP.5.6.M	Vegetable Oil	6”	Medium	25:00	No	
IP.5.6.H	Vegetable Oil	6”	High	17:16	Yes	17:16
IP.5.8.L	Vegetable Oil	8”	Low	No test	No	
IP.5.8.M	Vegetable Oil	8”	Medium	25:00	No	
IP.5.8.H	Vegetable Oil	8”	High	13:13	Yes	13:13

IP.5.6.H: The test conducted using the Electric Coil Cooktop Appliance and a cast iron cover plate with the vegetable oil using the 6-inch diameter heating element set to the high setting, resulted in flaming ignition in 17 minutes 16 seconds.

IP.5.6.M: The test conducted using the Electric Coil Cooktop Appliance and a cast iron cover plate with the vegetable oil using the 6-inch diameter heating element set to the medium setting after a 25-minute test resulted in no flaming ignition.

IP.5.6.L: No test conducted. The test was not conducted using the Electric Coil Cooktop Appliance and a cast iron plate with vegetable oil using the 6-inch diameter heating element set to the low setting based on the low energy output data collected from the rate of rise test.

IP.5.8.H: The test conducted using the Electric Coil Cooktop Appliance and a cast iron cover plate with the vegetable oil using the 8-inch diameter heating element set to the high setting, resulted in flaming ignition in 13 minutes 13 seconds.

IP.5.8.M: The test conducted using the Electric Coil Cooktop Appliance and a cast iron cover plate with the vegetable oil using the 8-inch diameter heating element set to the medium setting after a 25-minute test resulted in no flaming ignition.

IP.5.8.L: No test conducted. The test was not conducted using the Electric Coil Cooktop Appliance and a cast iron plate with canola oil using the 8-inch diameter heating element set to the low setting based on the low energy output data collected from the rate of rise test.

Table 32: Ignition Results of Cast Iron Cover Plate Cooktop and Nylon Spatula

Test Id	Fuel	Diameter	Setting	Time (min:sec)	Ignition (Yes/No)	Ignition temp (°C)	Time to Ignition (min:sec)
IP.6.6.L	Nylon spatula	6″	Low	No Test	No		
IP.6.6.M	Nylon spatula	6″	Medium	15:00	No		
IP.6.6.H	Nylon spatula	6″	High	4:45	Yes		4:45
IP.6.8.L	Nylon spatula	8″	Low	No Test	No		
IP.6.8.M	Nylon spatula	8″	Medium	15:00	No		
IP.6.8.H	Nylon spatula	8″	High	7:55	Yes		7:55

IP.6.6.H: The test conducted using the Electric Coil Cooktop Appliance and a cast iron cover plate with the nylon (short turner spatula-cooking utensil) using the 6-inch diameter heating element set to the high setting, resulted in flaming ignition in 4 minutes 45 seconds. At the time of ignition, the thermocouples located between the element and the fuel recorded the following temperatures: TC-0=366°C, TC-2=217°C.

IP.6.6.M: The test conducted using the Electric Coil Cooktop Appliance and a cast iron cover plate with the nylon (short turner spatula-cooking utensil) using the 6-inch diameter heating element set to the medium setting after a 15-minute test resulted in no flaming ignition.

IP.6.6.L: No test conducted. The test was not conducted because the fuel did not show the potential of ignition on the next higher setting.

IP.6.8.H: The test conducted using the Electric Coil Cooktop Appliance and a cast iron cover plate with the nylon (short turner spatula-cooking utensil) using the 8-inch diameter heating element set to the high setting, resulted in flaming ignition in 7 minutes 45 seconds. At the time of ignition, the thermocouples located between the element and the fuel recorded the following temperatures: TC-0=544°C, TC-2=350°C.

IP.6.8.M: The test conducted using the Electric Coil Cooktop Appliance and a cast iron cover plate with the nylon (short turner spatula-cooking utensil) using the 8-inch diameter heating element set to the medium setting after a 15-minute test resulted in no flaming ignition.

IP.6.8.L: No test conducted. The test was not conducted because the fuel did not show the potential of ignition on the next higher setting.

Table 33: Ignition Results of Cast Iron Cover Plate Cooktop and Toaster

Test Id	Fuel	Diameter	Setting	Time (min:sec)	Ignition (Yes/No)	Time to Ignition (min:sec)
IP.7.6.L	Toaster	6″	Low	No test	No	
IP.7.6.M	Toaster	6″	Medium	25:00	No	
IP.7.6.H	Toaster	6″	High	6:20	Yes	6:20
IP.7.8.L	Toaster	8″	Low	No test	No	
IP.7.8.M	Toaster	8″	Medium	25:00	No	
IP.7.8.H	Toaster	8″	High	5:20	Yes	5:20

IP.7.6.H: The test conducted using the Electric Coil Cooktop Appliance and a cast iron cover plate with the polypropylene (toaster-kitchen appliance) using the 6-inch diameter heating element set to the high setting, resulted in flaming ignition in 6 minutes 20 seconds. At the time of ignition, the thermocouples located between the element and the fuel recorded the following temperatures: TC-0=306^{o}C, TC-1=68^{o}C TC-2= 197^{o}C.

IP.7.6.M: The test conducted using the Electric Coil Cooktop Appliance and a cast iron cover plate with the polypropylene (toaster-kitchen appliance) using the 6-inch diameter heating element set to the medium setting after a 25-minute test resulted in no flaming ignition.

IP.7.6.L: No test conducted. The test was not conducted because the fuel did not show the potential of ignition on the next higher setting.

IP.7.8.H: The test conducted using the Electric Coil Cooktop Appliance and a cast iron cover plate with the polypropylene (toaster-kitchen appliance) using the 8-inch diameter heating element set to the high setting, resulted in flaming ignition in 5 minutes 20 seconds. At the time of ignition, the thermocouples located between the element and the fuel recorded the following temperatures: TC-0=96^{o}C, TC-1=194^{o}C TC-2=203^{o}C.

IP.7.8.M: The test conducted using the Electric Coil Cooktop Appliance and a cast iron cover plate with the polypropylene (toaster-kitchen appliance) using the 8-inch diameter

heating element set to the medium setting after a 25-minute test resulted in no flaming ignition.

IP.7.8.L: No test conducted. The test was not conducted because the fuel did not show the potential of ignition on the next higher setting.

Table 34: Ignition Results of Cast Iron Cover Plate Cooktop and Food Storage Container

Test Id	Fuel	Diameter	Setting	Time (min:sec)	Ignition (Yes/No)	Time to Ignition (min:sec)
IP.8.6.L	Food Storage Container (Polyethylene)	6”	Low	No test	No	
IP.8.6.M	Food Storage Container (Polyethylene)	6”	Medium	20:00	No	
IP.8.6.H	Food Storage Container (Polyethylene)	6”	High	6:26	Yes	6:26
IP.8.8.L	Food Storage Container (Polyethylene)	8”	Low	No test	No	
IP.8.8.M	Food Storage Container (Polyethylene)	8”	Medium	6:30	No	
IP.8.8.H	Food Storage Container (Polyethylene)	8”	High	5:40	Yes	5:40

IP.8.6.H: The test conducted using the Electric Coil Cooktop Appliance and a cast iron cover plate with Polyethylene (Food Storage Container) using the 6-inch diameter heating element set to the high setting, resulted in flaming ignition in 6 minutes 26 seconds. At the time of ignition, the thermocouples located between the element and the fuel recorded the following temperatures: TC-0=358^{o}C, TC-1=369^{o}C TC-2=211^{o}C.

IP.8.6.M: The test conducted using the Electric Coil Cooktop Appliance and a cast iron cover plate with Polyethylene (Food Storage Container) using the 6-inch diameter heating element set to the medium setting after a 15-minute test resulted in no flaming ignition. The test was stopped after the fuel mass was consumed and the temperature recorded by the thermocouples decreased.

IP.8.6.L: No test conducted. The test was not conducted because the fuel did not show the potential of ignition on the next higher setting.

IP.8.8.H: The test conducted using the Electric Coil Cooktop Appliance and a cast iron cover plate with Polyethylene (Food Storage Container) using the 8-inch diameter heating element set to the high setting, resulted in flaming ignition in 5 minute 40 seconds. At the time of ignition, the thermocouples located between the element and the fuel recorded the following temperatures: TC-0=411^{o}C, TC-1=378^{o}C TC-2=350^{o}C.

IP.8.8.M: The test conducted using the Electric Coil Cooktop Appliance and a cast iron cover plate with Polyethylene (Food Storage Container) using the 8-inch diameter heating element set to the medium setting after a 15-minute test resulted in no flaming ignition. The test was stopped after the fuel mass was consumed and the temperature recorded by the thermocouples decreased.

IP.8.8.L: No test conducted. The test was not conducted because the fuel did not show the potential of ignition on the next higher setting.

Table 35: Ignition Results of Cast Iron Cover Plate Cooktop and Corn Oil

Test Id	Fuel	Diameter	Setting	Time (min:sec)	Ignition (Yes/No)	Time to Ignition (min:sec)
IP.9.6.L	Corn Oil	6″	Low	No test	No	
IP.9.6.M	Corn Oil	6″	Medium	25:00	No	
IP.9.6.H	Corn Oil	6″	High	25:00	No	
IP.9.8.L	Corn Oil	8″	Low	No test	No	
IP.9.8.M	Corn Oil	8″	Medium	25:00	No	
IP.9.8.H	Corn Oil	8″	High	8:45	Yes	8:45

IP.9.6.H: The test conducted using the Electric Coil Cooktop Appliance and a cast iron cover plate with the corn oil using the 6-inch diameter heating element set to the high setting, resulted in no flaming ignition during a 25 minute test. The test did show potential signs of ignition.

IP.9.6.M: The test conducted using the Electric Coil Cooktop Appliance and a cast iron cover plate with the corn oil using the 6-inch diameter heating element set to the medium

setting, resulted in no flaming ignition during a 25 minute test. There were no significant signs of ignition.

IP.9.6.L: No test conducted. The test was not conducted using the Electric Coil Cooktop Appliance and a cast iron plate with corn oil using the 6-inch diameter heating element set to the low setting based on the low energy output data collected from the rate of rise test.

IP.9.8.H: The test conducted using the Electric Coil Cooktop Appliance and a cast iron cover plate with the corn oil using the 8-inch diameter heating element set to the high setting, resulted in flaming ignition in 8 minutes 45 seconds.

IP.9.8.M: The test conducted using the Electric Coil Cooktop Appliance and a cast iron cover plate with the corn oil using the 8-inch diameter heating element set to the medium setting, resulted in no flaming ignition during a 25 minute test. There were no significant signs of ignition.

IP.9.8.L: No test conducted. The test was not conducted using the Electric Coil Cooktop Appliance and a cast iron plate with corn oil using the 8-inch diameter heating element set to the low setting based on the low energy output data collected from the rate of rise test.

4.5 Electric Coil Cooktop Range with Temperature Control Sensor: Selected Observations

This section provides tables (Tables 36-44) that summarize the results for each ignition test, including the general conditions for the individual fuels that were evaluated with the electric coil cooktop range with the Safe-T-element technology's temperature control sensor installed. Below each table is a brief discussion regarding the selected observations witnessed during each test. The thermocouple data for each test can be found in Appendix G.

Table 36: Ignition Results of Temperature Control Sensor Cooktop and Corn Oil

Test Id	Fuel	Diameter	Setting	Time (min:sec)	Ignition (Yes/No)	Time to Ignition (min:sec)

TS.1.6.L	Cardboard	6”	Low	30:00	No	
TS.1.6.M	Cardboard	6”	Medium	30:00	No	
TS.1.6.H	Cardboard	6”	High	30:00	No	
TS.1.6.H.*	Cardboard	6”	High	20:00	No	
TS.1.8.L	Cardboard	8”	Low	30:00	No	
TS.1.8.M	Cardboard	8”	Medium	30:00	No	
TS.1.8.H	Cardboard	8”	High	30:00	No	
TS.1.8.H.*	Cardboard	8”	High	20:00	No	

TS.1.6.H: The test conducted using the Electric Coil Cooktop Appliance and a temperature control sensor with the corrugated paper (cardboard pizza box) using the 6-inch diameter heating element set to the high setting after a 30-minute test resulted in no flaming ignition.

TS.1.6.H.*: The repeat test conducted using the Electric Coil Cooktop Appliance and a temperature control sensor with the corrugated paper (cardboard pizza box) using the 6-inch diameter heating element set to the high setting after a 20-minute test resulted in no flaming ignition. The test was stopped after most of the fuels mass were consumed by smoldering combustion and the TC temperatures began to decrease.

TS.1.6.M: The test conducted using the Electric Coil Cooktop Appliance and a temperature control sensor with the corrugated paper (cardboard pizza box) using the 6-inch diameter heating element set to the medium setting after a 30-minute test resulted in no flaming ignition.

TS.1.6.L: The test conducted using the Electric Coil Cooktop Appliance and a temperature control sensor with the corrugated paper (cardboard pizza box) using the 6-inch diameter heating element set to the low setting after a 30-minute test resulted in no flaming ignition.

TS.1.8.H: The test conducted using the Electric Coil Cooktop Appliance and a temperature control sensor with the corrugated paper (cardboard pizza box) using the 8-inch diameter heating element set to the high setting after a 26-minute test resulted in no flaming ignition. The test was stopped at 26-minutes due to the fuel being consumed by smoldering combustion and temperatures began to decrease.

TS.1.8.H.*: The repeat test conducted using the Electric Coil Cooktop Appliance and a temperature control sensor with the corrugated paper (cardboard pizza box) using the 8-inch diameter heating element set to the high setting after a 20-minute test resulted in no flaming ignition. The test was stopped after most of the fuels mass were consumed by smoldering combustion and the TC temperatures began to decrease.

TS.1.8.M: The test conducted using the Electric Coil Cooktop Appliance and a temperature control sensor with the corrugated paper (cardboard pizza box) using the 8-inch diameter heating element set to the medium setting after a 30-minute test resulted in no flaming ignition.

TS.1.8.L: The test conducted using the Electric Coil Cooktop Appliance and a temperature control sensor with the corrugated paper (cardboard pizza box) using the 8-inch diameter heating element set to the low setting after a 30-minute test resulted in no flaming ignition.

Table 37: Ignition Results of Temperature Control Sensor Cooktop and Dish Towel

Test Id	Fuel	Diameter	Setting	Time (min:sec)	Ignition (Yes/No)	Time to Ignition (min:sec)
TS.2.6.L	Dish Towel	6”	Low	No test	No	
TS.2.6.M	Dish Towel	6”	Medium	25:00	No	
TS.2.6.H	Dish Towel	6”	High	25:00	No	
TS.2.8.L	Dish Towel	8”	Low	No Test	No	
TS.2.8.M	Dish Towel	8”	Medium	25:00	No	
TS.2.8.H	Dish Towel	8”	High	25:00	No	

TS.2.6.H: The test conducted using the Electric Coil Cooktop Appliance and a temperature control sensor with the cotton (dish towel) using the 6-inch diameter heating element set to the high setting, resulted in no flaming ignition during a 25 minute test. The fuel did show signs of ignition and released significant smoke during first cycle of heating.

TS.2.6.M: The test conducted using the Electric Coil Cooktop Appliance and a temperature control sensor with the cotton (dish towel) using the 6-inch diameter heating element set to the medium setting, resulted in no flaming ignition during a 25 minute

test. The fuel did show signs of ignition and released significant smoke during first cycle of heating.

TS.2.6.L: No test conducted. The test was not conducted because the fuel did not show the potential of ignition on the next higher setting.

TS.2.6.H: The test conducted using the Electric Coil Cooktop Appliance and a temperature control sensor with the cotton (dish towel) using the 8-inch diameter heating element set to the high setting, resulted in no flaming ignition during a 25 minute test. The fuel did show signs of ignition and released significant smoke during first cycle of heating.

TS.2.6.M: The test conducted using the Electric Coil Cooktop Appliance and a temperature control sensor with the cotton (dish towel) using the 8-inch diameter heating element set to the medium setting, resulted in no flaming ignition during a 25 minute test. The fuel did show signs of ignition and released significant smoke during first cycle of heating.

TS.2.6.L: No test conducted. The test was not conducted because the fuel did not show the potential of ignition on the next higher setting.

Table 38: Ignition Results of Temperature Control Sensor Cooktop and Paper Towel

Test Id	Fuel	Diameter	Setting	Time (min:sec)	Ignition (Yes/No)	Time to Ignition (min:sec)
TS.3.6.L	Paper Towel	6″	Low	25:00	No	
TS.3.6.M	Paper Towel	6″	Medium	25:00	No	
TS.3.6.H	Paper Towel	6″	High	40:00	No	
TS.3.8.L	Paper Towel	8″	Low	25:00	No	
TS.3.8.M	Paper Towel	8″	Medium	25:00	No	
TS.3.8.H	Paper Towel	8″	High	40:00	No	

TS.3.6.H: The test conducted using the Electric Coil Cooktop Appliance and a temperature control sensor with the paper (paper towel) using the 6-inch diameter heating element set to the high setting, resulted in no flaming ignition. The fuel did show signs

of ignition and released significant smoke during first cycle of heating. Flaming ignition did occur when removing fuel from heating element after testing was complete.

TS.3.6.M: The test conducted using the Electric Coil Cooktop Appliance and a temperature control sensor with the paper (paper towel) using the 6-inch diameter heating element set to the medium setting, resulted in no flaming ignition during a 25 minute test. The fuel did show signs of ignition and released significant smoke during first cycle of heating.

TS.3.6.L: : The test conducted using the Electric Coil Cooktop Appliance and a temperature control sensor with the paper (paper towel) using the 6-inch diameter heating element set to the low setting, resulted in no flaming ignition during a 25 minute test. The fuel did not show signs of ignition and was only warm to the touch following test.

TS.3.8.H: The test conducted using the Electric Coil Cooktop Appliance and a temperature control sensor with the paper (paper towel) using the 8-inch diameter heating element set to the high setting, resulted in no flaming ignition. The fuel did show signs of ignition and released significant smoke during first cycle of heating. Flaming ignition did occur when removing fuel from heating element after testing was complete.

TS.3.8.M: The test conducted using the Electric Coil Cooktop Appliance and a temperature control sensor with the paper (paper towel) using the 8-inch diameter heating element set to the medium setting, resulted in no flaming ignition during a 25 minute test. The fuel did show signs of ignition and released significant smoke during first cycle of heating.

TS.3.8.L: The test conducted using the Electric Coil Cooktop Appliance and a temperature control sensor with the paper (paper towel) using the 8-inch diameter heating element set to the low setting, resulted in no flaming ignition during a 25 minute test. The fuel did not show signs of ignition and was only warm to the touch following test.

Table 39: Ignition Results of Temperature Control Sensor Cooktop and Canola Oil

Test Id	Fuel	Diameter	Setting	Time (min:sec)	Ignition (Yes/No)	Time to Ignition (min:sec)
TS.4.6.L	Canola Oil	6”	Low	No test	No	

TS.4.6.M	Canola Oil	6”	Medium	25:00	No	
TS.4.6.H	Canola Oil	6”	High	25:00	No	
TS.4.8.L	Canola Oil	8”	Low	No test	No	
TS.4.8.M	Canola Oil	8”	Medium	25:00	No	
TS.4.8.H	Canola Oil	8”	High	25:00	No	

TS.4.6.H: The test conducted using the Electric Coil Cooktop Appliance and a temperature control sensor with the canola oil using the 6-inch diameter heating element set to the high setting, resulted in no flaming ignition during a 25 minute test. The fuel did not show signs of ignition

TS.4.6.M: The test conducted using the Electric Coil Cooktop Appliance and a temperature control sensor with the canola oil using the 6-inch diameter heating element set to the medium setting, resulted in no flaming ignition during a 25 minute test. The fuel did not show signs of ignition.

TS.4.6.L: No test conducted. The test was not conducted because the fuel did not show the potential of ignition on the next higher setting.

TS.4.8.H: The test conducted using the Electric Coil Cooktop Appliance and a temperature control sensor with the canola oil using the 8-inch diameter heating element set to the high setting, resulted in no flaming ignition during a 25 minute test. The fuel did not show signs of ignition

TS.4.8.M: The test conducted using the Electric Coil Cooktop Appliance and a temperature control sensor with the canola oil using the 8-inch diameter heating element set to the medium setting, resulted in no flaming ignition during a 25 minute test. The fuel did not show signs of ignition.

TS.4.8.L: No test conducted. The test was not conducted because the fuel did not show the potential of ignition on the next higher setting.

Table 40: Ignition Results of Temperature Control Sensor Cooktop and Vegetable Oil

Test Id	Fuel	Diameter	Setting	Time (min:sec)	Ignition (Yes/No)	Time to Ignition (min:sec)

TS.5.6.L	Vegetable Oil	6”	Low	No test	No	
TS.5.6.M	Vegetable Oil	6”	Medium	25:00	No	
TS.5.6.H	Vegetable Oil	6”	High	25:00	No	
TS.5.8.L	Vegetable Oil	8”	Low	No test	No	
TS.5.8.M	Vegetable Oil	8”	Medium	25:00	No	
TS.5.8.H	Vegetable Oil	8”	High	25:00	No	

TS.5.6.H: The test conducted using the Electric Coil Cooktop Appliance and a temperature control sensor with the vegetable oil using the 6-inch diameter heating element set to the high setting, resulted in no flaming ignition during a 25 minute test. The fuel did not show signs of ignition

TS.5.6.M: The test conducted using the Electric Coil Cooktop Appliance and a temperature control sensor with the vegetable oil using the 6-inch diameter heating element set to the medium setting, resulted in no flaming ignition during a 25 minute test. The fuel did not show signs of ignition.

TS.5.6.L: No test conducted. The test was not conducted because the fuel did not show the potential of ignition on the next higher setting.

TS.5.8.H: The test conducted using the Electric Coil Cooktop Appliance and a temperature control sensor with the vegetable oil using the 8-inch diameter heating element set to the high setting, resulted in no flaming ignition during a 25 minute test. The fuel did not show signs of ignition

TS.5.8.M: The test conducted using the Electric Coil Cooktop Appliance and a temperature control sensor with the vegetable oil using the 8-inch diameter heating element set to the medium setting, resulted in no flaming ignition during a 25 minute test. The fuel did not show signs of ignition.

TS.5.8.L: No test conducted. The test was not conducted because the fuel did not show the potential of ignition on the next higher setting.

Table 41: Ignition Results of Temperature Control Sensor Cooktop and Nylon Spatula

Test Id	Fuel	Diameter	Setting	Time	Ignition	Time to Ignition

				(min:sec)	(Yes/No)	(min:sec)
TS.6.6.L	Nylon spatula	6”	Low	No Test	No	
TS.6.6.M	Nylon spatula	6”	Medium	15:00	No	
TS.6.6.H	Nylon spatula	6”	High	15:00	No	
TS.6.8.L	Nylon spatula	8”	Low	No Test	No	
TS.6.8.M	Nylon spatula	8”	Medium	15:00	No	
TS.6.8.H	Nylon spatula	8”	High	15:00	No	

TS.6.6.H: The test conducted using the Electric Coil Cooktop Appliance and a temperature control sensor with the nylon (short turner spatula-cooking utensil) using the 6-inch diameter heating element set to the high setting, resulted in no flaming ignition during a 15 minute test. The fuel did not show signs of ignition

TS.6.6.M: The test conducted using the Electric Coil Cooktop Appliance and a temperature control sensor with the nylon (short turner spatula-cooking utensil) using the 6-inch diameter heating element set to the medium setting, resulted in no flaming ignition during a 15 minute test. The fuel did not show signs of ignition.

TS.6.6.L: No test conducted. The test was not conducted because the fuel did not show the potential of ignition on the next higher setting.

TS.6.8.H: The test conducted using the Electric Coil Cooktop Appliance and a temperature control sensor with the nylon (short turner spatula-cooking utensil) using the 8-inch diameter heating element set to the high setting, resulted in no flaming ignition during a 15 minute test. The fuel did not show signs of ignition

TS.6.8.M: The test conducted using the Electric Coil Cooktop Appliance and a temperature control sensor with the nylon (short turner spatula-cooking utensil) using the 8-inch diameter heating element set to the medium setting, resulted in no flaming ignition during a 15 minute test. The fuel did not show signs of ignition.

TS.6.8.L: No test conducted. The test was not conducted because the fuel did not show the potential of ignition on the next higher setting.

Table 42: Ignition Results of Temperature Control Sensor Cooktop and Toaster

Test Id	Fuel	Diameter	Setting	Time	Ignition	Time to Ignition

				(min:sec)	(Yes/No)	(min:sec)
TS.7.6.L	Toaster	6”	Low	No test	No	
TS.7.6.M	Toaster	6”	Medium	20:00	No	
TS.7.6.H	Toaster	6”	High	20:00	No	
TS.7.8.L	Toaster	8”	Low	No test	No	
TS.7.8.M	Toaster	8”	Medium	20:00	No	
TS.7.8.H	Toaster	8”	High	20:00	No	

TS.7.6.H: The test conducted using the Electric Coil Cooktop Appliance and a temperature control sensor with the polypropylene (toaster-kitchen appliance) using the 6-inch diameter heating element set to the high setting, resulted in no flaming ignition during a 20 minute test. The fuel did not show signs of ignition

TS.7.6.M: The test conducted using the Electric Coil Cooktop Appliance and a temperature control sensor with the polypropylene (toaster-kitchen appliance) using the 6-inch diameter heating element set to the medium setting, resulted in no flaming ignition during a 20 minute test. The fuel did not show signs of ignition.

TS.7.6.L: No test conducted. The test was not conducted because the fuel did not show the potential of ignition on the next higher setting.

TS.7.8.H: The test conducted using the Electric Coil Cooktop Appliance and a temperature control sensor with the polypropylene (toaster-kitchen appliance) using the 8-inch diameter heating element set to the high setting, resulted in no flaming ignition during a 20 minute test. The fuel did not show signs of ignition

TS.7.8.M: The test conducted using the Electric Coil Cooktop Appliance and a temperature control sensor with the polypropylene (toaster-kitchen appliance) using the 8-inch diameter heating element set to the medium setting, resulted in no flaming ignition during a 20 minute test. The fuel did not show signs of ignition.

TS.7.8.L: No test conducted. The test was not conducted because the fuel did not show the potential of ignition on the next higher setting.

Table 43: Ignition Results of Temperature Control Sensor and Food Storage Container

Test Id	Fuel	Diameter	Setting	Time (min:sec)	Ignition (Yes/No)	Time to Ignition (min:sec)
TS.8.6.L	Food Storage Container (Polyethylene)	6”	Low	No test	No	
TS.8.6.M	Food Storage Container (Polyethylene)	6”	Medium	20:00	No	
TS.8.6.H	Food Storage Container (Polyethylene)	6”	High	20:00	No	
TS.8.8.L	Food Storage Container (Polyethylene)	8”	Low	No test	No	
TS.8.8.M	Food Storage Container (Polyethylene)	8”	Medium	20:00	No	
TS.8.8.H	Food Storage Container (Polyethylene)	8”	High	20:00	No	

TS.8.6.H: The test conducted using the Electric Coil Cooktop Appliance and a temperature control sensor with the polyethylene (Food Storage Container) using the 6-inch diameter heating element set to the high setting, resulted in no flaming ignition during a 20 minute test. The fuel did not show signs of ignition

TS.8.6.M: The test conducted using the Electric Coil Cooktop Appliance and a temperature control sensor with the polyethylene (Food Storage Container) using the 6-inch diameter heating element set to the medium setting, resulted in no flaming ignition during a 20 minute test. The fuel did not show signs of ignition.

TS.8.6.L: No test conducted. The test was not conducted because the fuel did not show the potential of ignition on the next higher setting.

TS.8.8.H: The test conducted using the Electric Coil Cooktop Appliance and a temperature control sensor with the polyethylene (Food Storage Container) using the 8-inch diameter heating element set to the high setting, resulted in no flaming ignition during a 20 minute test. The fuel did not show signs of ignition

TS.8.8.M: The test conducted using the Electric Coil Cooktop Appliance and a temperature control sensor with the polyethylene (Food Storage Container) using the 8-

inch diameter heating element set to the medium setting, resulted in no flaming ignition during a 20 minute test. The fuel did not show signs of ignition.

TS.8.8.L: No test conducted. The test was not conducted because the fuel did not show the potential of ignition on the next higher setting.

Table 44: Ignition Results of Temperature Control Sensor Cooktop and Corn Oil

Test Id	Fuel	Diameter	Setting	Time (min:sec)	Ignition (Yes/No)	Time to Ignition (min:sec)
TS.9.6.L	Corn Oil	6"	Low	No Test	No	
TS.9.6.M	Corn Oil	6"	Medium	25:00	No	
TS.9.6.H	Corn Oil	6"	High	25:00	No	
TS.9.8.L	Corn Oil	8"	Low	No Test	No	
TS.9.8.M	Corn Oil	8"	Medium	25:00	No	
TS.9.8.H	Corn Oil	8"	High	25:00	No	

TS.9.6.H: The test conducted using the Electric Coil Cooktop Appliance and a temperature control sensor with the corn oil using the 6-inch diameter heating element set to the high setting, resulted in no flaming ignition during a 25 minute test. The fuel did not show signs of ignition

TS.9.6.M: The test conducted using the Electric Coil Cooktop Appliance and a temperature control sensor with the corn oil using the 6-inch diameter heating element set to the medium setting, resulted in no flaming ignition during a 25 minute test. The fuel did not show signs of ignition.

TS.9.6.L: No test conducted. The test was not conducted because the fuel did not show the potential of ignition on the next higher setting.

TS.9.8.H: The test conducted using the Electric Coil Cooktop Appliance and a temperature control sensor with the corn oil using the 8-inch diameter heating element set to the high setting, resulted in no flaming ignition during a 25 minute test. The fuel did not show signs of ignition

TS.9.8.M: The test conducted using the Electric Coil Cooktop Appliance and a temperature control sensor with the corn oil using the 8-inch diameter heating element set

to the medium setting, resulted in no flaming ignition during a 25 minute test. The fuel did not show signs of ignition.

TS.9.8.L: No test conducted. The test was not conducted because the fuel did not show the potential of ignition on the next higher setting.

CHAPTER FIVE

DISCUSION AND CONCLUSIONS

A study was conducted to evaluate the competency of several types of electric cooktop ranges igniting a variety of common kitchen items. Four types of electric cooktop ranges were tested including a ceramic-glass cooktop range, an electric coil range, an electric coil cooktop with a cast iron plate installed, and an electric coil cooktop range with a temperature-limiting control sensor. The latest research was reviewed to select a representative sample of fuels commonly noted as the first fuel ignited in kitchen fires. The nine selected fuels included cardboard (pizza box), a cotton dish towel, a roll of paper towels, a pan of canola oil, a pan of vegetable oil, a nylon short turn spatula (cooking utensil), a kitchen appliance (toaster), a plastic storage container, a pan of corn oil.

The maximum temperatures and heat fluxes were achieved with the 8-inch diameter heating element on the electric coil cooktop. The variation in maximum temperature of the 8-inch heating elements had much to do with the 600 wattage output differences between the two different cooktop types. A summary of the ignition results can be found in Table 45.

The high setting for all three cooktop types, excluding the temperature-limiting sensor cooktops, tested at both the 6-inch and 8-inch diameter heating element resulted in the ignition of 47 of 54 potential tests. The temperature-limiting sensor cooktop did not ignite any of the fuels on any setting. Table 45 quickly illustrates, as logic would, that the potential for ignition is greatest when the cooktop is set to the high setting. Although not all fuels ignited at the high setting, it was noted that the potential for ignition was

possible due to the quick consumption of mass, smoldering combustion (cellulosic fuels), and increased volume of vaporization/pyrolysis products. The high setting for all three cooktop types showed the maximum potential for ignition based on the total heat output produced by the 6-inch diameter and 8-inch diameter heating elements.

The medium setting for all three cooktop types for both diameter heating elements resulted in few instances of flaming combustion of the fuels. Approximately half of the fuels tested on the ceramic-glass cooktop ignited at the medium setting, while it was more difficult to ignite fuels on the electric coil and cast iron plate cooktops. Although only select fuels ignited on the different electric range types tested at the medium-setting, it was noted that a majority of the fuels did demonstrate the potential of reaching flaming combustion through evidence of smoldering combustion and significant loss of mass for those cooktops without the temperature-limiting sensor. The medium setting for all three ranges demonstrated moderate potential for ignition based on the total heat output produced by the 6-inch diameter and 8 inch diameter heating elements. No fuels ignited at the medium setting for the temperature-limiting sensor cooktop.

The low setting for all four cooktop types tested for both the 6-inch and the 8-inch diameter heating element resulted in no flaming ignition. All tests conducted using the three different electric range types for both the 6-inch and 8-inch diameter heating elements demonstrated no potential for ignition of any of the fuels tested. Based on the research conducted it can be concluded that the low setting for all three electric range types has minor-to-no potential for ignition of the fuels tested.

Table 45: Summary of Ignition Results (Y=Yes, N=No for Ignition)

	Dia	Ceramic-Glass			Coil			Cast Iron Plate			Temperature-limiting Sensor		
		High	Medium	Low	High	Medium	Low	High	Medium	Low	High	Medium	Low
Cardboard	6”	Y	Y	N	Y	Y	N	Y	Y	N	N	N	N
	8”	Y	Y	N	N	Y	N	N	Y	N	N	N	N
Dish Towel	6”	Y	Y	N	Y	Y	N	Y	N	N	N	N	N
	8”	Y	Y	N	Y	Y	N	Y	N	N	N	N	N
Paper Towel	6”	Y	Y	N	Y	N	N	Y	N	N	N	N	N
	8”	Y	Y	N	Y	N	N	Y	N	N	N	N	N
Canola Oil	6”	Y	Y	N	Y	N	N	Y	N	N	N	N	N
	8”	Y	N	N	Y	N	N	Y	N	N	N	N	N
Vegetable Oil	6”	Y	Y	N	Y	N	N	Y	N	N	N	N	N
	8”	Y	N	N	Y	N	N	Y	N	N	N	N	N
Nylon Spatula	6”	Y	N	N	Y	N	N	Y	N	N	N	N	N
	8”	N	N	N	Y	N	N	Y	N	N	N	N	N
Toaster	6”	Y	N	N	Y	N	N	Y	N	N	N	N	N
	8”	Y	N	N	Y	N	N	Y	N	N	N	N	N
Food Storage Container	6”	N	N	N	Y	N	N	Y	N	N	N	N	N
	8”	N	N	N	Y	N	N	Y	N	N	N	N	N
Corn Oil	6”	N	N	N	N	N	N	N	N	N	N	N	N
	8”	N	N	N	Y	N	N	Y	N	N	N	N	N

5.1 Future Testing

Further research in this area would enhance the understanding of how kitchen ranges may serve as a competent ignition source to common household kitchen items. Do to the number of materials tested on the four different electric cooktop range types, few tests were conducted multiple times. Conducting additional multiple tests would further validate the findings. Some fuels ignited on the same element size on a lower setting when compared to its higher setting. This observation needs multiply test conducted to evaluate how energy output relates to mass loss and potential for ignition. In addition, further testing needs to be conducted on the fuels identified relating to their orientation and placement of the fuels on the heating elements. The tests conducted here only evaluated one orientation of the fuel on the heating element. Additional tests need to be conducted to establish if a change in orientation of fuel results in different findings

CHAPTER SIX

REFRENCES

Ahrens, M. (2011). *Home Fires Involving Cooking Equipment.* NFPA: Quincy, MA.

ASTM E459-05 (2011). *Standard Test Method for Measuring Heat Transfer Rate Using a Thin-Skin Calorimeter.* ASTM International: West Conshohocken, PA.

Alston, J. (2004). *Room/Corner Fire Calibration Data: Marine Composite Screening Specimens.* Masters thesis, Worcester Polytechnic Institute: Worcester, MA.

Babrauskas, V. (2003). *Ignition Handbook.* Fire Science Publishers: Issaquah, WA.

Buda-Ortins, K., and Sunderland, P. (2010). *Auto-Ignition of Cooking Oils*. Department of Fire Protection Engineering. University of Maryland: College Park, MD.

FEMA (2005). *Structure Cooking Fire: Volume 5, Issue 6.* FEMA/USFA: Emmitsburg, MD. Retrieved June 20, 2012, from: http://www.usfa.fema.gov/downloads/pdf/statistics/v5i6.pdf

Fire Findings (1997). *Kitchen Fire: Electric Range Tests Produce Results Similar to 1993 Gas Range Experiment.* Volume 5, No. 3. Fire Findings: Benton Harbor, MI.

Fire Findings (2000). *New Range's Coils Heat Faster and Hotter.* Volume 8, No.2. Fire Findings: Benton Harbor, MI.

Karter, M. (2011). *Fire Loss in the U.S. During 2010.* NFPA: Quincy, MA.

Kitchen fire prevention technologies workshop report. (2010, November). Retrieved from http://www.strategicfire.org/images/ueserfiles/files/kitchen Final Report.pdf

Mowrer, F. (2003). *Ignition Characteristics of Various Fire Indicators Subjected to Radiant Heat Fluxes.* Fire and Materials, Interscience: San Francisco, CA.

Ohlemiller, T., and Villa, K. (1991). *Material Flammability Test Assessment for the Space Station Freedom,* Technical Report NISTIR 4591, National Institute of Standards and Technology: Gaithersburg, MD.

OnSpex Consumer Product Evaluation, "Cooking Performance Comparison," Tech. Report Number 30013030, Canadian Standards Association, February 2010.

Pioneering Technology. (2012). Safe-T-Element Product Brochure. Retrieved June 20, 2012, from: *http://www.pioneeringtech.com/sites/default/files/STE-sellsheet-web%20%281%29.pdf*

Underwriters Laboratories Inc., "Safe-T-element Special Investigation on Safe-T-Element," January 2005

Appendix A – Specifications of Electric Ranges

Specifications for the Electric Coil Cooktop Range: GE JBP23DRWW

ADA Compliant	No	**ANSI Certified**	Yes
Amperage (amp)	40.0	**Appliance Thermostat**	Electro-Mechanical
Assembled Depth (in.)	27.75 in	**Assembled Height (in.)**	46.88 in
Assembled Width (in.)	29.88 in	**Baby UPC**	084691230052
Broiler Location	Oven	**Broiler Watt Range**	2480-3410
CASE DEPTH (In decimal format)	30.2	**CSA Listed**	No
Capacity of Oven (cu. ft.)	5.3	**Cleaning Type**	Self Cleaning
Clock	Yes	**Color of Cooktop**	White
Color/Finish	White	**Color/Finish Family**	White
Control Lockout	No	**Control Type**	Electronic
Convection	No	**Convection Type**	None
Cooktop Surface Type	Coil	**Cut-Out Depth (in.)**	27.75 in
Cut-Out Height (in.)	46.88 in	**Cut-Out Width (in.)**	29.88 in
Delay Bake Option (Time Bake)	Yes	**Digital Display**	Yes
Downdraft Exhaust	No	**ETL Listed**	No
ETL Safety Listed	No	**Element No.1 Size (In.)**	8.0
Element No.1 Type	Coil	**Element No.1 Wattage**	2600
Element No.2 Size (In.)	8.0	**Element No.2 Type**	Coil
Element No.2 Wattage	2600	**Element No.3 Size (In.)**	6.0
Element No.3 Type	Coil	**Element No.3 Wattage**	1500
Element No.4 Size (In.)	6.0	**Element No.4 Type**	Coil
Element No.4 Wattage	1500	**Energy Star Compliant**	No
ExcludedSellToStates	Ontario	**Food Temperature Probe**	No
Fuel Type	Electric	**Griddle**	No
Heating Element On Indicator Light	Yes	**Hidden Bake Element**	No
Hot Surface Indicator Light	No	**Item Package Type**	Cardboard Container

Specifications for the Electric Coil Cooktop Range: GE JBP23DRWW

Continued:

Item Package UOM	Pieces	**Manufacturer Warranty**	Limited 1-year entire appliance
NSF Listed	No	**Number of Elements**	4
Number of Glide/Rollout Racks	2	**Oven Light**	Yes
Oven Racks	2	**Oven Window**	Yes
Pan Presence Sensor	No	**Pan Size Sensor**	No
Power Cord Included	No	**Product Depth (in.)**	27.75 in
Product Height (in.)	46.88 in	**Product Weight (lb.)**	149 lb
Product Width (in.)	29.88 in	**Proofing Mode**	No
Range Type	Freestanding	**Returnable**	Non-Returnable
Sabbath Mode	Yes	**Self-Cleaning**	Yes
Sell Pack (Baby)	1	**Specific Color**	White
Surface Material	Other	**Voltage (volts)**	240.0 V
Warming Drawer	No		

Specifications for the Electric Ceramic-Glass Cooktop Range: GE JBS55DMWW

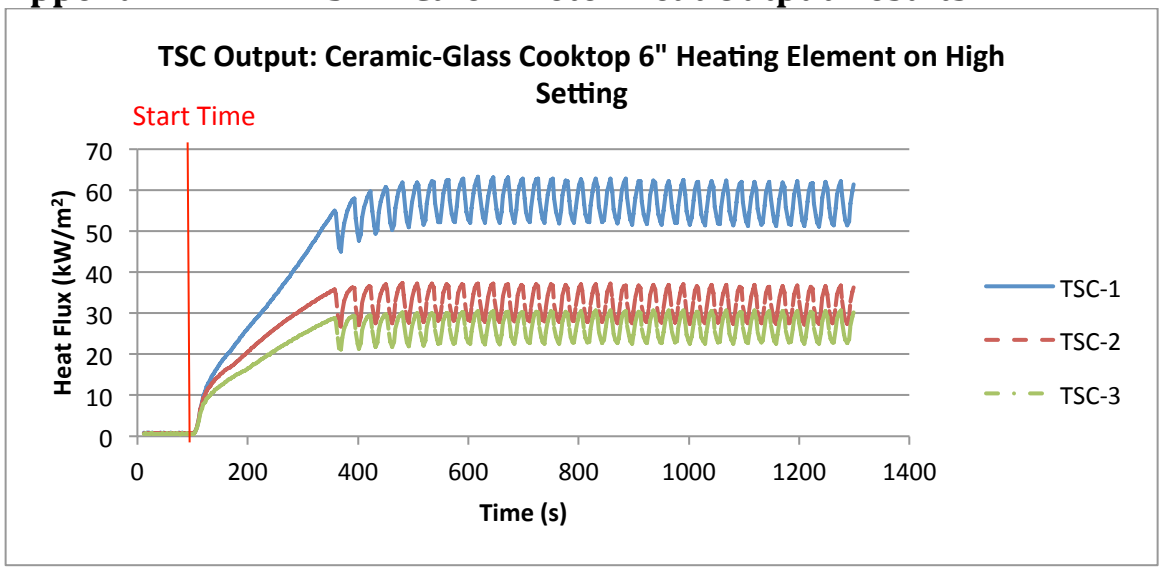
ADA Compliant	No	**ANSI Certified**	No
Amperage (amp)	40.0	**Assembled Depth (in.)**	27.75 in
Assembled Height (in.)	46.88 in	**Assembled Width (in.)**	29.88 in
Broiler Location	Oven	**Broiler Watt Range**	3410
CSA Listed	No	**Capacity of Oven (cu. ft.)**	5.3
Cleaning Type	Manual Clean	**Clock**	Yes
Color of Cooktop	White	**Color/Finish**	White
Color/Finish Family	White	**Control Lockout**	No
Control Type	Electro-Mechanical	**Convection**	No
Convection Type	None	**Cooktop Surface Type**	Smooth Surface
Cut-Out Depth (in.)	27.75 in	**Cut-Out Height (in.)**	46.88 in
Cut-Out Width (in.)	29.88 in	**Delay Bake Option (Time Bake)**	No
Digital Display	Yes	**Downdraft Exhaust**	No
ETL Listed	No	**ETL Safety Listed**	No
Element No.1 Size (In.)	8.0	**Element No.1 Type**	Radiant
Element No.1 Wattage	2000	**Element No.2 Size (In.)**	8.0
Element No.2 Type	Radiant	**Element No.2 Wattage**	2000
Element No.3 Size (In.)	6.0	**Element No.3 Type**	Radiant
Element No.3 Wattage	1500	**Element No.4 Size (In.)**	6.0
Element No.4 Type	Radiant	**Element No.4 Wattage**	1500
Energy Star Compliant	No	**Food Temperature Probe**	No
Fuel Type	Electric	**Griddle**	No
Heating Element On Indicator Light	Yes	**Hidden Bake Element**	No
Hot Surface Indicator Light	Yes	**Item Package Type**	Cardboard Container
Manufacturer Warranty	Limited 1-year entire appliance	**NSF Listed**	No
Number of Elements	4	**Number of Glide/Rollout Racks**	2

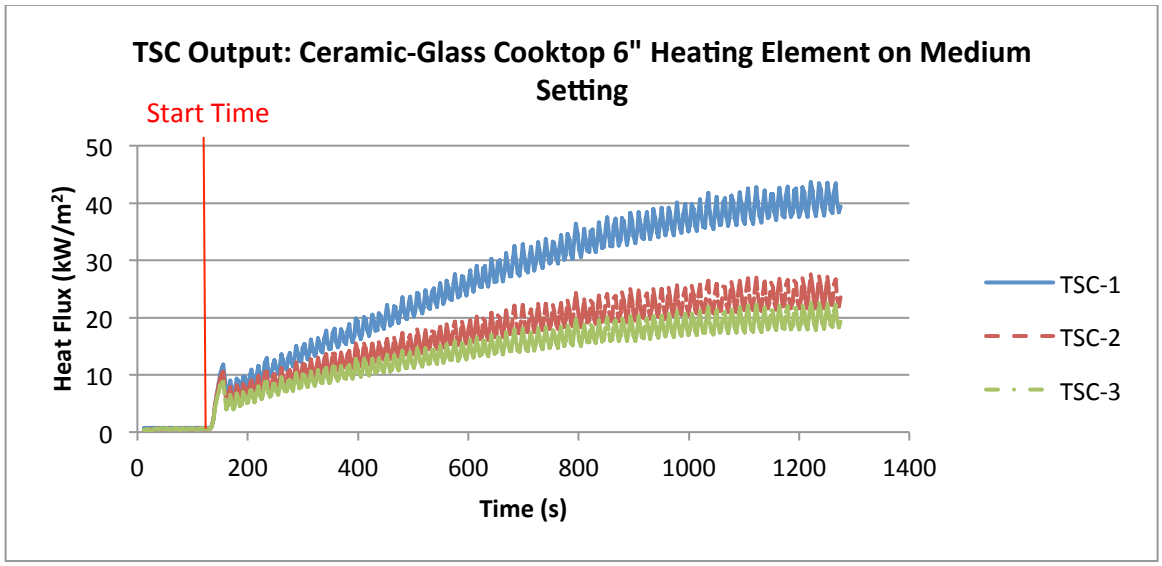
Specifications for the Electric Ceramic-Glass Cooktop Range: GE JBS55DMWW

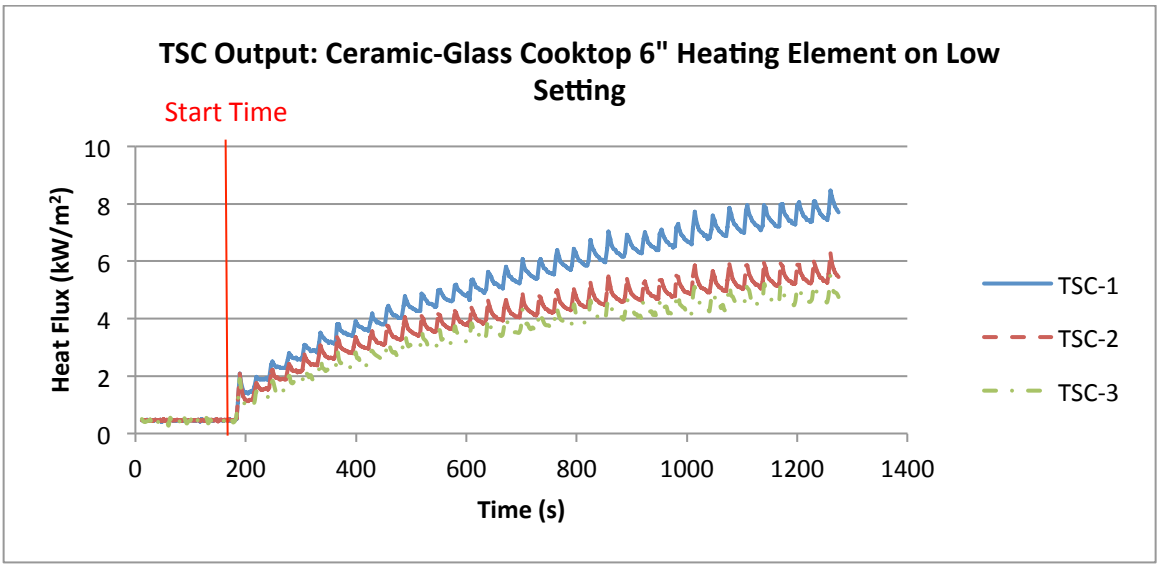
Continued:

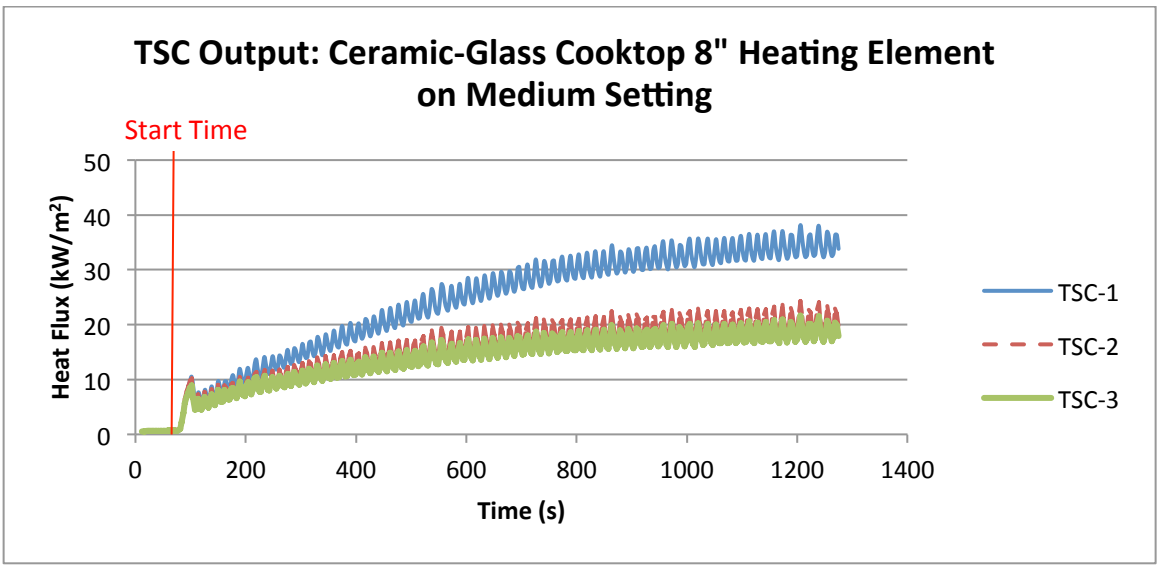
Oven Light	Yes	**Oven Racks**	2
Oven Window	Yes	**Pan Presence Sensor**	No
Pan Size Sensor	No	**Power Cord Included**	No
Product Depth (in.)	27.75 in	**Product Height (in.)**	46.88 in
Product Weight (lb.)	141 lb	**Product Width (in.)**	29.88 in
Proofing Mode	No	**Range Type**	Freestanding
Returnable	Non-Returnable	**Sabbath Mode**	Yes
Self-Cleaning	No	**Specific Color**	White
Voltage (volts)	240.0 V	**Warming Drawer**	No

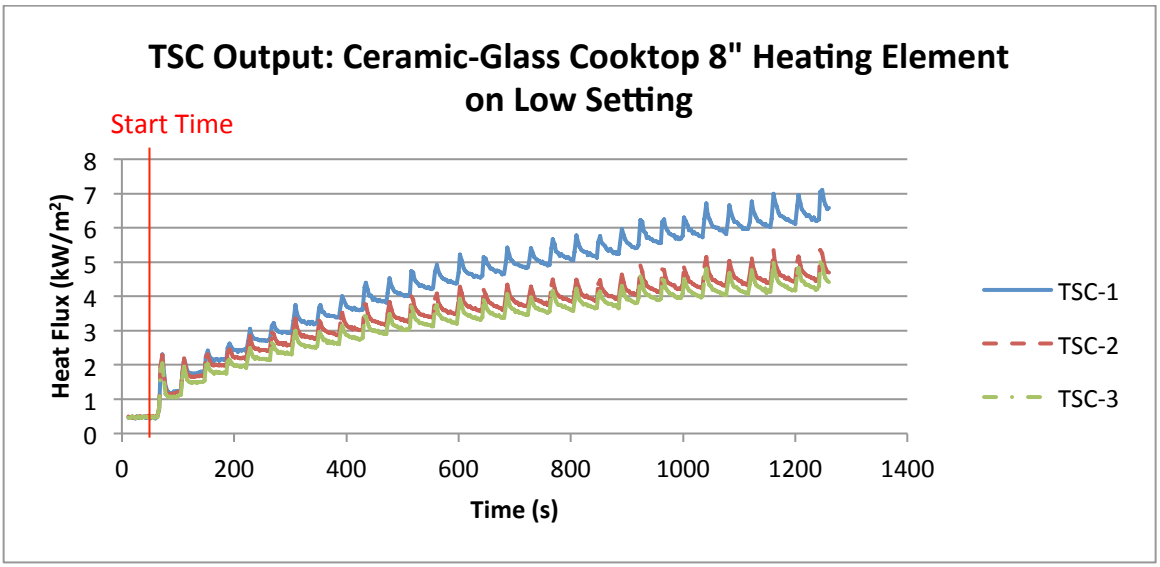
Appendix B – Thin Skin Calorimeter Heat Output Results:

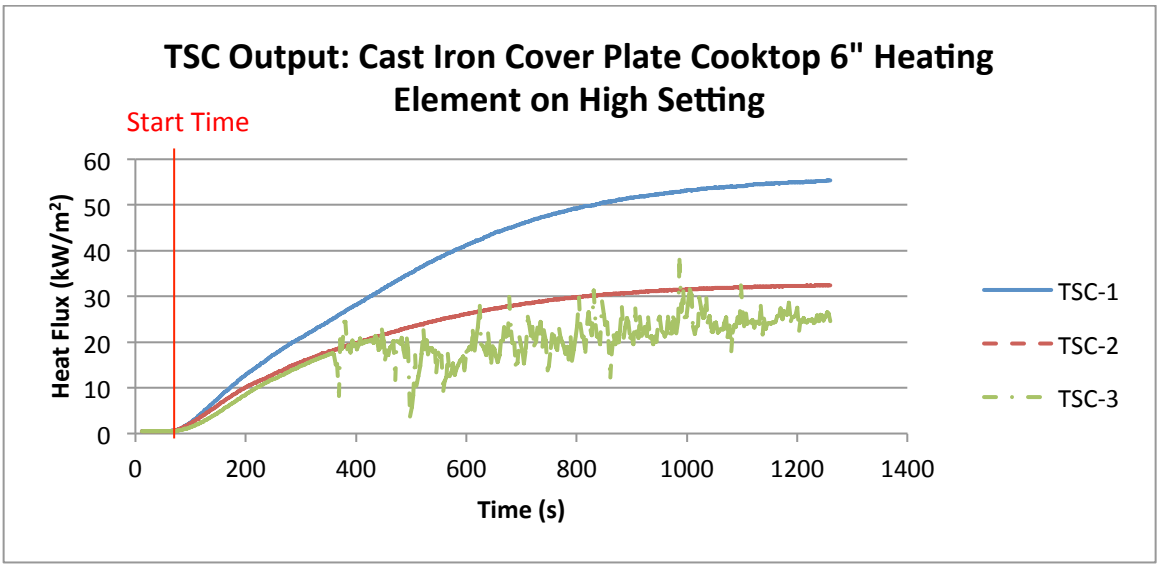


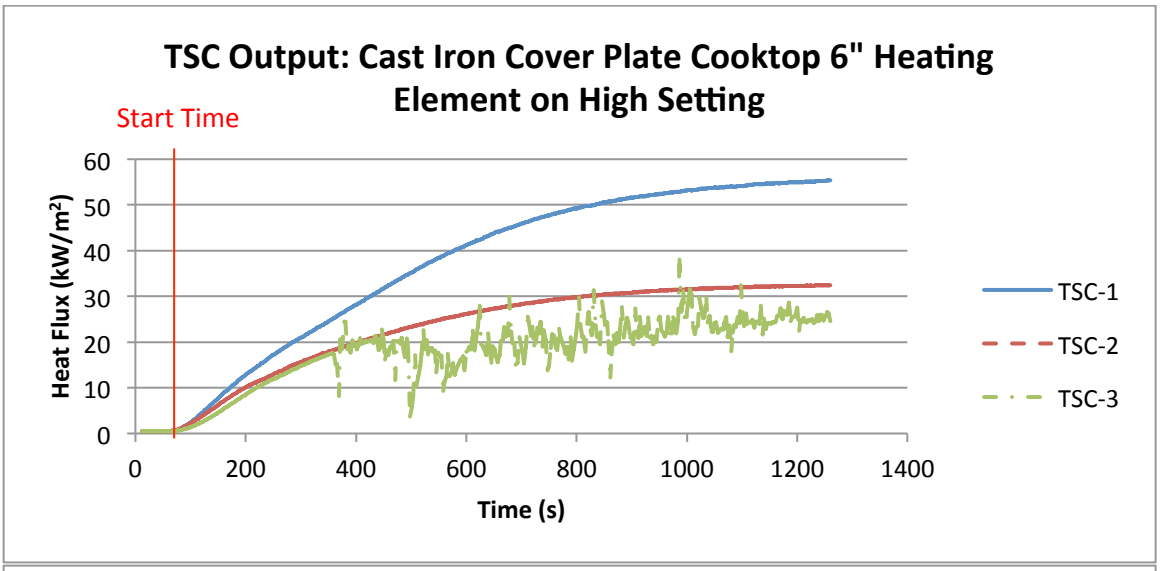


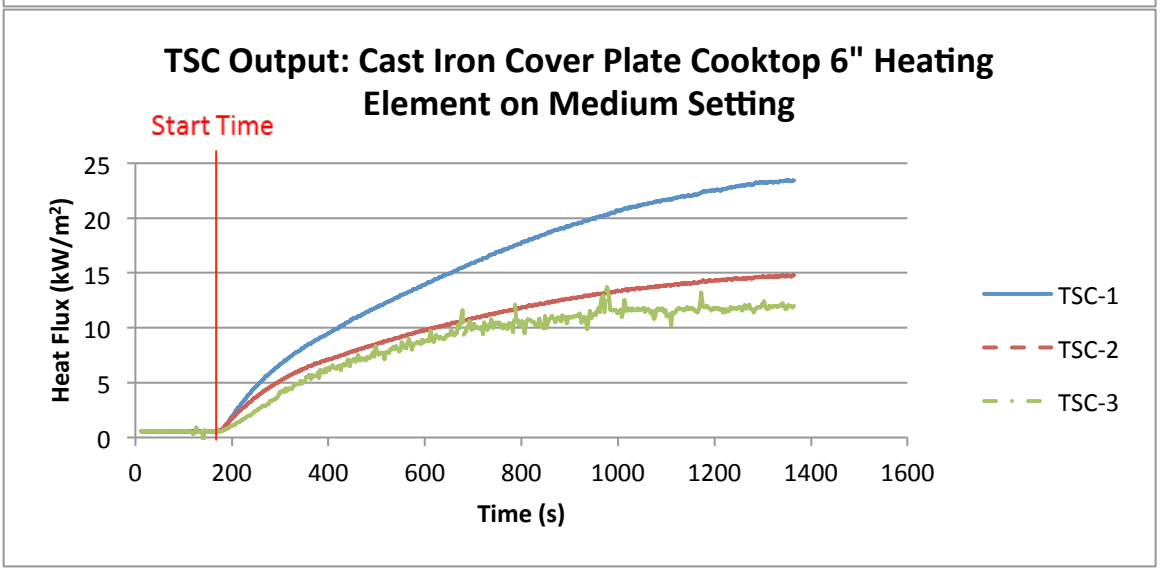

TSC Output: Ceramic-Glass Cooktop 6" Heating Element on Low Setting
Start Time
Heat Flux (kW/m²)
0
2
4
6
8
10
0
200
400
600
800
1000
1200
1400
Time (s)
TSC-1
TSC-2
TSC-3

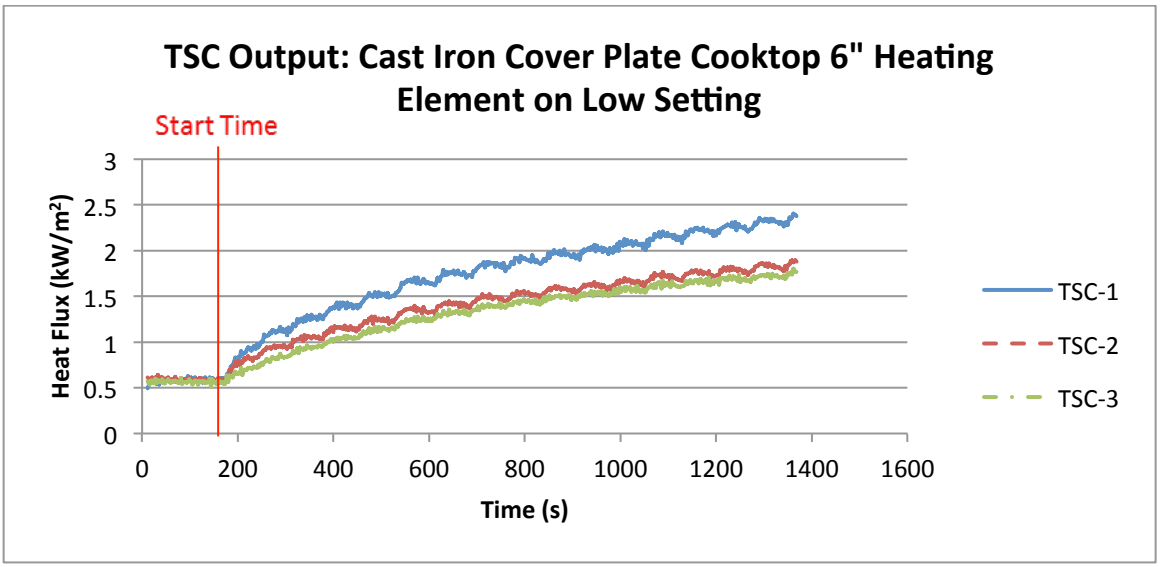

TSC Output: Ceramic-Glass Cooktop 8" Heating Element on Medium Setting
Start Time
Heat Flux (kW/m²)
0
10
20
30
40
50
0
200
400
600
800
1000
1200
1400
Time (s)
TSC-1
TSC-2
TSC-3

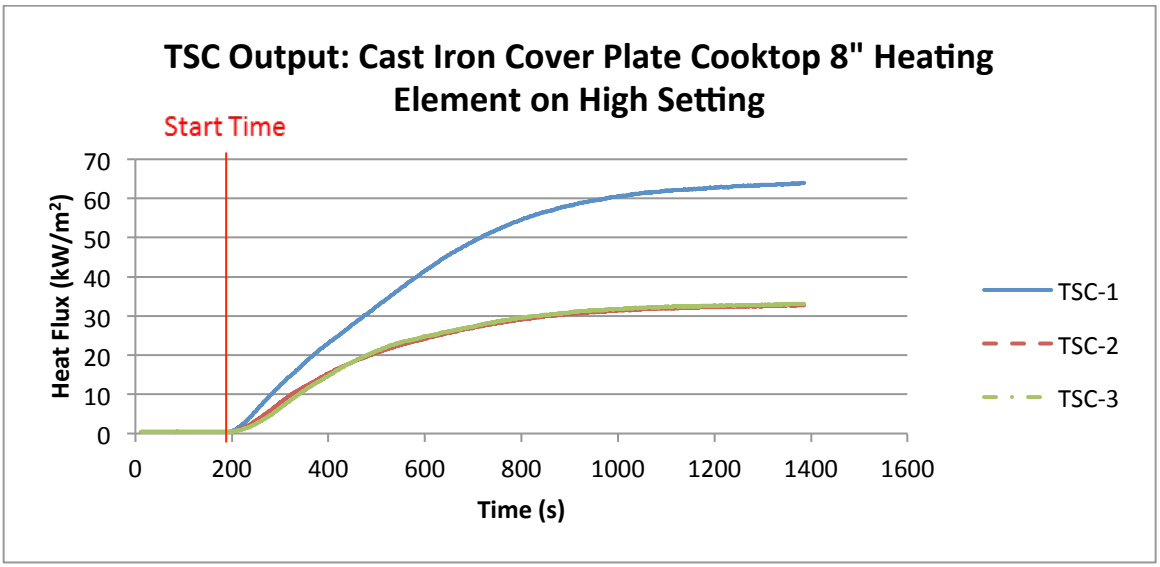

TSC Output: Ceramic-Glass Cooktop 8" Heating Element on Low Setting
Start Time
Heat Flux (kW/m²)
0
1
2
3
4
5
6
7
8
0
200
400
600
800
1000
1200
1400
Time (s)
TSC-1
TSC-2
TSC-3

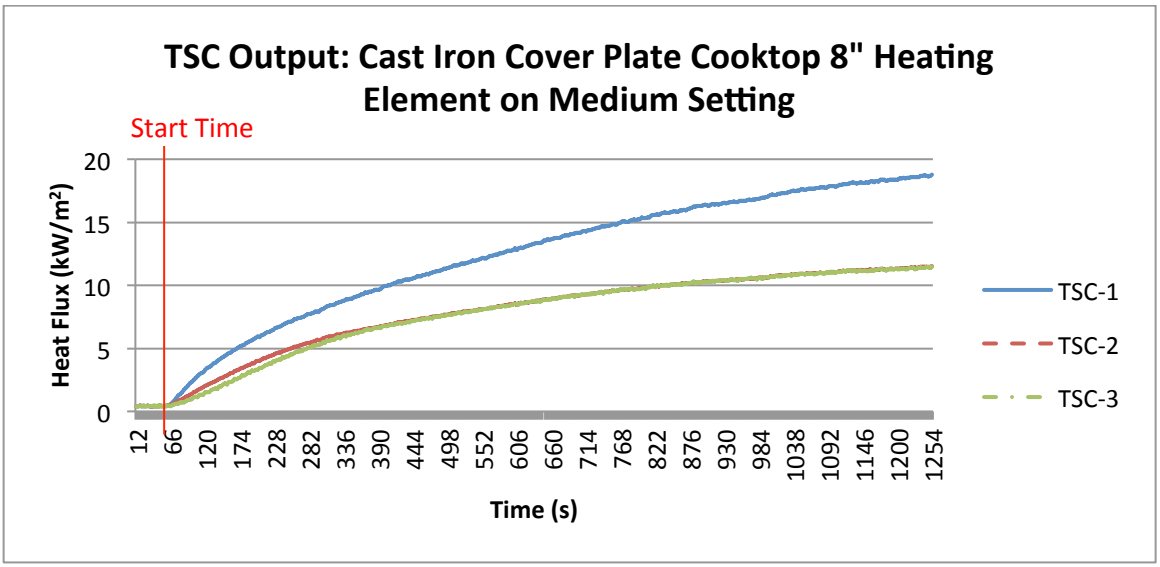

TSC Output: Cast Iron Cover Plate Cooktop 6" Heating Element on High Setting
Start Time
Heat Flux (kW/m²)
0
10
20
30
40
50
60
0
200
400
600
800
1000
1200
1400
Time (s)
TSC-1
TSC-2
TSC-3

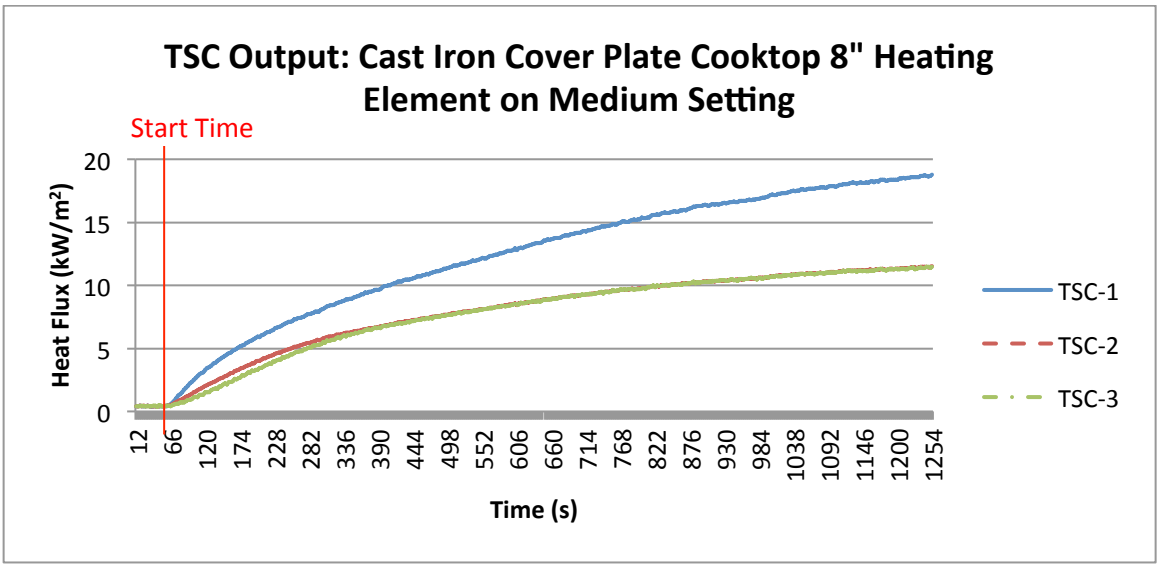

TSC Output: Cast Iron Cover Plate Cooktop 6" Heating Element on High Setting
Start Time
Heat Flux (kW/m²)
60
50
40
30
20
10
0
0
200
400
600
800
1000
1200
1400
Time (s)
TSC-1
TSC-2
TSC-3

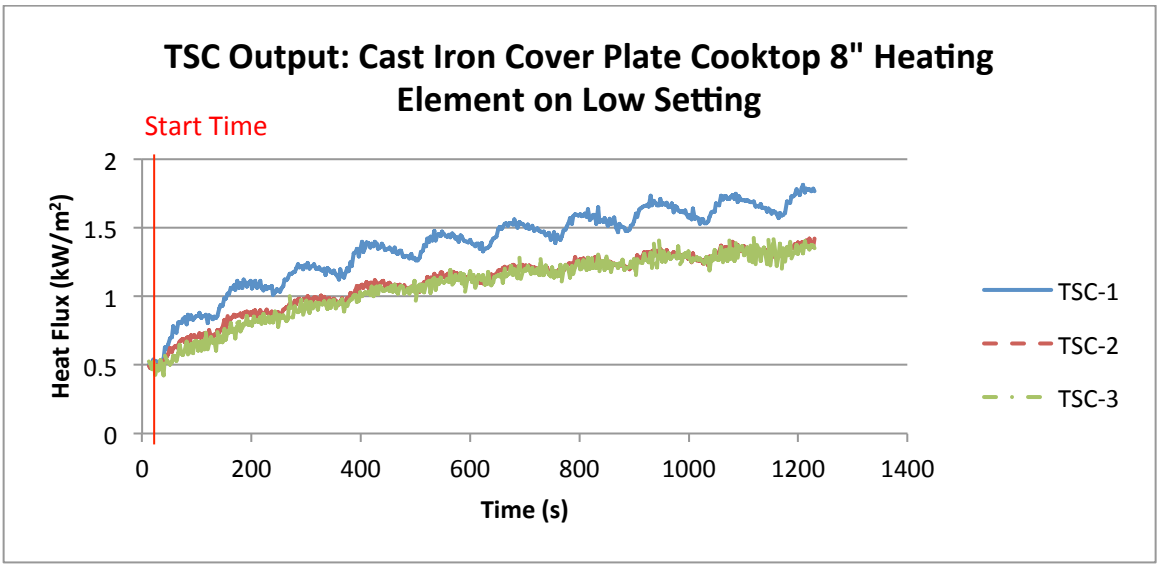

TSC Output: Cast Iron Cover Plate Cooktop 6" Heating Element on Medium Setting
Start Time
Heat Flux (kW/m²)
25
20
15
10
5
0
0
200
400
600
800
1000
1200
1400
1600
Time (s)
TSC-1
TSC-2
TSC-3

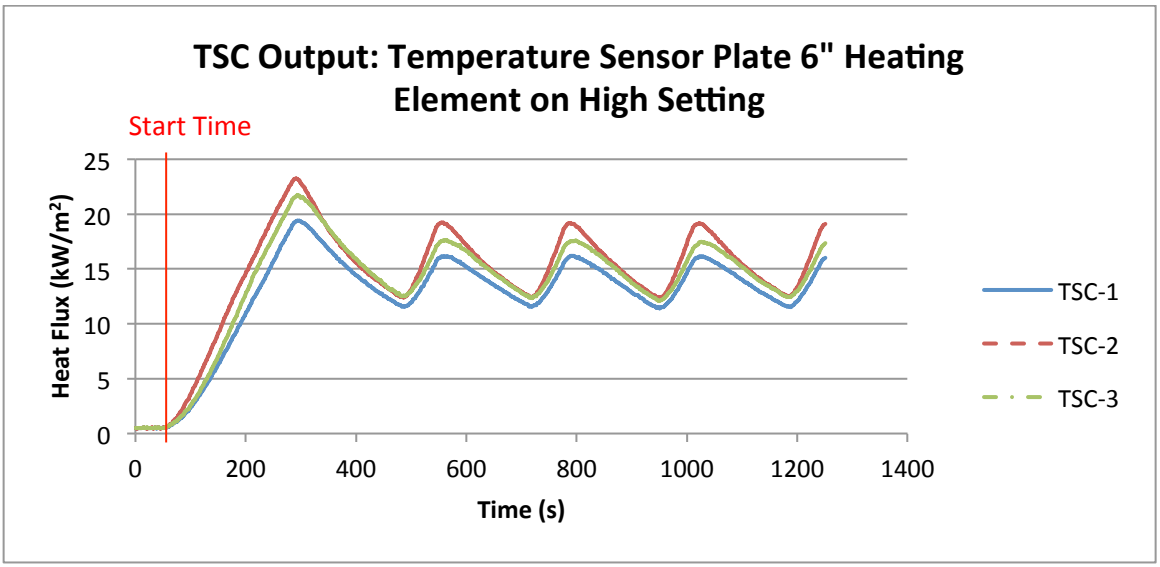

TSC Output: Cast Iron Cover Plate Cooktop 6" Heating Element on Low Setting
Start Time
Heat Flux (kW/m²)
3
2.5
2
1.5
1
0.5
0
0
200
400
600
800
1000
1200
1400
1600
Time (s)
TSC-1
TSC-2
TSC-3

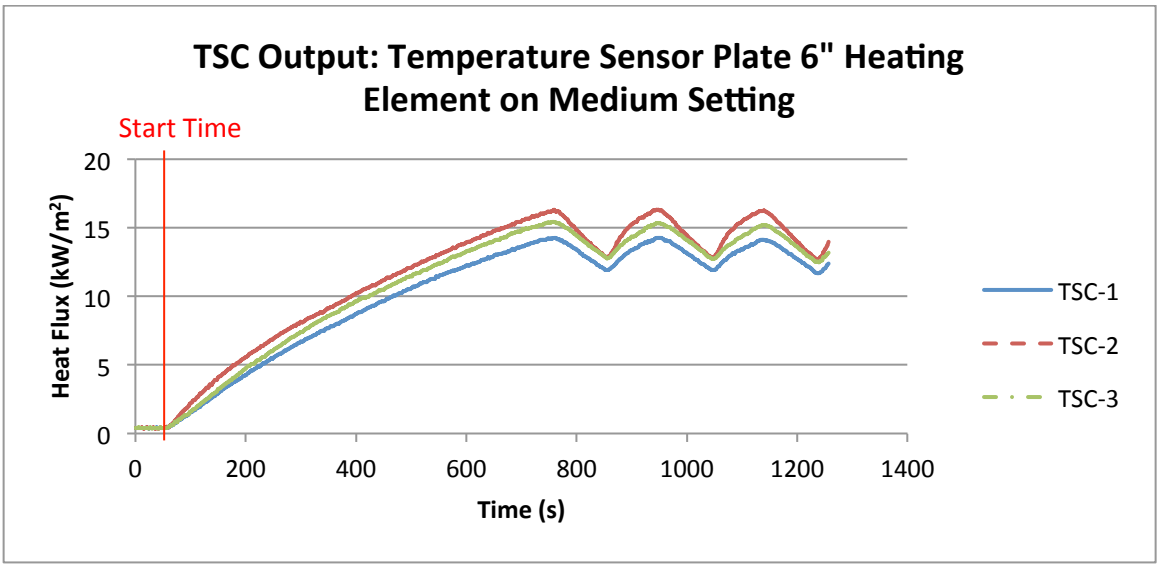

TSC Output: Cast Iron Cover Plate Cooktop 8" Heating Element on High Setting
Start Time
Heat Flux (kW/m²)
70
60
50
40
30
20
10
0
0
200
400
600
800
1000
1200
1400
1600
Time (s)
TSC-1
TSC-2
TSC-3

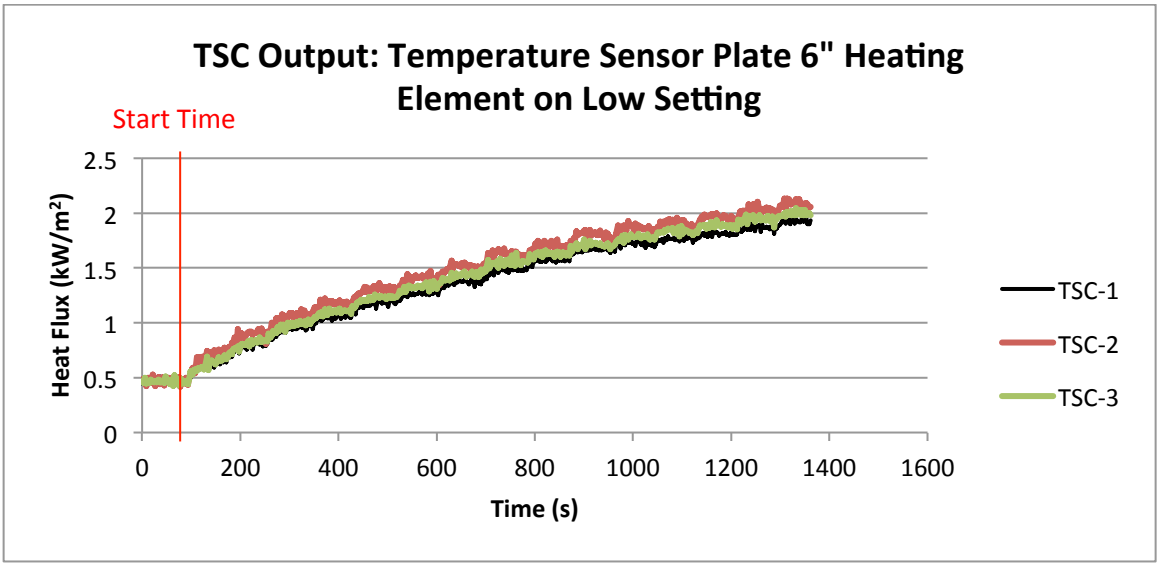

TSC Output: Cast Iron Cover Plate Cooktop 8" Heating Element on Medium Setting
Start Time
Heat Flux (kW/m²)
0
5
10
15
20
12
66
120
174
228
282
336
390
444
498
552
606
660
714
768
822
876
930
984
1038
1092
1146
1200
1254
Time (s)
TSC-1
TSC-2
TSC-3

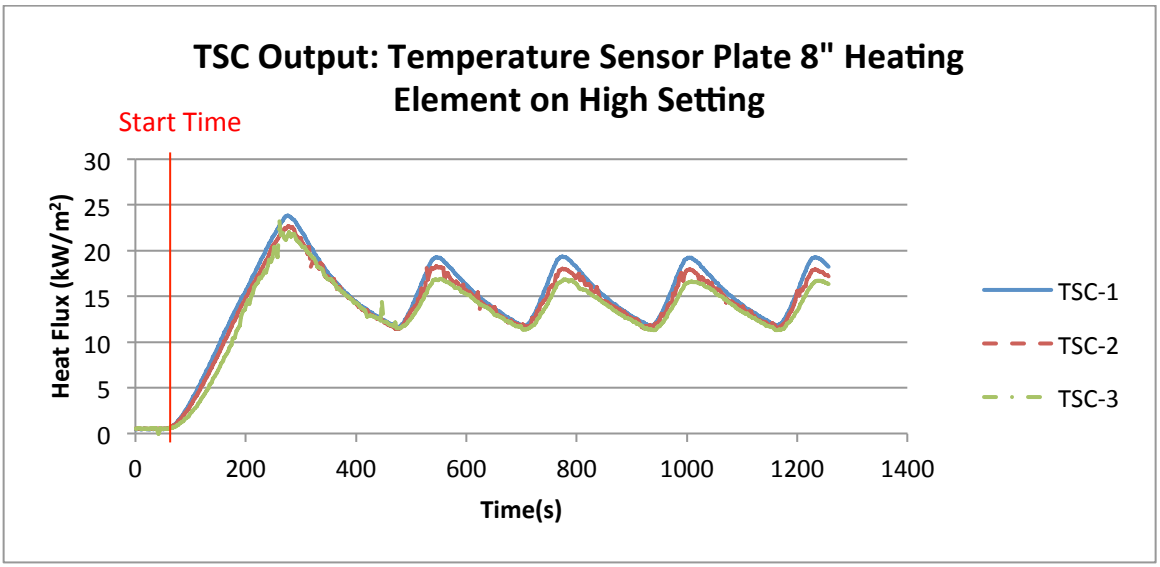

TSC Output: Cast Iron Cover Plate Cooktop 8" Heating Element on Medium Setting
Start Time
Heat Flux (kW/m²)
0
5
10
15
20
12
66
120
174
228
282
336
390
444
498
552
606
660
714
768
822
876
930
984
1038
1092
1146
1200
1254
Time (s)
TSC-1
TSC-2
TSC-3

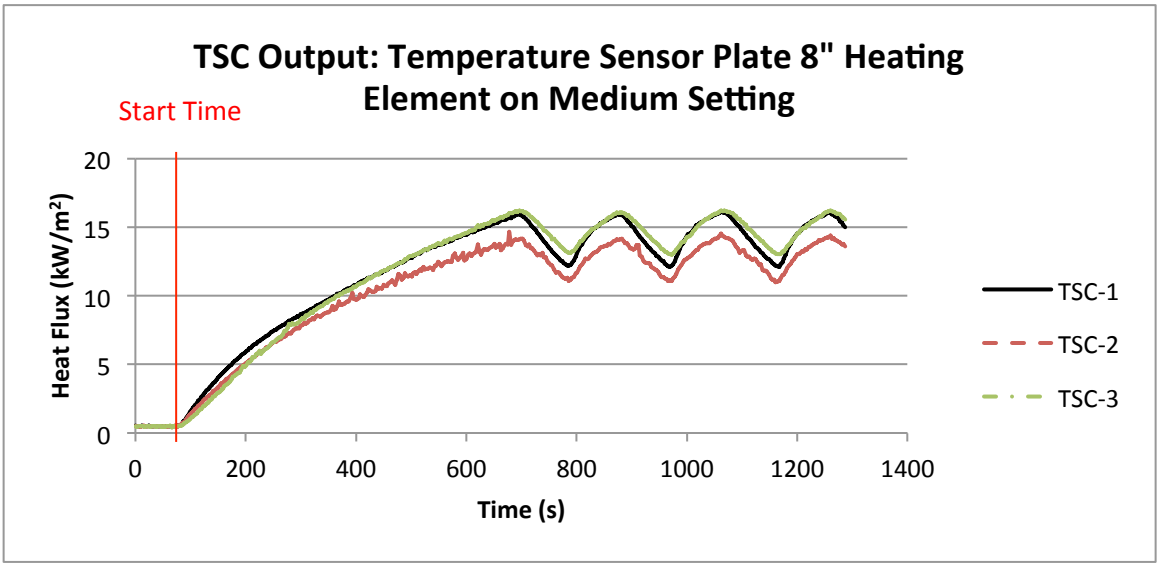

TSC Output: Cast Iron Cover Plate Cooktop 8" Heating Element on Low Setting
Start Time
Heat Flux (kW/m²)
2
1.5
1
0.5
0
0
200
400
600
800
1000
1200
1400
Time (s)
TSC-1
TSC-2
TSC-3

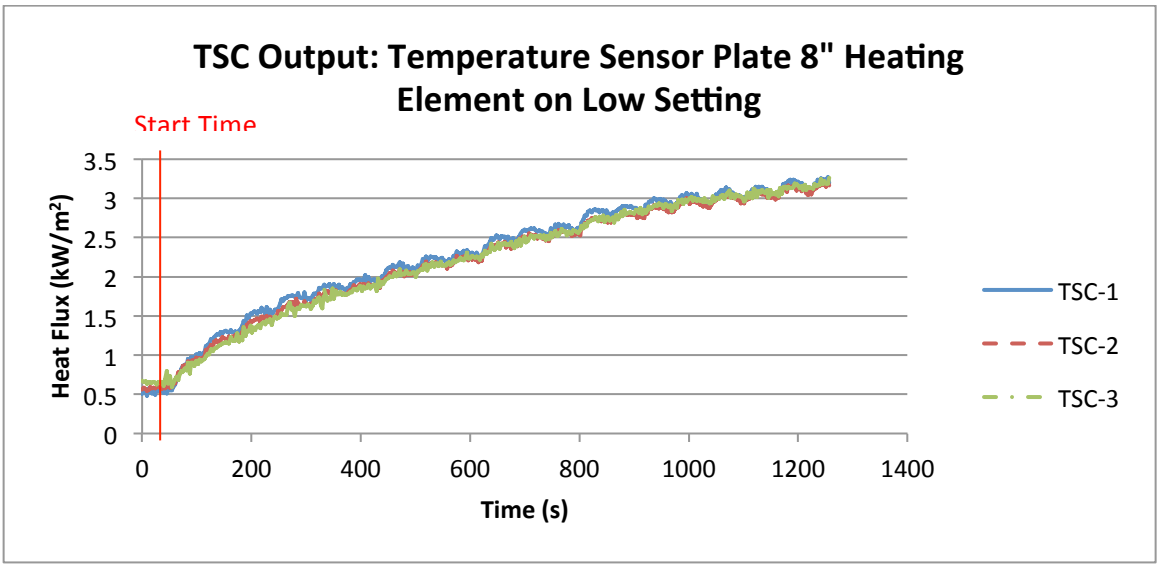

TSC Output: Temperature Sensor Plate 6" Heating Element on High Setting
Start Time
Heat Flux (kW/m²)
25
20
15
10
5
0
0
200
400
600
800
1000
1200
1400
Time (s)
TSC-1
TSC-2
TSC-3

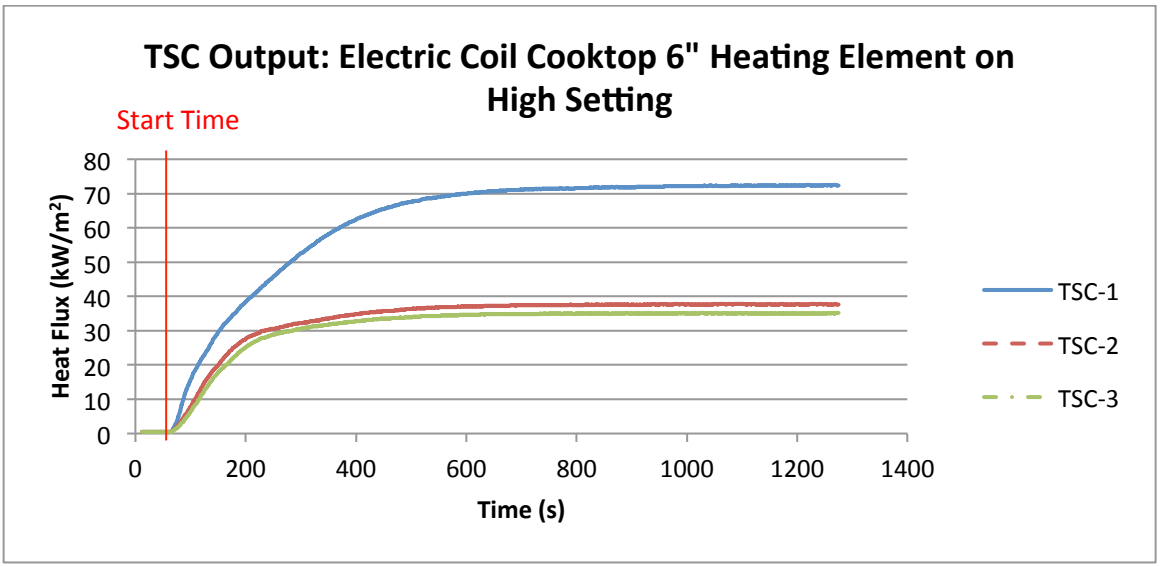

TSC Output: Temperature Sensor Plate 6" Heating Element on Medium Setting
Start Time
Heat Flux (kW/m²)
20
15
10
5
0
0
200
400
600
800
1000
1200
1400
Time (s)
TSC-1
TSC-2
TSC-3

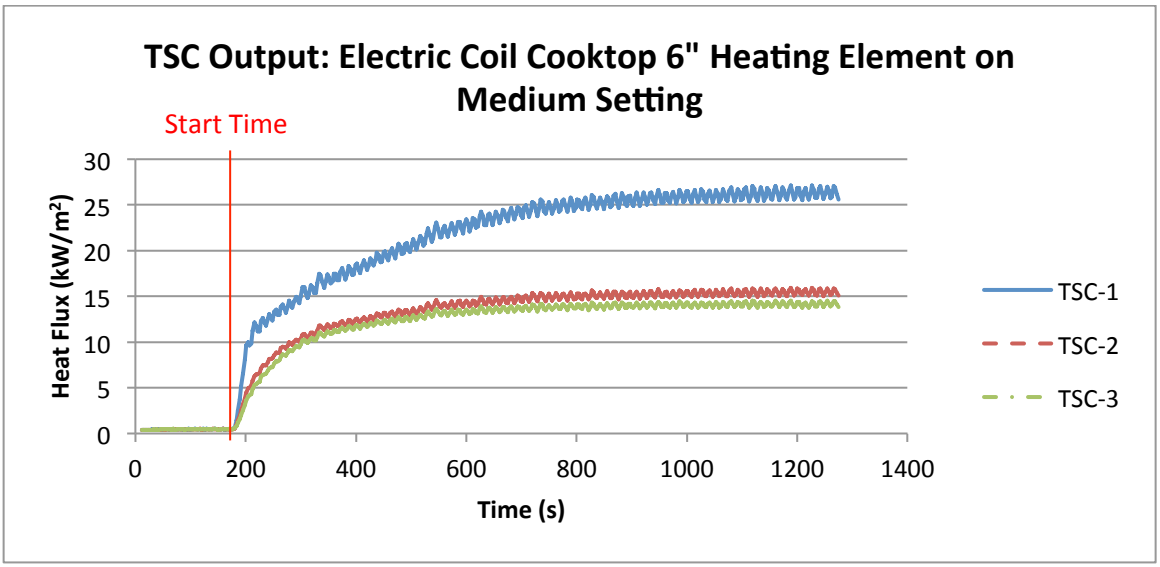

TSC Output: Temperature Sensor Plate 6" Heating Element on Low Setting
Start Time
Heat Flux (kW/m²)
2.5
2
1.5
1
0.5
0
0
200
400
600
800
1000
1200
1400
1600
Time (s)
TSC-1
TSC-2
TSC-3

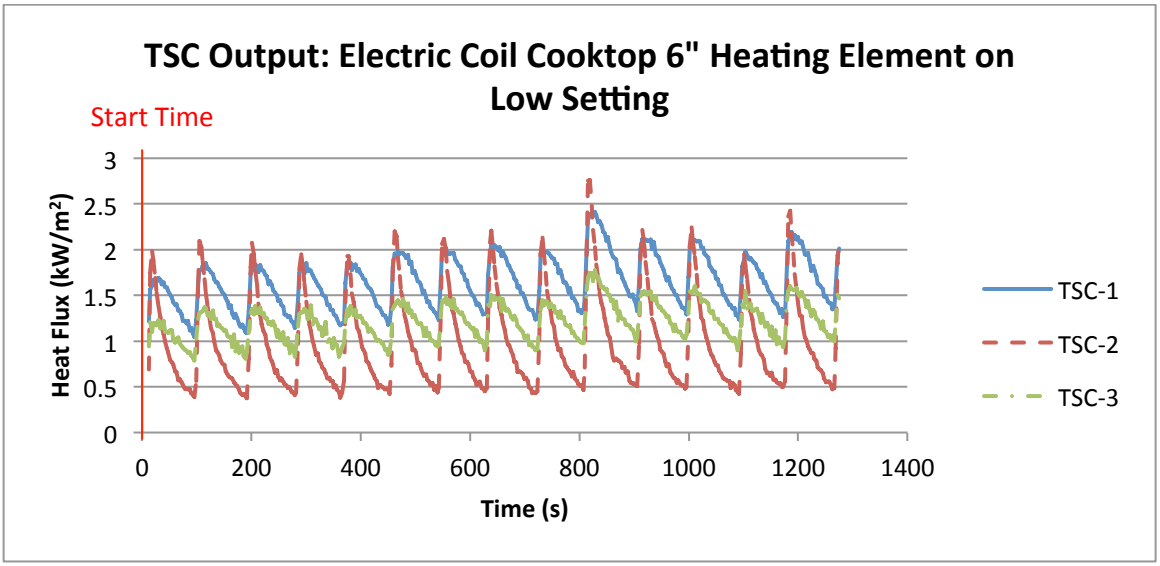

TSC Output: Temperature Sensor Plate 8" Heating Element on High Setting
Start Time
Heat Flux (kW/m²)
30
25
20
15
10
5
0
0
200
400
600
800
1000
1200
1400
Time(s)
TSC-1
TSC-2
TSC-3

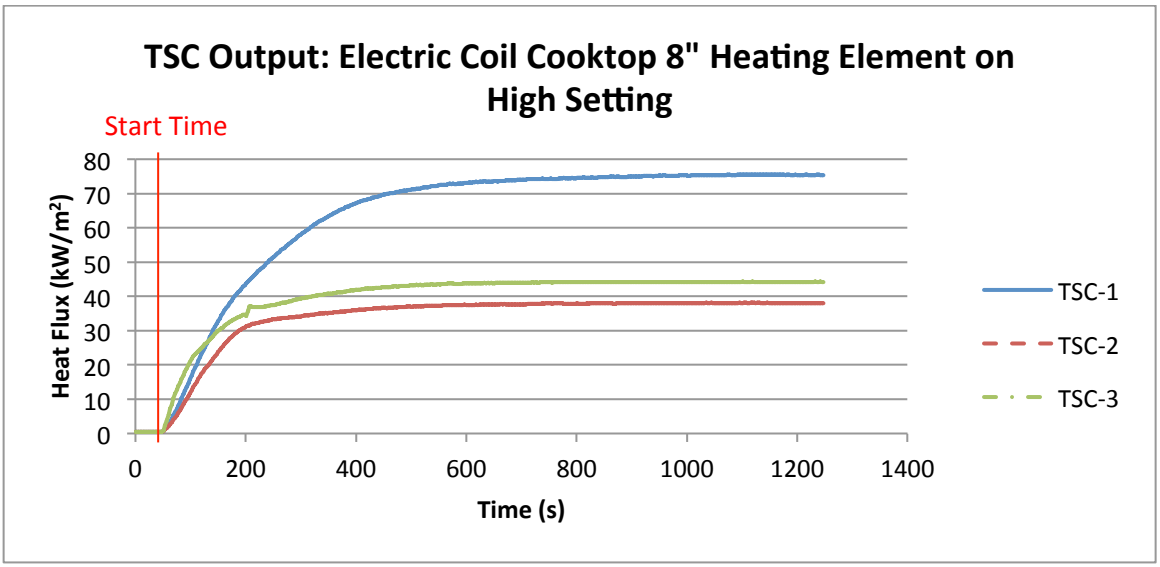

TSC Output: Temperature Sensor Plate 8" Heating Element on Medium Setting
Start Time
Heat Flux (kW/m²)
20
15
10
5
0
0
200
400
600
800
1000
1200
1400
Time (s)
TSC-1
TSC-2
TSC-3

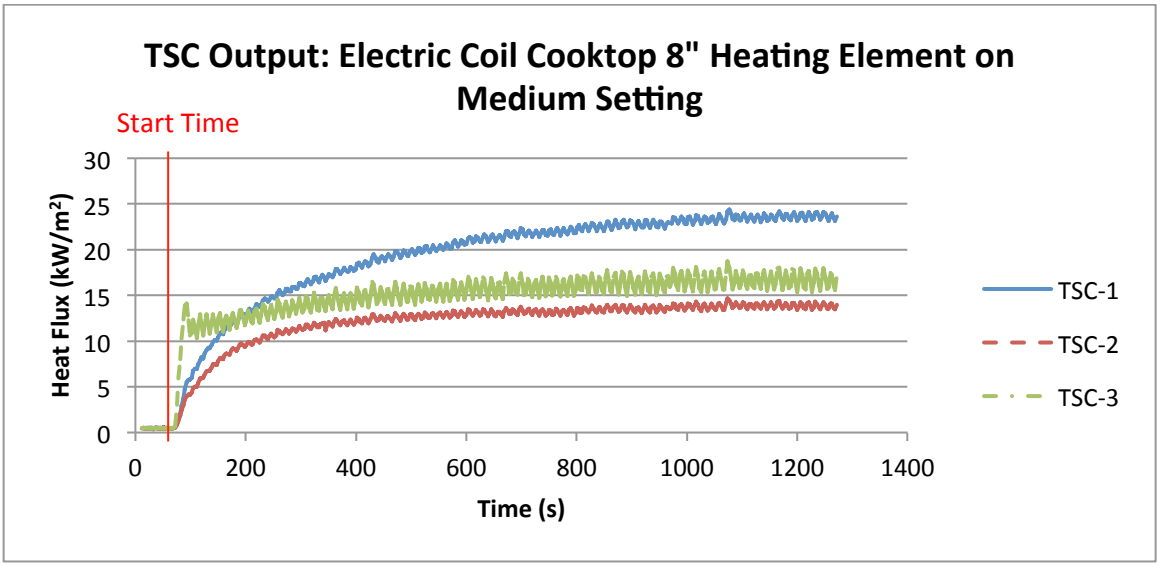

TSC Output: Temperature Sensor Plate 8" Heating Element on Low Setting
Start Time
Heat Flux (kW/m²)
3.5
3
2.5
2
1.5
1
0.5
0
0
200
400
600
800
1000
1200
1400
Time (s)
TSC-1
TSC-2
TSC-3

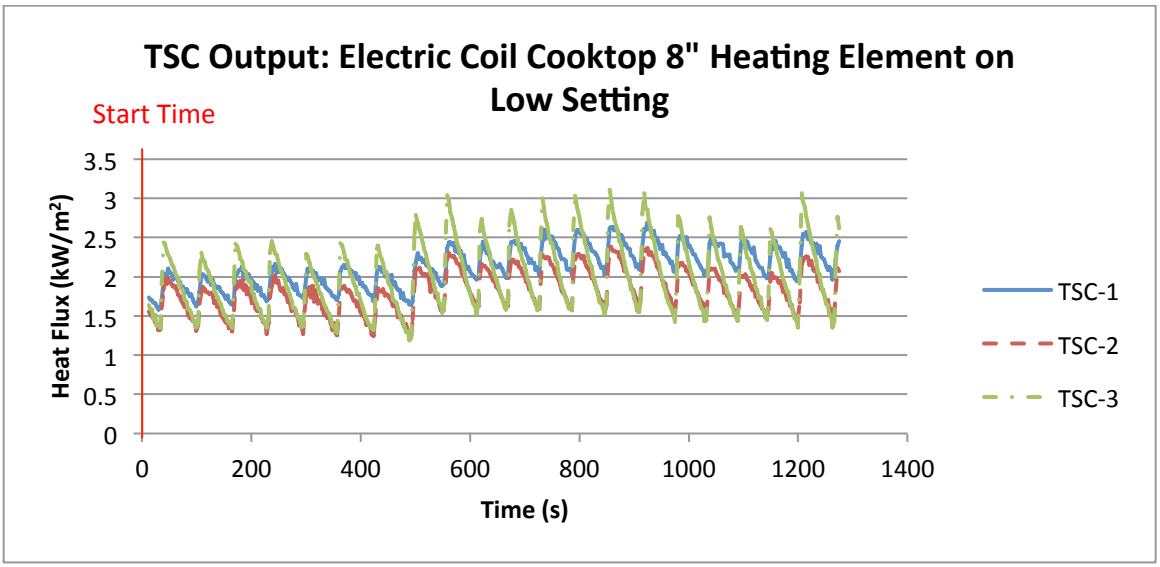

TSC Output: Electric Coil Cooktop 6" Heating Element on High Setting
Start Time
Heat Flux (kW/m²)
80
70
60
50
40
30
20
10
0
0
200
400
600
800
1000
1200
1400
Time (s)
TSC-1
TSC-2
TSC-3


TSC Output: Electric Coil Cooktop 6" Heating Element on Medium Setting
Start Time
Heat Flux (kW/m²)
30
25
20
15
10
5
0
0
200
400
600
800
1000
1200
1400
Time (s)
TSC-1
TSC-2
TSC-3


TSC Output: Electric Coil Cooktop 6" Heating Element on Low Setting
Start Time
Heat Flux (kW/m²)
3
2.5
2
1.5
1
0.5
0
0
200
400
600
800
1000
1200
1400
Time (s)
TSC-1
TSC-2
TSC-3


TSC Output: Electric Coil Cooktop 8" Heating Element on High Setting
Start Time
Heat Flux (kW/m²)
80
70
60
50
40
30
20
10
0
0
200
400
600
800
1000
1200
1400
Time (s)
TSC-1
TSC-2
TSC-3


TSC Output: Electric Coil Cooktop 8" Heating Element on Medium Setting
Start Time
Heat Flux (kW/m²)
30
25
20
15
10
5
0
0
200
400
600
800
1000
1200
1400
Time (s)
TSC-1
TSC-2
TSC-3


TSC Output: Electric Coil Cooktop 8" Heating Element on Low Setting
Start Time
Heat Flux (kW/m²)
3.5
3
2.5
2
1.5
1
0.5
0
0
200
400
600
800
1000
1200
1400
Time (s)
TSC-1
TSC-2
TSC-3

TSC Heat Flux MATLAB Calculation Script

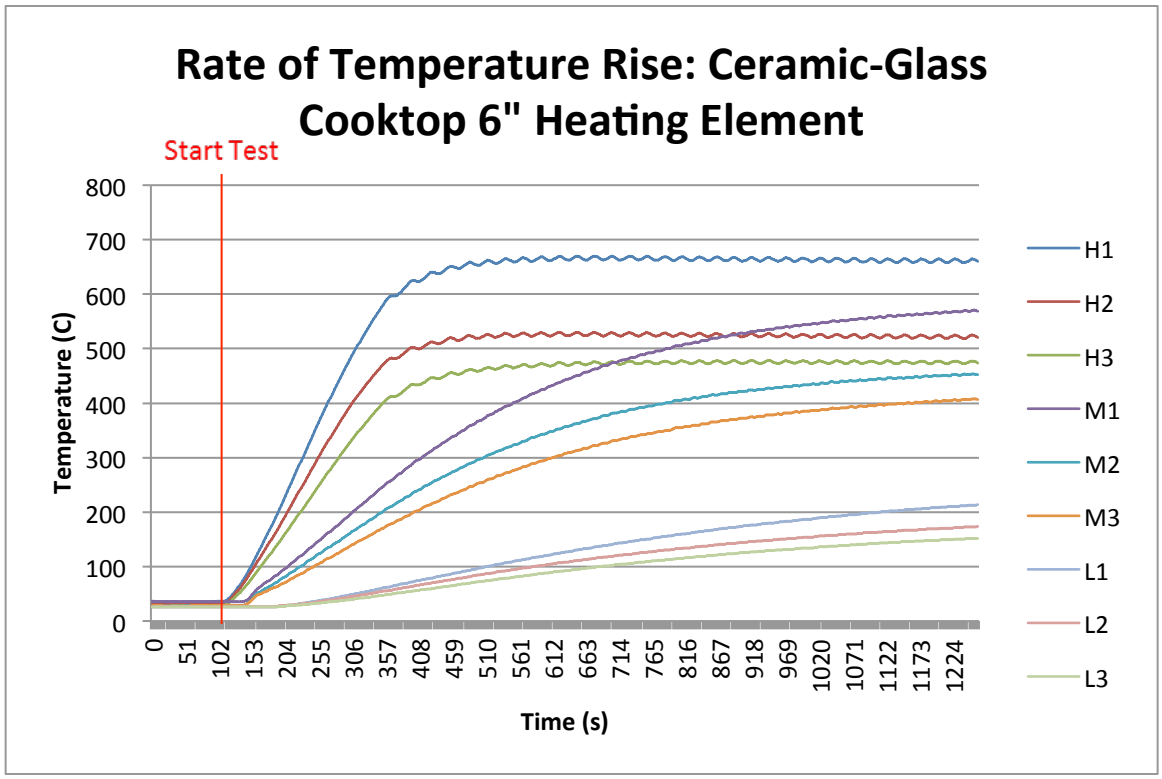
Source: For Additional information regarding this process and script,please visit the following website: https://sites.google.com/site/srcombexp/home/matlab-script-help/thin-skin-calorimeter

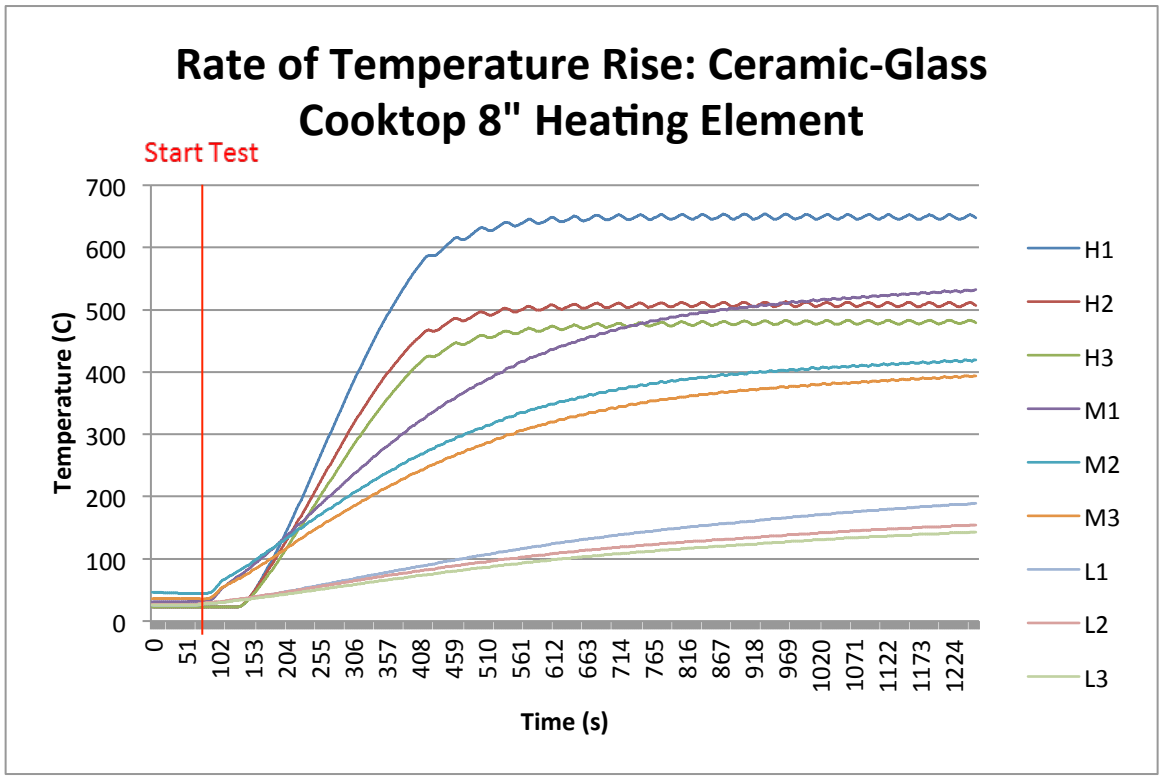
```
clear all
close all
clc
sigma          = 5.67e-8          ; %[W/m2K4)]
epsilon        = 0.8              ; %[]
h              = 20               ; %[W/(m2 K)]
rho            = 7600             ; %[kg/m3] density of stainless steel
c_p            = 510              ; %[J/(kg K)] specific heat of stainless steel
delta          = 0.00158          ; %[m]  thickness of stainless steel 1/16inch
T_g            = 298              ; %[K]
num_pt_ave     = 8                ; % number of points being averaged
perc_net       = 0.3              ; %percentage of incident or net heat flux
perc_inc       = 0.05 ;
perc_time = 0.1 ;

   data = xlsread('E:\FPE 587 - Fire Science Laboratory\Data_Lods\group3_TSC_cal.xls')
;
   time1          = data(:,1)          ;
   TSC_tempp      = data(:,2) +273     ;
   tempp          = data(:,3) +273     ;
   time_start     = [230 1540 2415]    ;
   time_steady    = [600 2000 2690]    ;
   time_stop      = [815 2120 2915]    ;
   time_test      = time_stop-time_start+1    ;

for count = 1:length(time_start)
   time(1:(time_stop(count)-time_start(count)),count)        =
time1(1:time_stop(count)-time_start(count))    ; % time stamp
   TSC_temp(1:(time_stop(count)-(time_start(count)-1)),count)    =
TSC_tempp(time_start(count):time_stop(count))  ; % Thin skin calorimeter temperature
   temp(1:(time_stop(count)-(time_start(count)-1)),count)       =
tempp(time_start(count):time_stop(count))     ; % insulated temperature
end

dt          = 1                                          ; %[s]
dT_dt       = (TSC_temp(2:end,:) - TSC_temp(1:end-1,:))/dt    ; %[K/s]
```

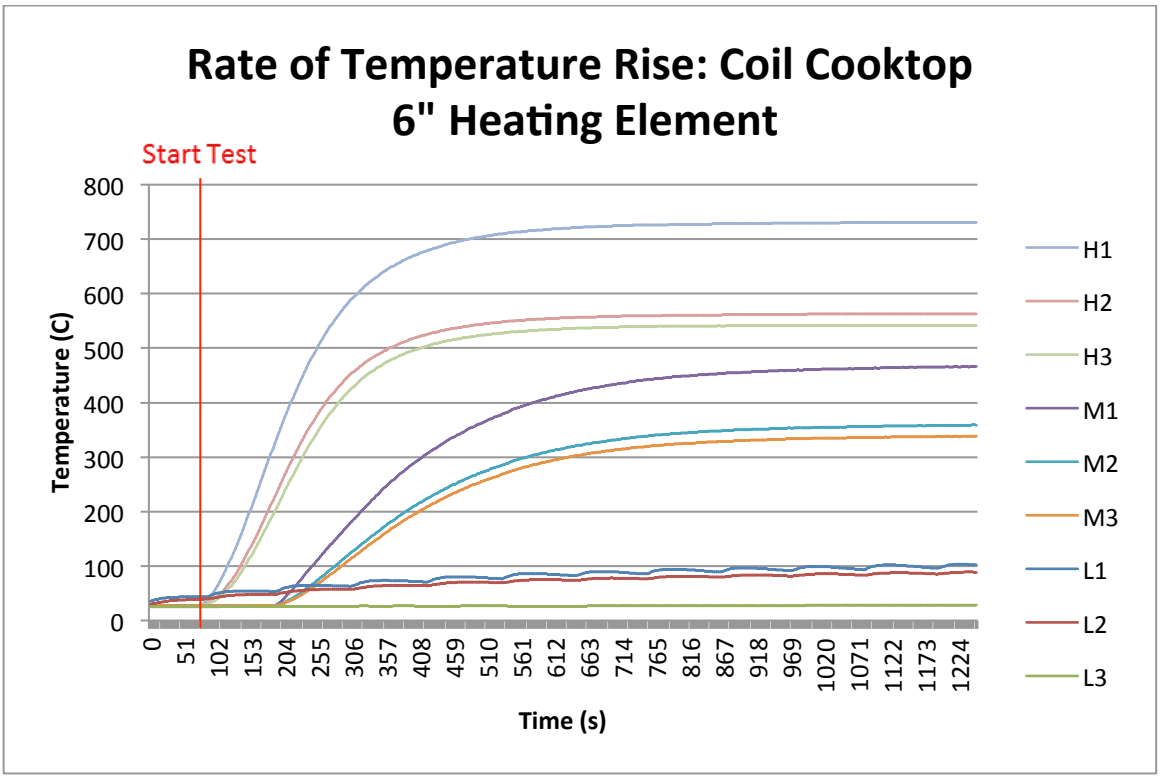
```
T_s            = TSC_temp(1:length(dT_dt),:)                    ; %[K]
T_ins          = temp(1:length(dT_dt),:)                        ; %[K]
q_net          = rho.*c_p.*delta.*dT_dt                         ; %[kW]
q_conv          = h.*(T_s-T_g)                                  ; %[kW]
q_rad          = epsilon.*sigma.*T_s.^4                         ; %[kW]
k             = 0.135               ; %[W/(m K)] insulation

TSC Heat Flux MATLAB Calculation Script
L             = 0.00635               ; %[m] length of substrate
h_c           = 150 ;
q_cond_k       = (T_s - T_ins)/(1/h_c + L/k) ; %[W]

q_inc_03       = ((q_net + q_conv + q_rad + q_cond_k)./epsilon )./1000     ; %[kW]

for ii = num_pt_ave+1:length(q_inc_03)-(num_pt_ave+1)
   q_inc_03(ii-num_pt_ave,:)                    = mean(q_inc_03(ii-num_pt_ave :
ii+num_pt_ave,: ) )     ;
end

q_inc_25ave = mean(q_inc_03(1:400,1)) ;
q_inc_50ave = mean(q_inc_03(1:400,2)) ;
q_inc_75ave = mean(q_inc_03(1:400,3)) ;

%% Plotting results
figure
hold on
plot(time(1:time_test(1)-63,1),TSC_temp(1:time_test(1)-63,1),'.b')
plot(time(1:time_test(2)-63,2),TSC_temp(1:time_test(2)-63,2),'.k')
plot(time(1:time_test(3)-63,3),TSC_temp(1:time_test(3)-63,3),'.g')

plot(time(1:time_test(1)-63,1),temp(1:time_test(1)-63,1),'-b')
plot(time(1:time_test(2)-63,2),temp(1:time_test(2)-63,2),'-k')
plot(time(1:time_test(3)-63,3),temp(1:time_test(3)-63,3),'-g')

xlabel('Time (s)')
ylabel('Thin Skin temp')
axis([0 900 0 1500])
legend('25kW-plate','50kW-plate','75kW-plate','25kW-ins','50kW-ins','75kW-ins')
hold off

% All three heat fluxes
```

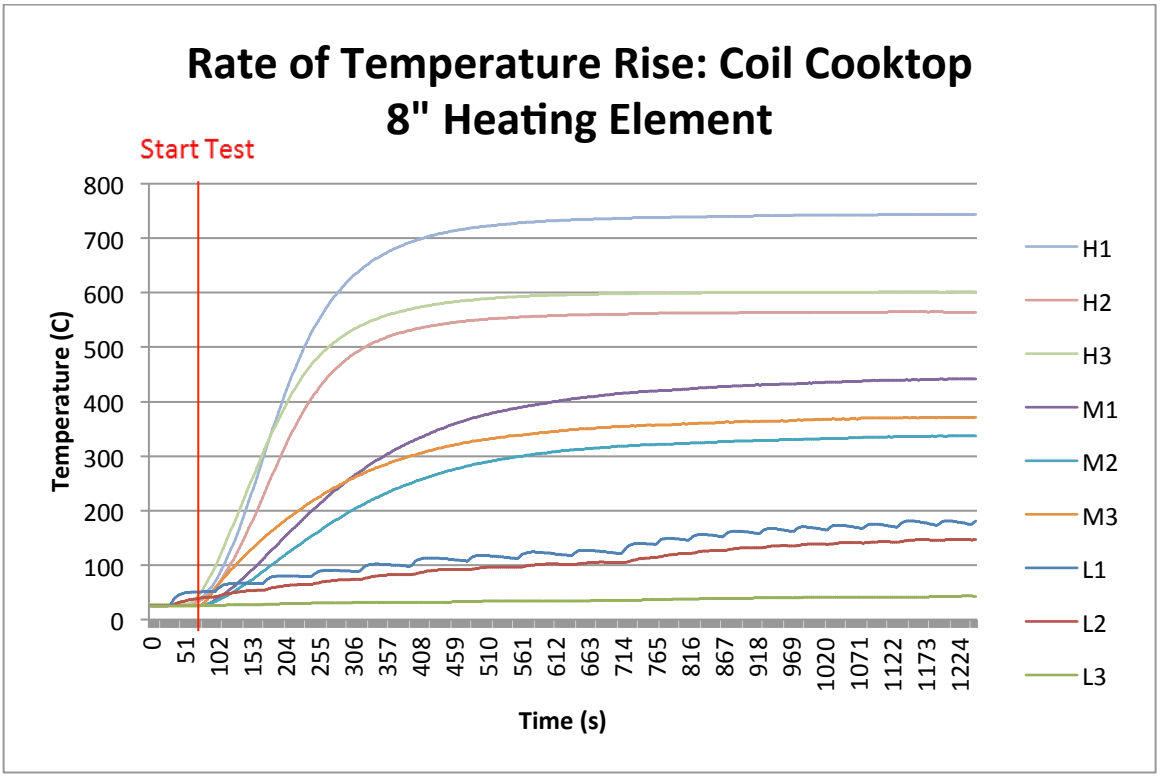
```
figure
hold on
plot(time(1:time_test(1)-64,1),q_inc_03(1:time_test(1)-64,1),'-b','LineWidth',2)
plot(time(1:time_test(2)-64,2),q_inc_03(1:time_test(2)-64,2),'-k','LineWidth',2)
plot(time(1:time_test(3)-64,3),q_inc_03(1:time_test(3)-64,3),'-g','LineWidth',2)
title('Heat transfer coefficient')
xlabel('Time (s)')
ylabel('Incident Heat flux (kW)')
axis([0 400 0 80])
% grid on
legend('25kW Coef','50kW Coef','75kW Coef','Location','SouthEast')
hold off


legend('25kW %time', '25kW %Net', '25kW %Inc', '25kW Coef','Location','SouthEast')
hold off
```

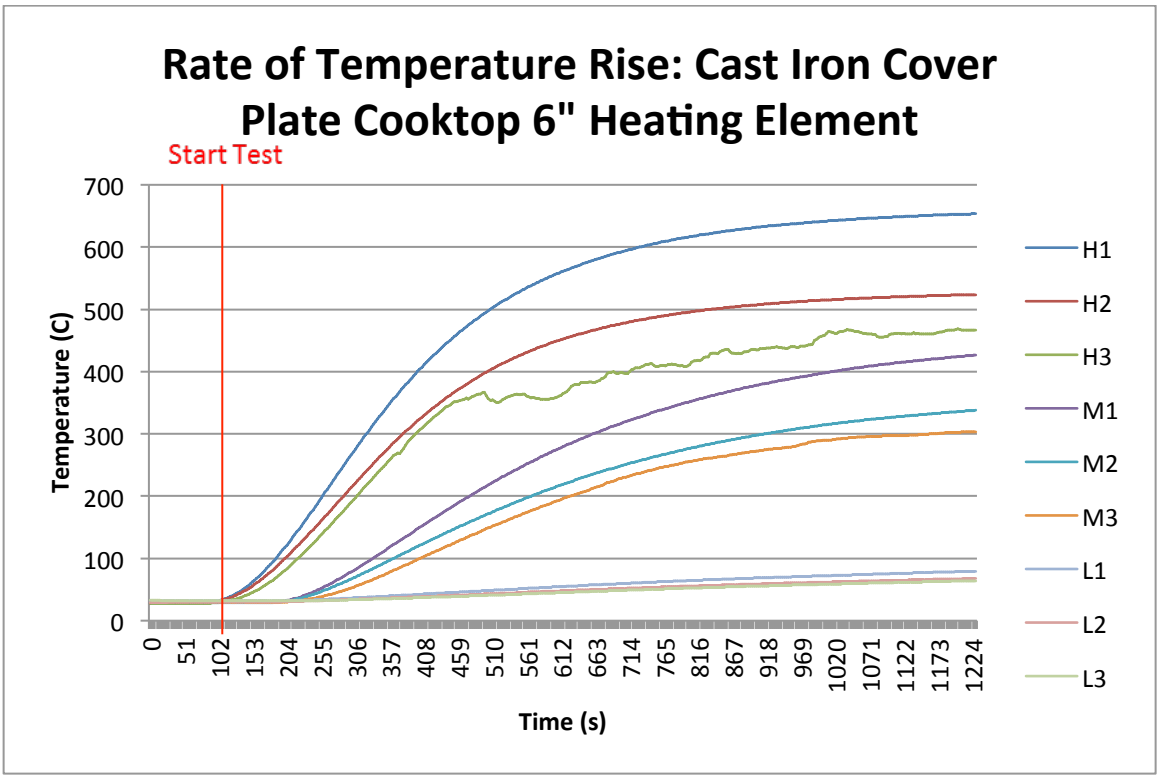
Appendix C – Rate of Temperature Rise Results

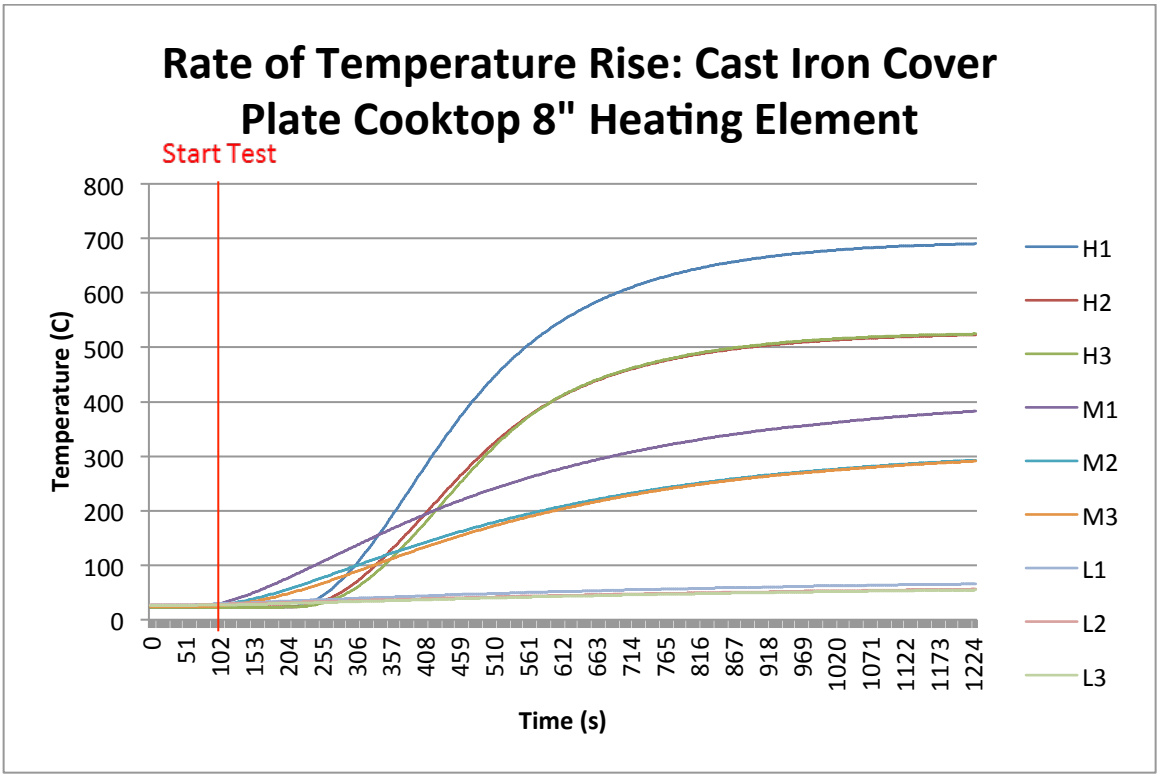


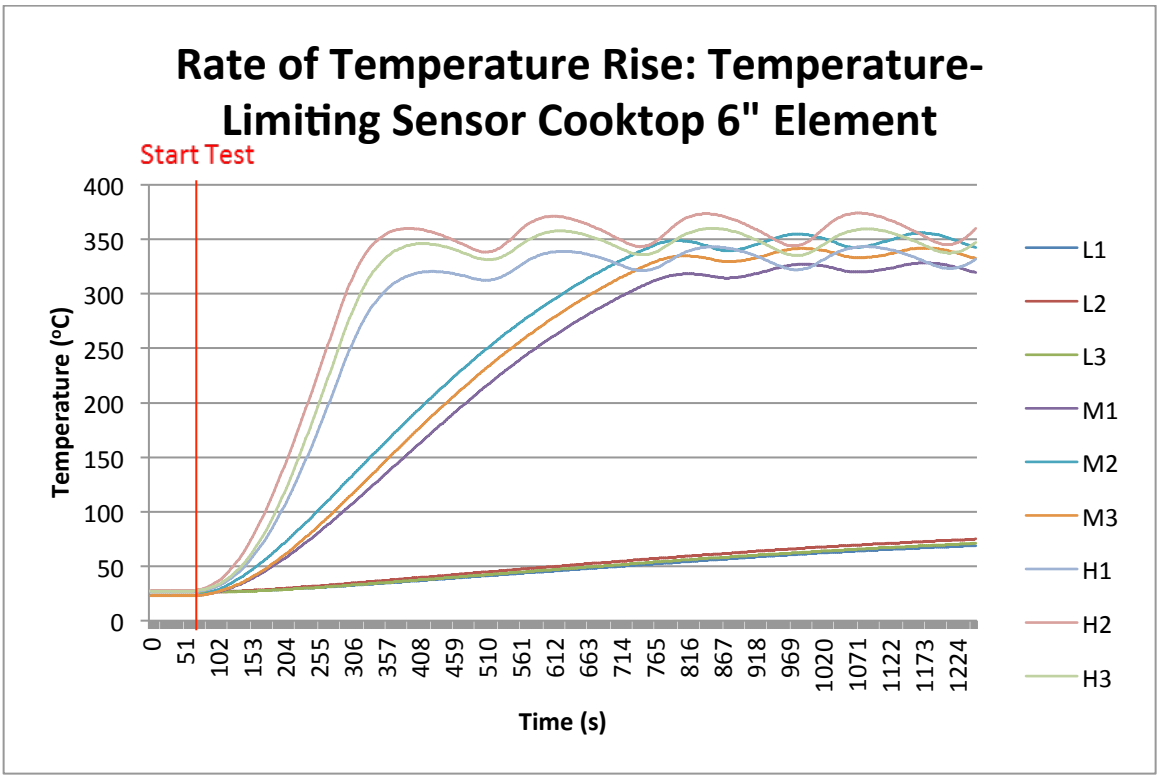


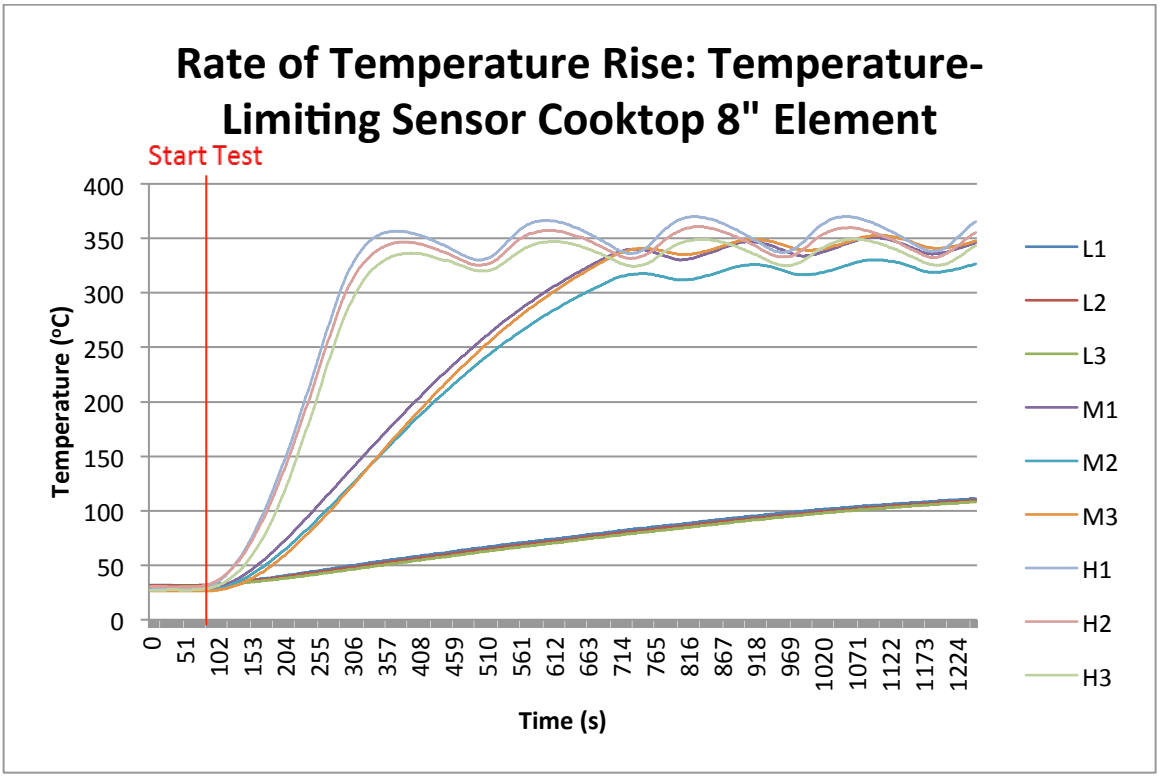

Rate of Temperature Rise: Coil Cooktop
6" Heating Element
Start Test
Temperature (C)
800
700
600
500
400
300
200
100
0
0
51
102
153
204
255
306
357
408
459
510
561
612
663
714
765
816
867
918
969
1020
1071
1122
1173
1224
Time (s)
H1
H2
H3
M1
M2
M3
L1
L2
L3

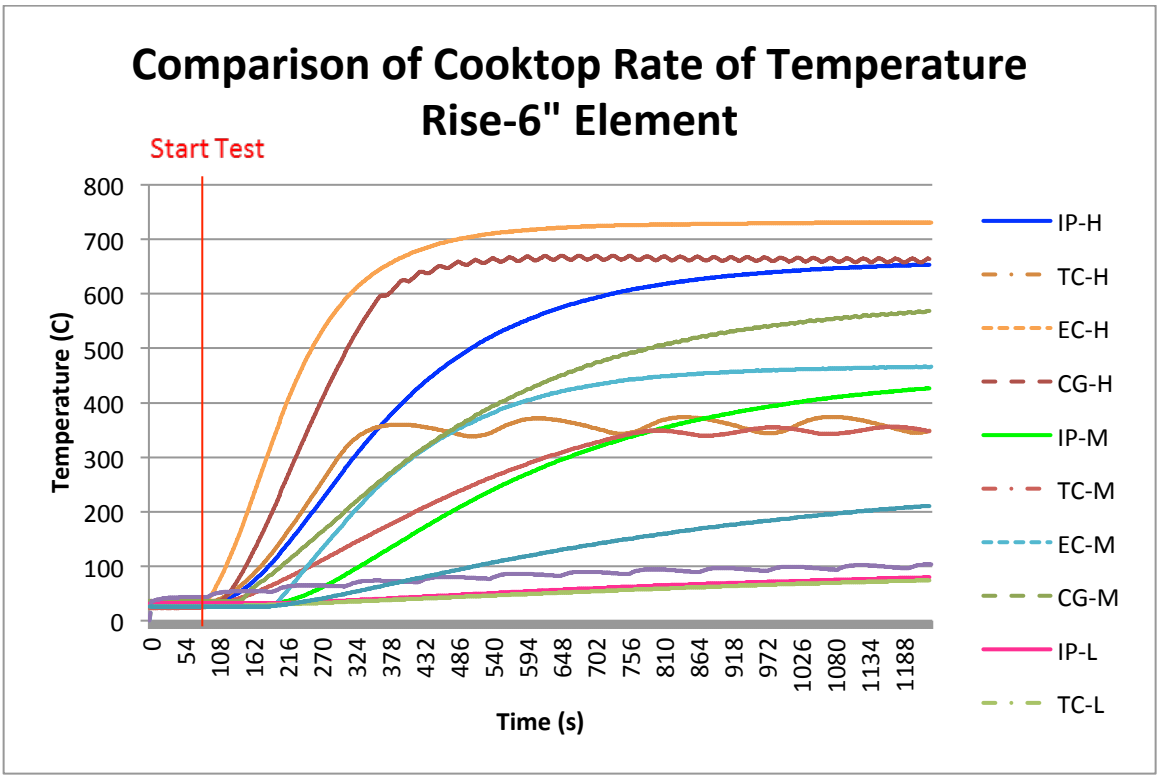

Rate of Temperature Rise: Coil Cooktop
8" Heating Element
Start Test
Temperature (C)
800
700
600
500
400
300
200
100
0
0
51
102
153
204
255
306
357
408
459
510
561
612
663
714
765
816
867
918
969
1020
1071
1122
1173
1224
Time (s)
H1
H2
H3
M1
M2
M3
L1
L2
L3

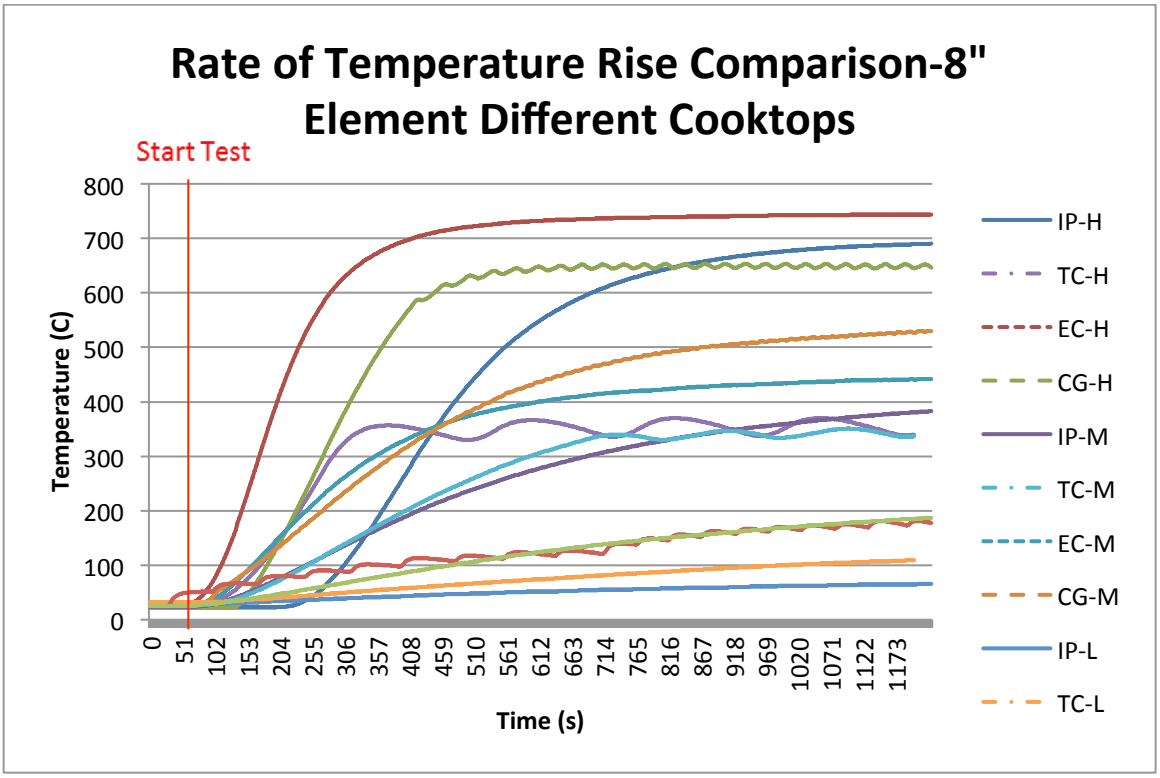

Rate of Temperature Rise: Cast Iron Cover Plate Cooktop 6" Heating Element
Start Test
Temperature (C)
Time (s)
H1
H2
H3
M1
M2
M3
L1
L2
L3


Rate of Temperature Rise: Cast Iron Cover Plate Cooktop 8" Heating Element
Start Test
Temperature (C)
Time (s)
H1
H2
H3
M1
M2
M3
L1
L2
L3


Rate of Temperature Rise: Temperature-Limiting Sensor Cooktop 6" Element
Start Test
Temperature (°C)
400
350
300
250
200
150
100
50
0
0
51
102
153
204
255
306
357
408
459
510
561
612
663
714
765
816
867
918
969
1020
1071
1122
1173
1224
Time (s)
L1
L2
L3
M1
M2
M3
H1
H2
H3

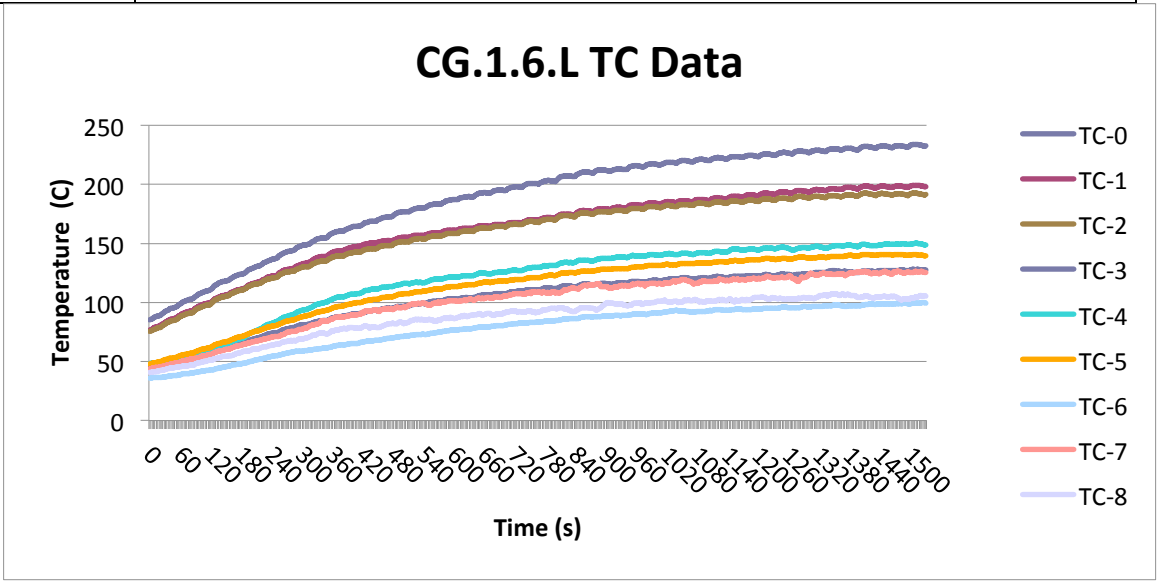

Rate of Temperature Rise: Temperature-Limiting Sensor Cooktop 8" Element
Start Test
Temperature (°C)
400
350
300
250
200
150
100
50
0
0
51
102
153
204
255
306
357
408
459
510
561
612
663
714
765
816
867
918
969
1020
1071
1122
1173
1224
Time (s)
L1
L2
L3
M1
M2
M3
H1
H2
H3


Comparison of Cooktop Rate of Temperature Rise-6" Element
Start Test
Temperature (C)
800
700
600
500
400
300
200
100
0
0
54
108
162
216
270
324
378
432
486
540
594
648
702
756
810
864
918
972
1026
1080
1134
1188
Time (s)
IP-H
TC-H
EC-H
CG-H
IP-M
TC-M
EC-M
CG-M
IP-L
TC-L

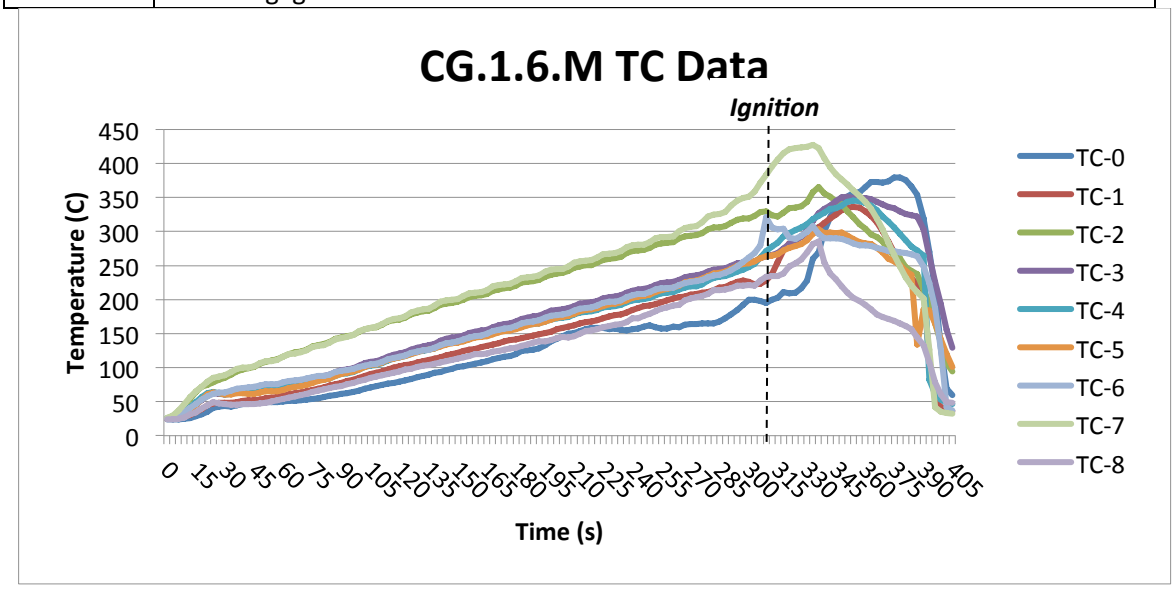

Rate of Temperature Rise Comparison-8" Element Different Cooktops
Start Test
Temperature (C)
800
700
600
500
400
300
200
100
0
0
51
102
153
204
255
306
357
408
459
510
561
612
663
714
765
816
867
918
969
1020
1071
1122
1173
Time (s)
IP-H
TC-H
EC-H
CG-H
IP-M
TC-M
EC-M
CG-M
IP-L
TC-L

Appendix D – Ceramic-Glass Cooktop Range Results

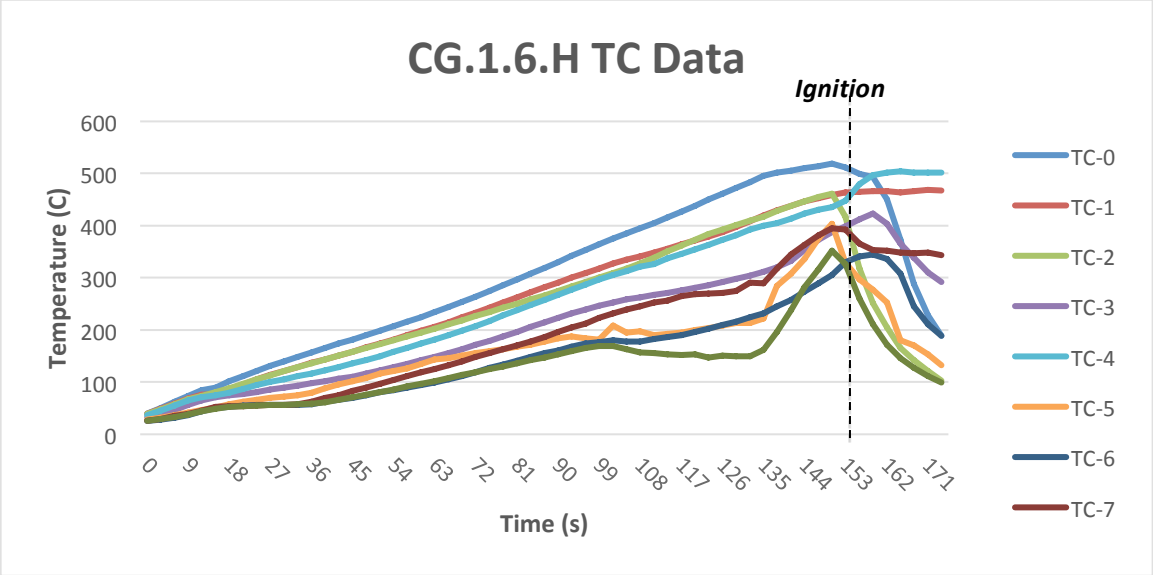
Test Id	Fuel	Diameter	Setting	Time (min:sec)	Ignition (Yes/No)	Time to Ignition (min:sec)
CG.1.6.L	Cardboard	6”	Low	25:00	No	
Comment	No signs of ignition. Material was only warm to touch after completion of test.					



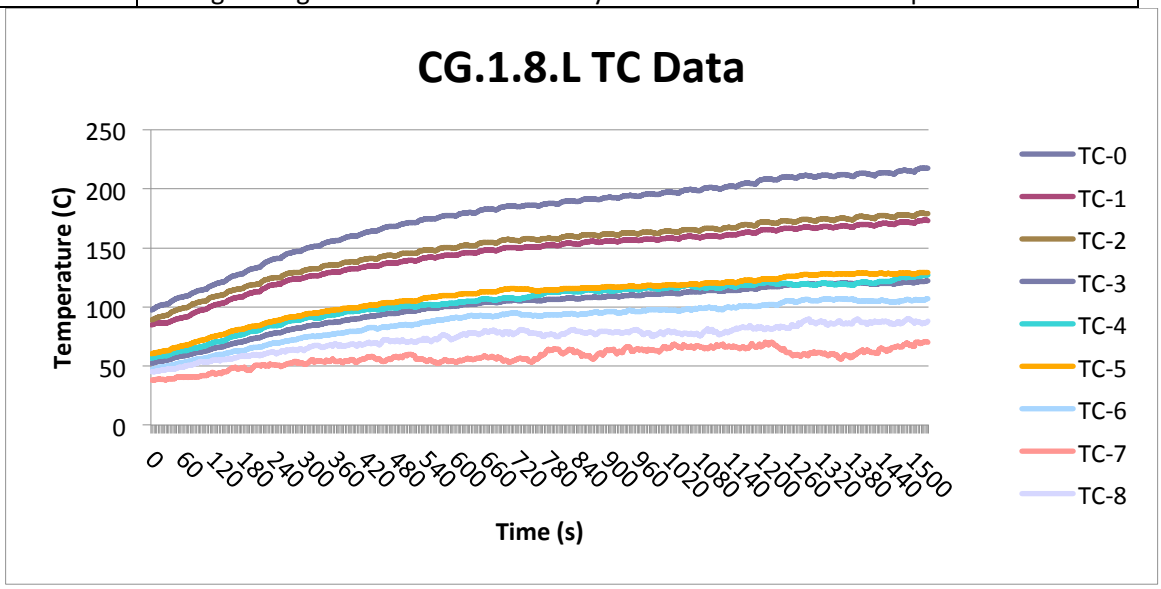
Test Id	Fuel	Diameter	Setting	Time (min:sec)	Ignition (Yes/No)	Time to Ignition (min:sec)
CG.1.6.M	Cardboard	6”	Medium	5:00	Yes	5:00
Comment	Significant mass loss prior to ignition. Significant smoke was released prior to and following ignition.					



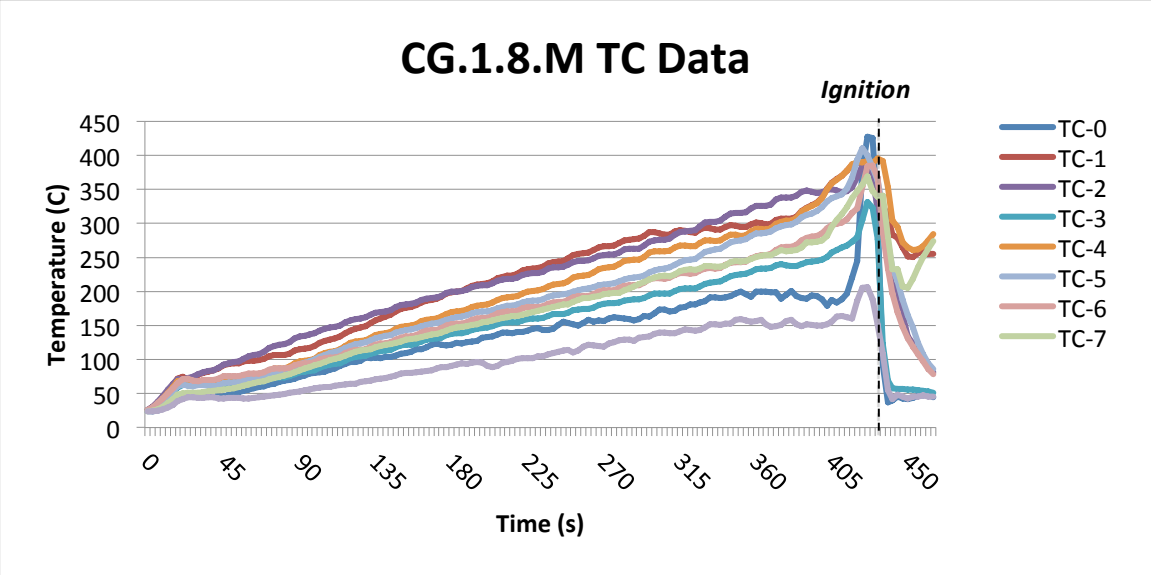
Test Id	Fuel	Diameter	Setting	Time (min:sec)	Ignition (Yes/No)	Time to Ignition (min:sec)
CG.1.6.H	Cardboard	6”	High	2:30	Yes	2:30
Comment	Within seconds the material began to off gas and release significant amounts of smoke prior to and following ignition.					



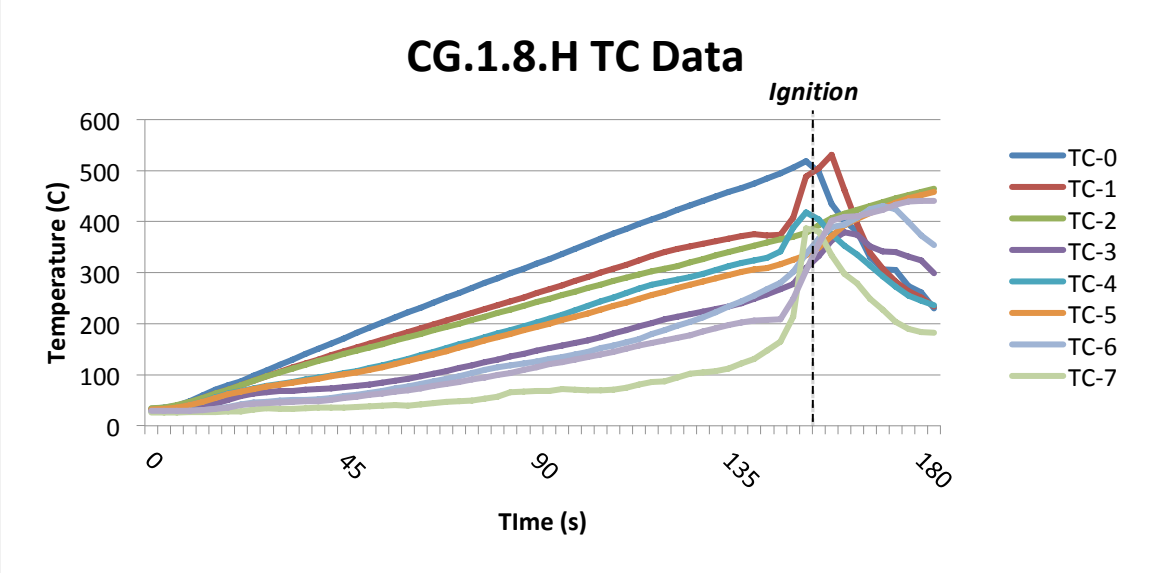
Test Id	Fuel	Diameter	Setting	Time (min:sec)	Ignition (Yes/No)	Time to Ignition (min:sec)
CG.1.8.L	Cardboard	8”	Low	25:00	No	
Comment	No signs of ignition. Material was only warm to touch after completion of test.					



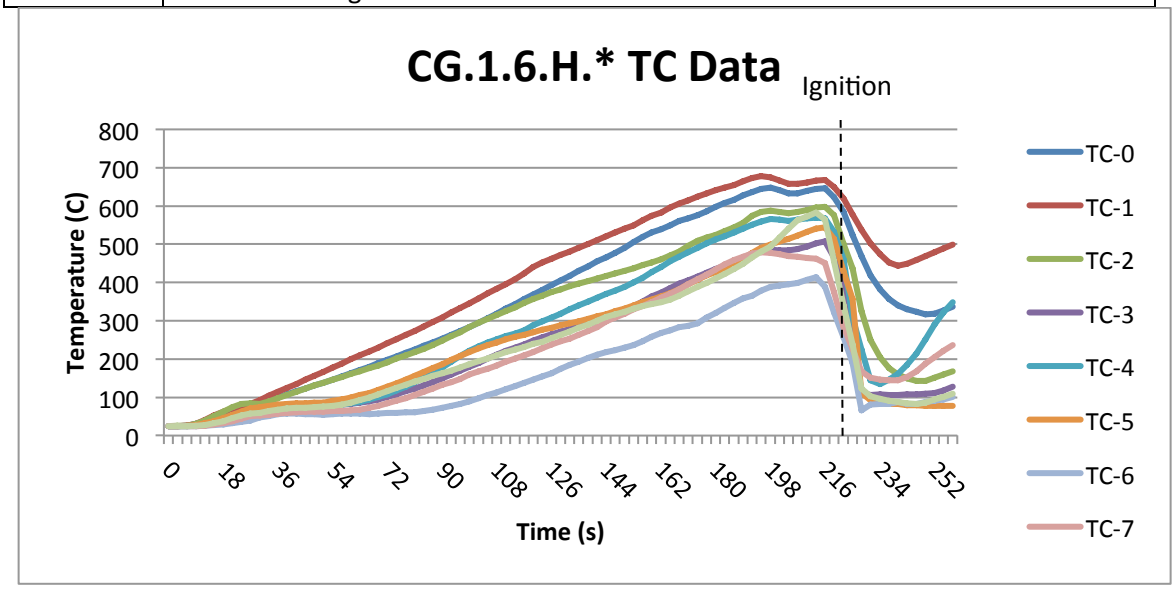
Test Id	Fuel	Diameter	Setting	Time (min:sec)	Ignition (Yes/No)	Time to Ignition (min:sec)
CG.1.8.M	Cardboard	8”	Medium	7:07	Yes	7:07
Comment	Significant mass loss prior to ignition. Significant smoke was released prior to and following ignition.					



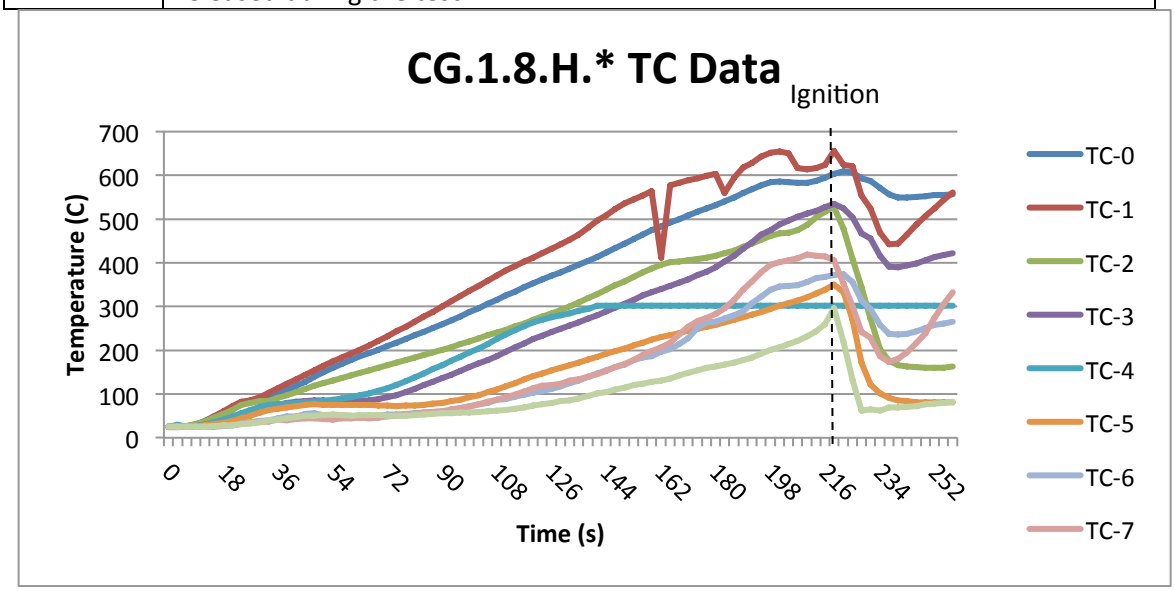
Test Id	Fuel	Diameter	Setting	Time (min:sec)	Ignition (Yes/No)	Time to Ignition (min:sec)
CG.1.8.H	Cardboard	8”	High	2:33	Yes	2:33
Comment	Within seconds the material began to off gas and release significant amounts of smoke prior to and following ignition.					



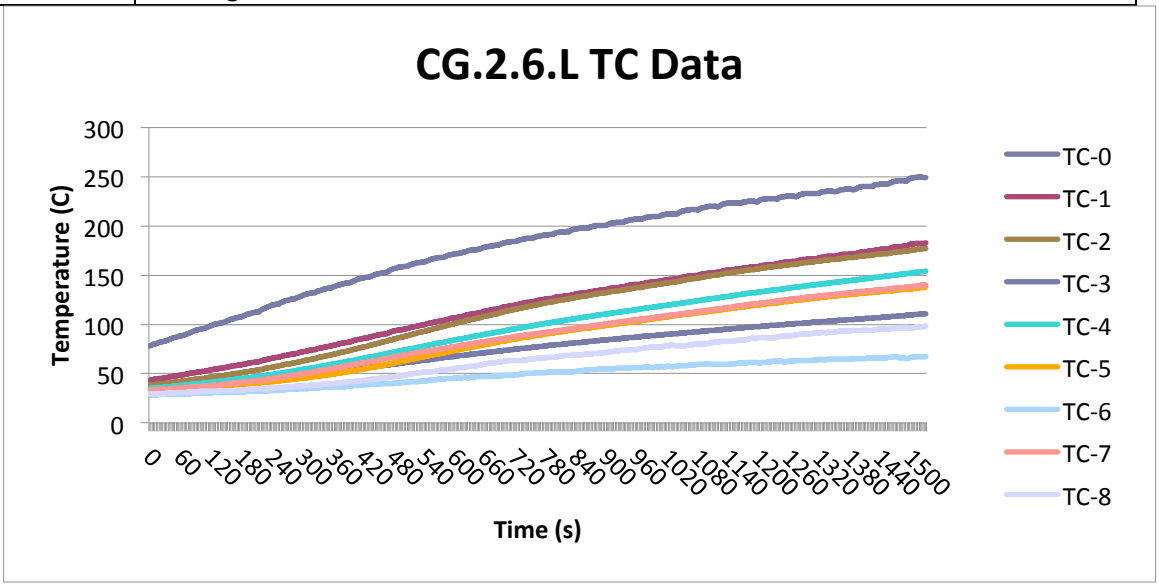
Test Id	Fuel	Diameter	Setting	Time (min:sec)	Ignition (Yes/No)	Time to Ignition (min:sec)
CG.1.6.H.*	Cardboard	6”	High	3:37	Yes	3:37
Comment	Most of the mass was consumed prior to flaming ignition. Heavy smoke was released during the test.					



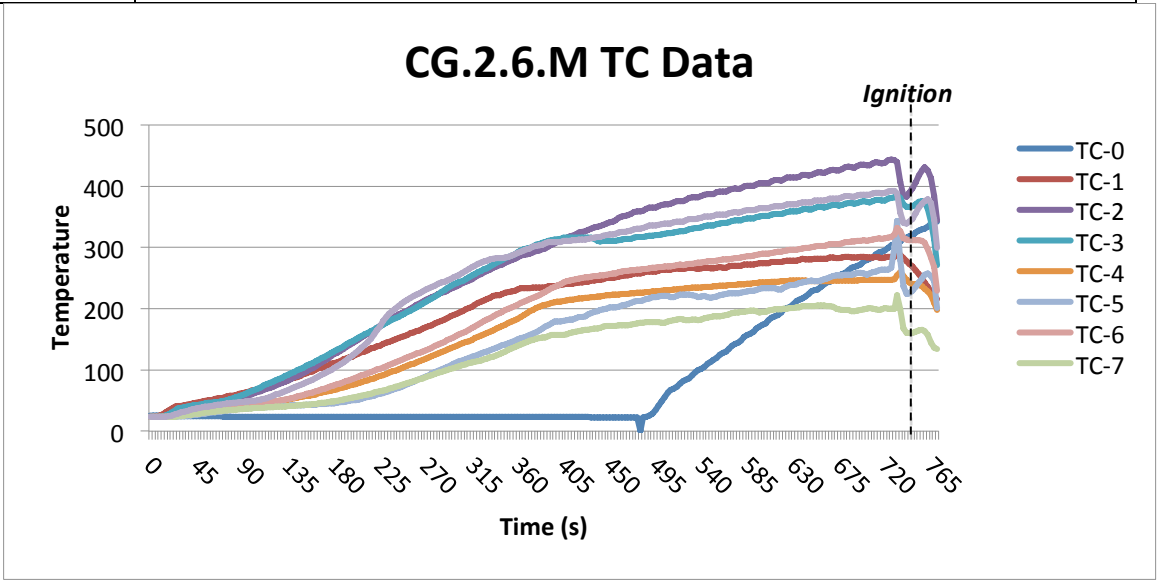
Test Id	Fuel	Diameter	Setting	Time (min:sec)	Ignition (Yes/No)	Time to Ignition (min:sec)
CG.1.8.H.*	Cardboard	8”	High	3:33	Yes	3:33
Comment	Most of the mass was consumed prior to flaming ignition. Heavy smoke was released during the test.					



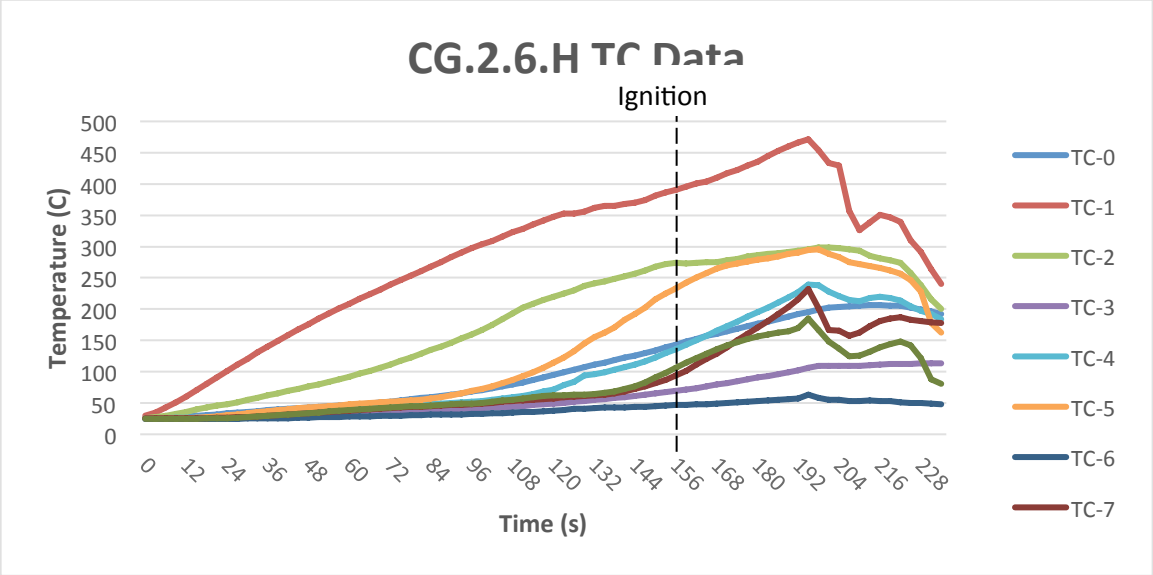
Test Id	Fuel	Diameter	Setting	Time (min:sec)	Ignition (Yes/No)	Time to Ignition (min:sec)
CG.2.6.L	Dish Towel	6”	Low	25:00	No	
Comment	No signs of ignition. Material was warm to touch following the removal from heating element.					



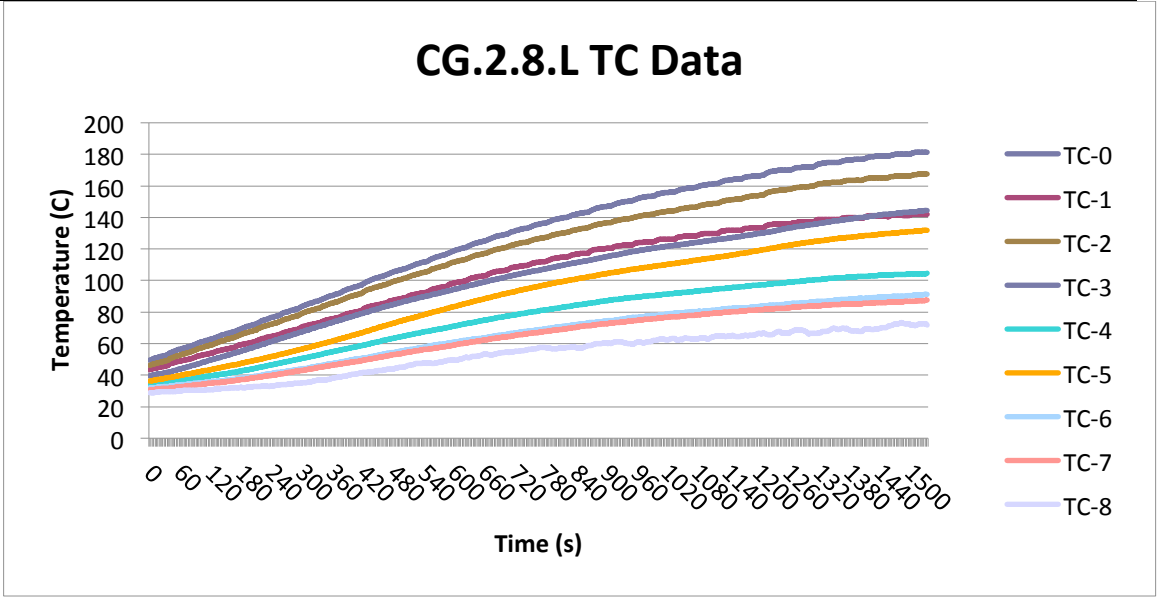
Test Id	Fuel	Diameter	Setting	Time (min:sec)	Ignition (Yes/No)	Time to Ignition (min:sec)
CG.2.6.M	Dish Towel	6”	Medium	12:09	Yes	12:09
Comment	Significant mass loss prior to ignition. Heavy amounts of smoke was released prior to and after ignition.					



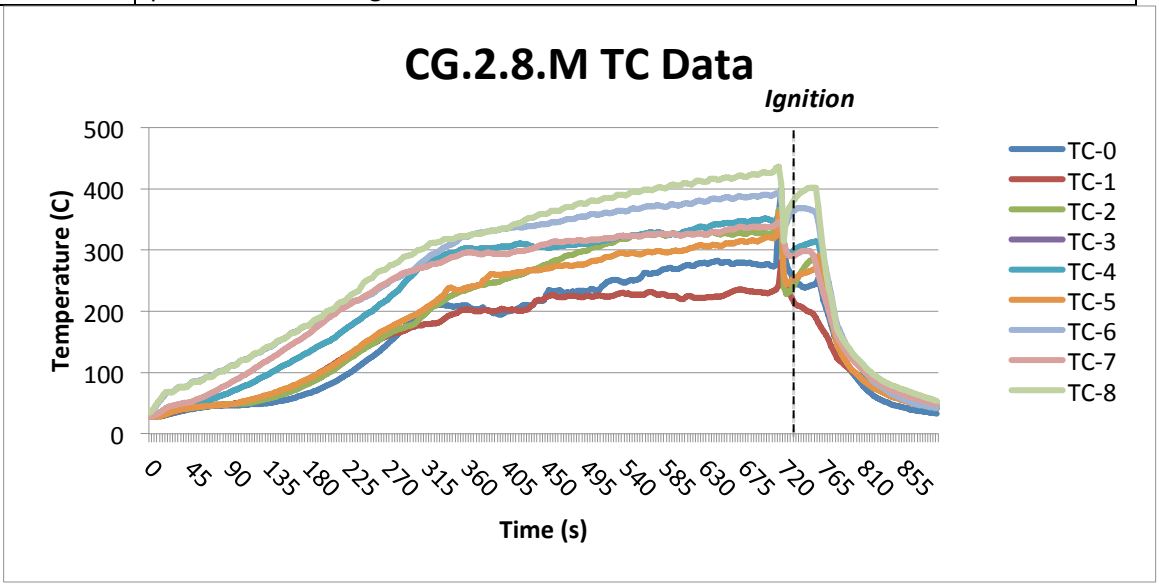
Test Id	Fuel	Diameter	Setting	Time (min:sec)	Ignition (Yes/No)	Time to Ignition (min:sec)
CG.2.6.H	Dish Towel	6”	High	2:30	Yes	2:30
Comment	Within seconds the material began to off gas and release significant amounts of smoke prior to and following ignition. Flames reached approximately 8” after ignition.					



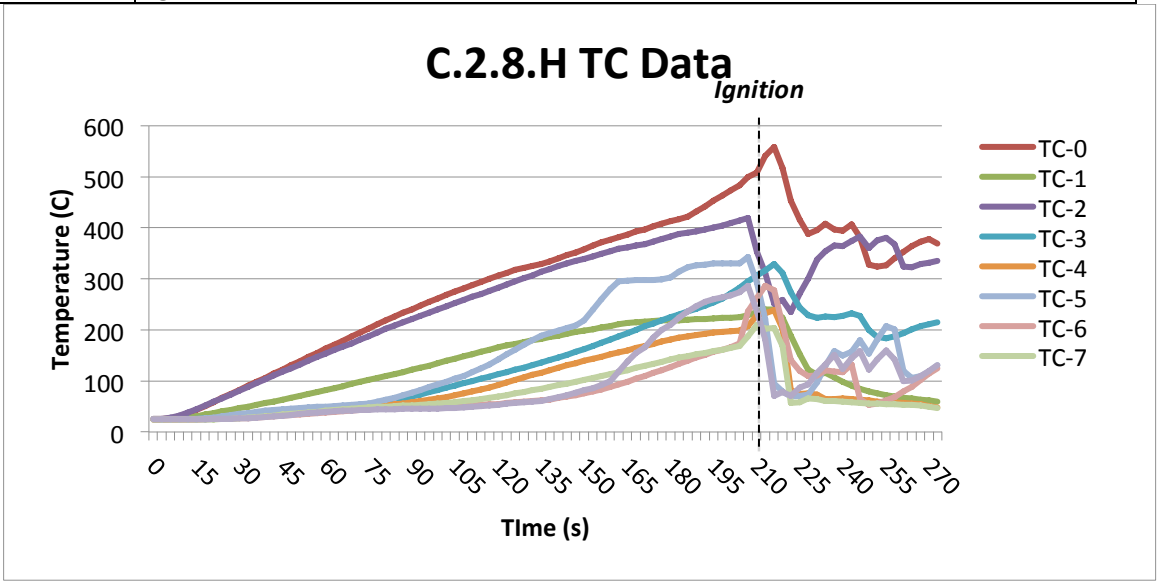
Test Id	Fuel	Diameter	Setting	Time (min:sec)	Ignition (Yes/No)	Time to Ignition (min:sec)
CG.2.8.L	Dish Towel	8”	Low	25:00	No	
Comment	No signs of ignition. Material was only warm to touch following the removal from heating element.					



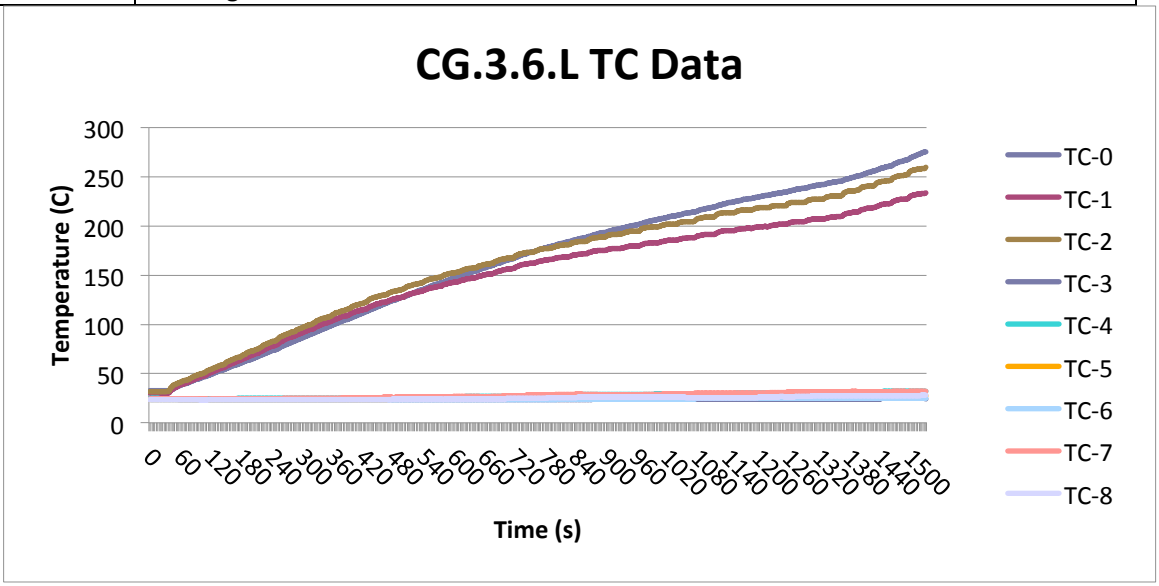
Test Id	Fuel	Diameter	Setting	Time (min:sec)	Ignition (Yes/No)	Time to Ignition (min:sec)
CG.2.8.M	Dish Towel	8”	Medium	12:00	Yes	12:00
Comment	Significant mass loss prior to ignition. Heavy amounts of smoke was released prior to and after ignition.					



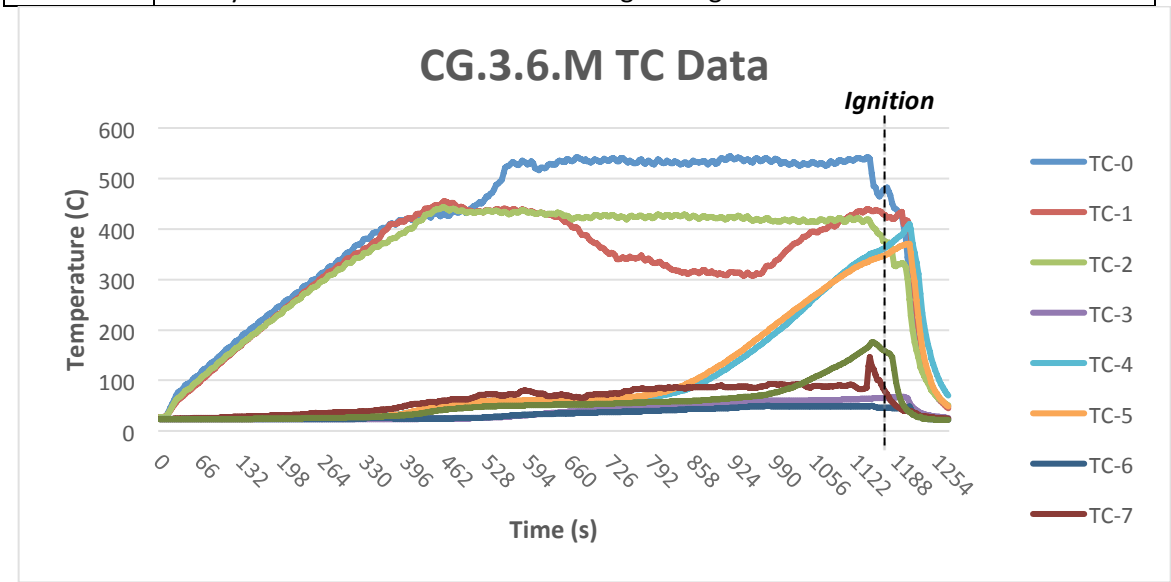
Test Id	Fuel	Diameter	Setting	Time (min:sec)	Ignition (Yes/No)	Time to Ignition (min:sec)
CG.2.8.H	Dish Towel	8”	High	3:26	Yes	3:26
Comment	Within seconds the material began to off gas and release significant amounts of smoke prior to and following ignition. Flames reached approximately 8” after ignition.					



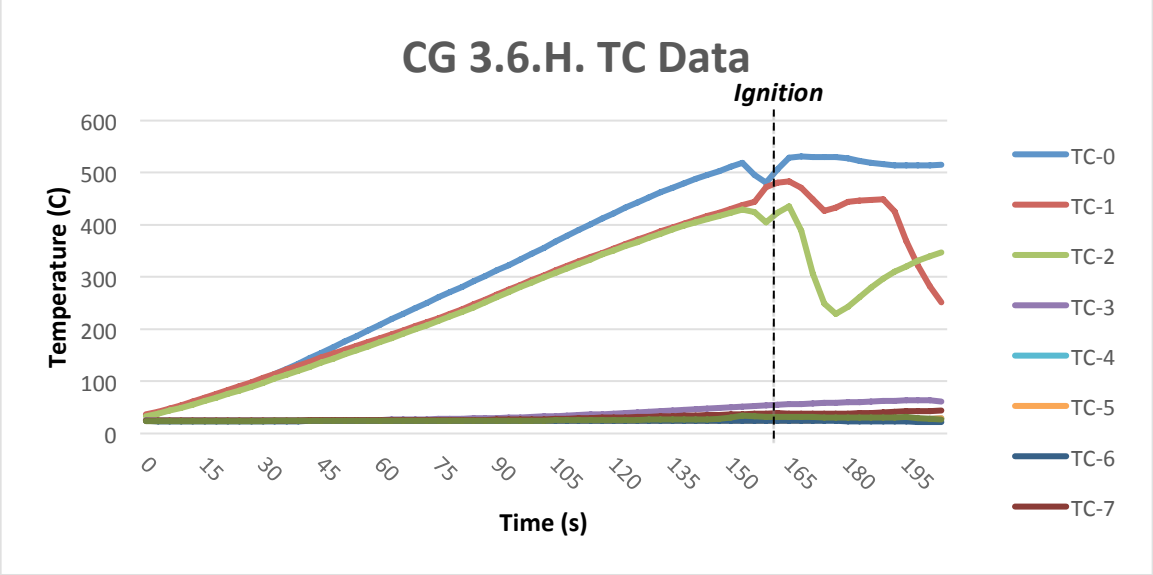
Test Id	Fuel	Diameter	Setting	Time (min:sec)	Ignition (Yes/No)	Time to Ignition (min:sec)
CG.3.6.L	Paper Towel	6”	Low	30:00	No	
Comment	No signs of ignition. Material was only warm to touch following the removal from heating element.					



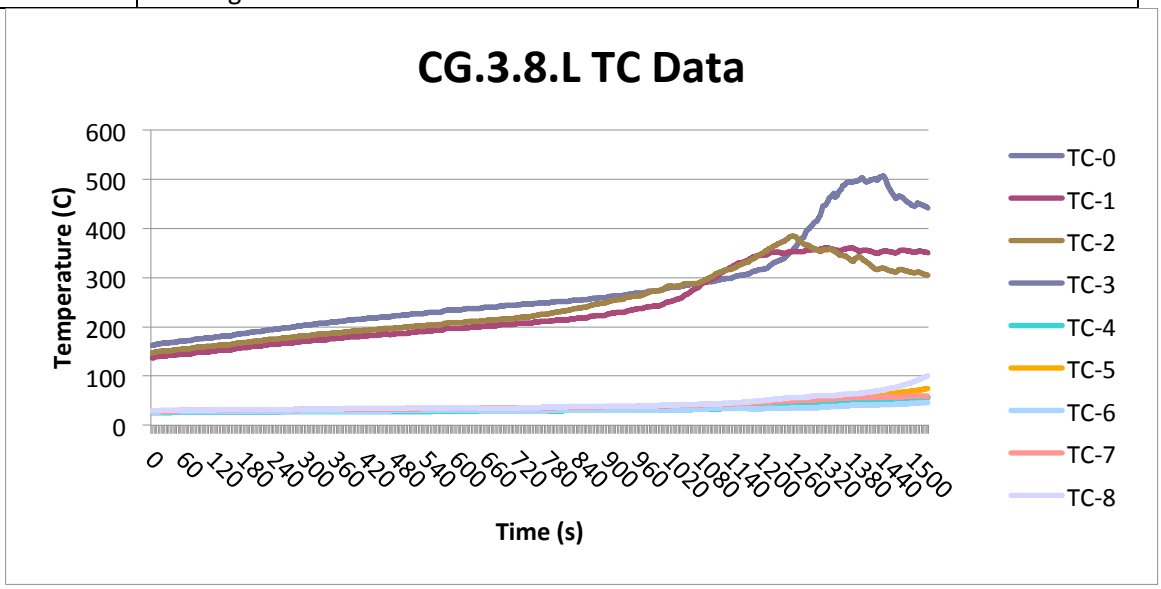
Test Id	Fuel	Diameter	Setting	Time (min:sec)	Ignition (Yes/No)	Time to Ignition (min:sec)
CG.3.6.M	Paper Towel	6”	Medium	18:57	Yes	18:57
Comment	Material had significant mass loss from smoldering combustion prior to ignition. Heavy smoke release was noted during testing.					



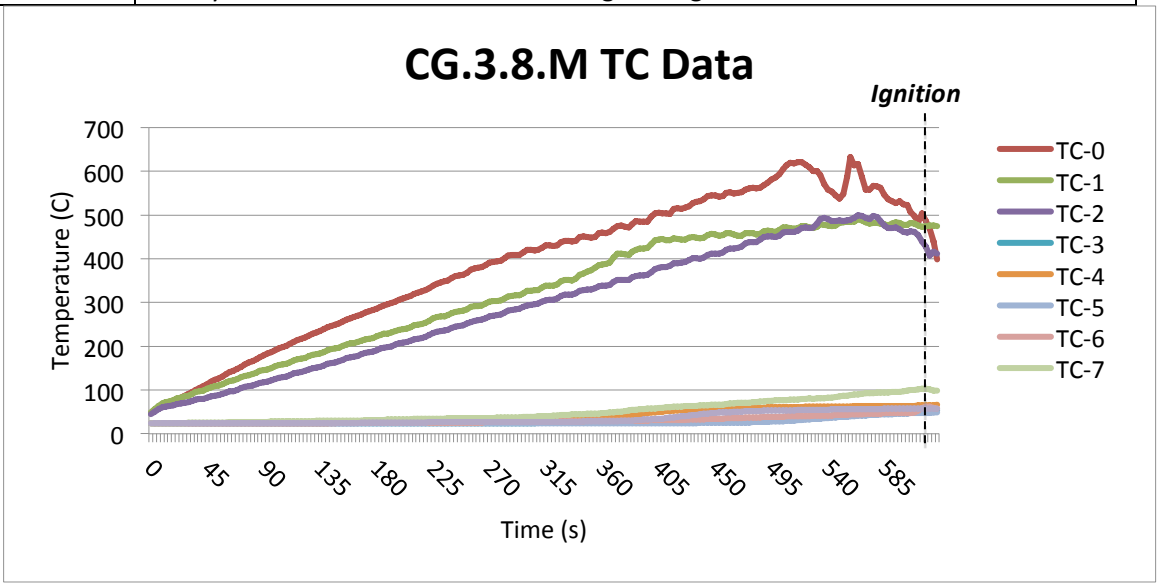
Test Id	Fuel	Diameter	Setting	Time (min:sec)	Ignition (Yes/No)	Time to Ignition (min:sec)
CG.3.6.H	Paper Towel	6”	High	2:36	Yes	2:36
Comment	Signs of ignition were noted within seconds after starting test prior to reaching flaming combustion. Heavy smoke release was noted during testing.					



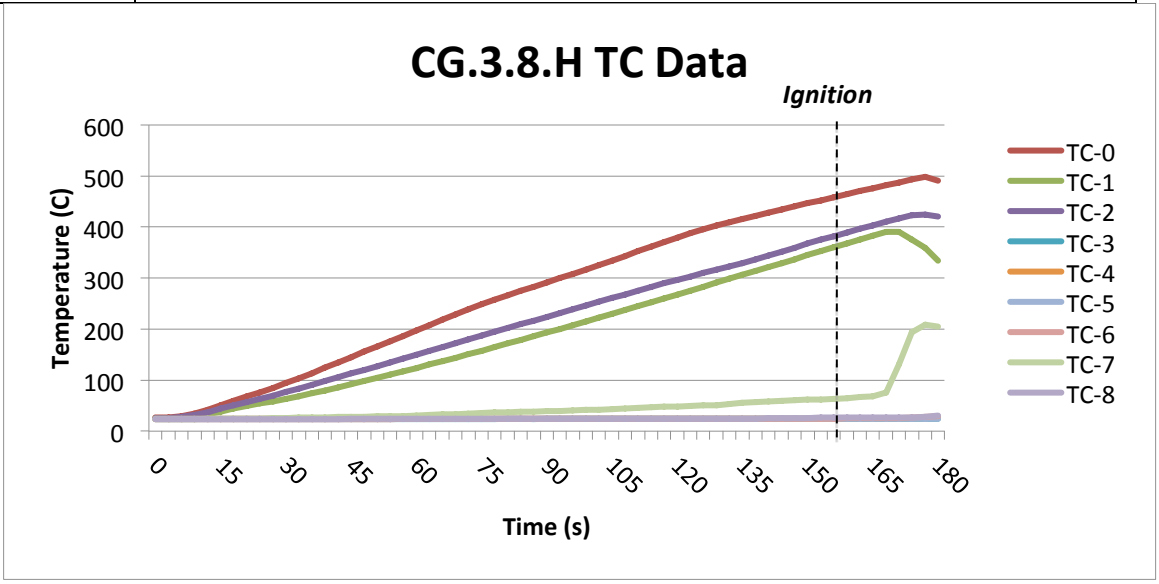
Test Id	Fuel	Diameter	Setting	Time (min:sec)	Ignition (Yes/No)	Time to Ignition (min:sec)
CG.3.8.L	Paper Towel	8”	Low	35:00	No	
Comment	No signs of ignition. Material was only warm to touch following the removal from heating element.					



Test Id	Fuel	Diameter	Setting	Time (min:sec)	Ignition (Yes/No)	Time to Ignition (min:sec)
CG.3.8.M	Paper Towel	8”	Medium	10:24	Yes	10:24
Comment	Material had significant mass loss from smoldering combustion prior to ignition. Heavy smoke release was noted during testing.					



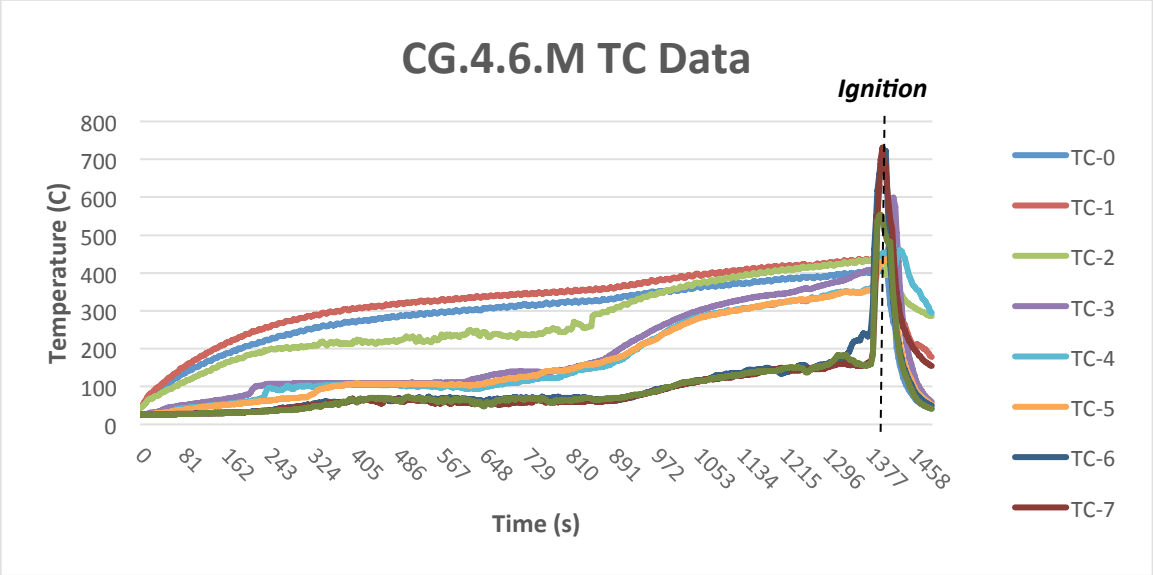
Test Id	Fuel	Diameter	Setting	Time (min:sec)	Ignition (Yes/No)	Time to Ignition (min:sec)
CG.3.8.H	Paper Towel	8”	High	2:30	Yes	2:30
Comment	Signs of ignition were noted within seconds after starting test prior to reaching flaming combustion. Heavy smoke release was noted during testing.					



Test Id	Fuel	Diameter	Setting	Time (min:sec)	Ignition (Yes/No)	Time to Ignition (min:sec)
CG.4.6.L	Canola Oil	6”	Low	No test	No	
Comment	No test was conducted using low setting based on low heat output.					

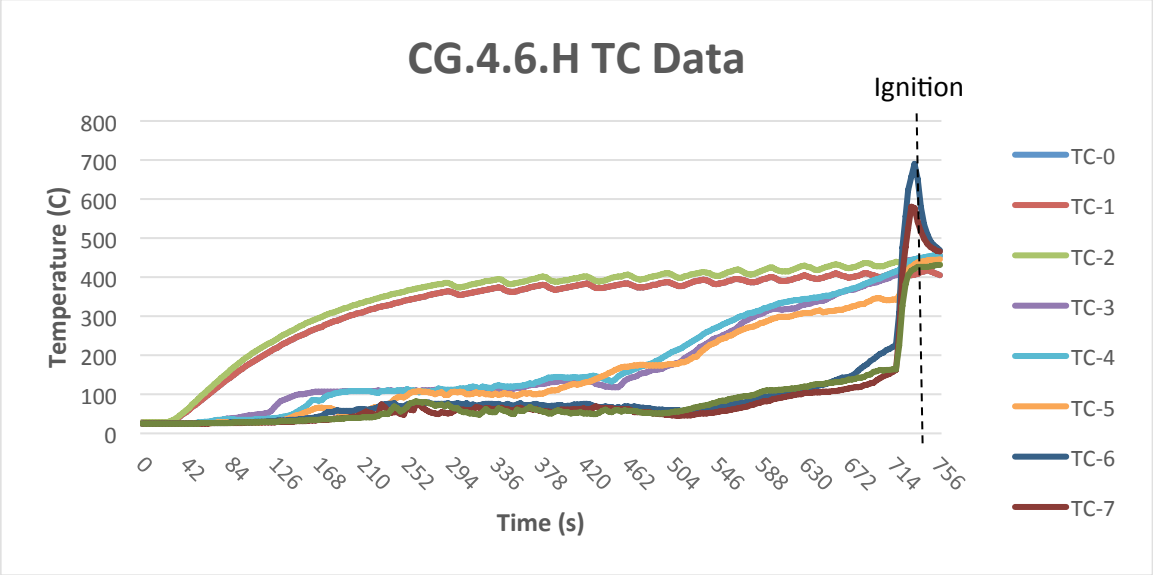
No Test Conducted

Test Id	Fuel	Diameter	Setting	Time (min:sec)	Ignition (Yes/No)	Time to Ignition (min:sec)
CG.4.6.M	Canola Oil	6”	Medium	22:16	Yes	22:16
Comment						



Test Id	Fuel	Diameter	Setting	Time	Ignition	Time to Ignition

				(min:sec)	(Yes/No)	(min:sec)
CG.4.6.H	Canola Oil	6”	High	12:02	Yes	12:02
Comment						

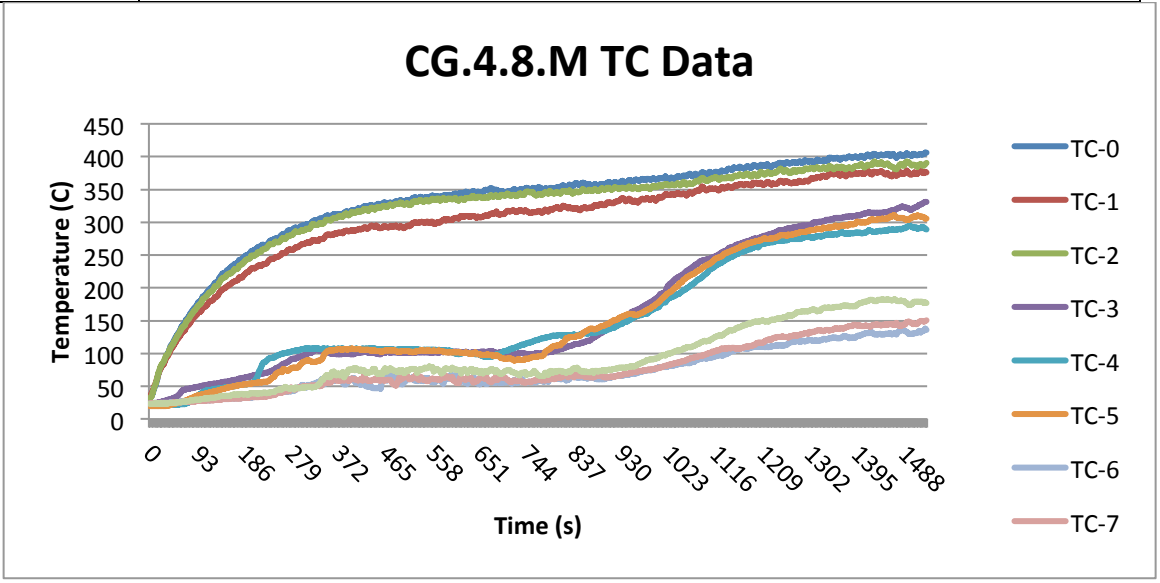


Test Id	Fuel	Diameter	Setting	Time (min:sec)	Ignition (Yes/No)	Time to Ignition (min:sec)
CG.4.8.L	Canola Oil	8”	Low	No test	No	
Comment	No test was conducted using low setting.					

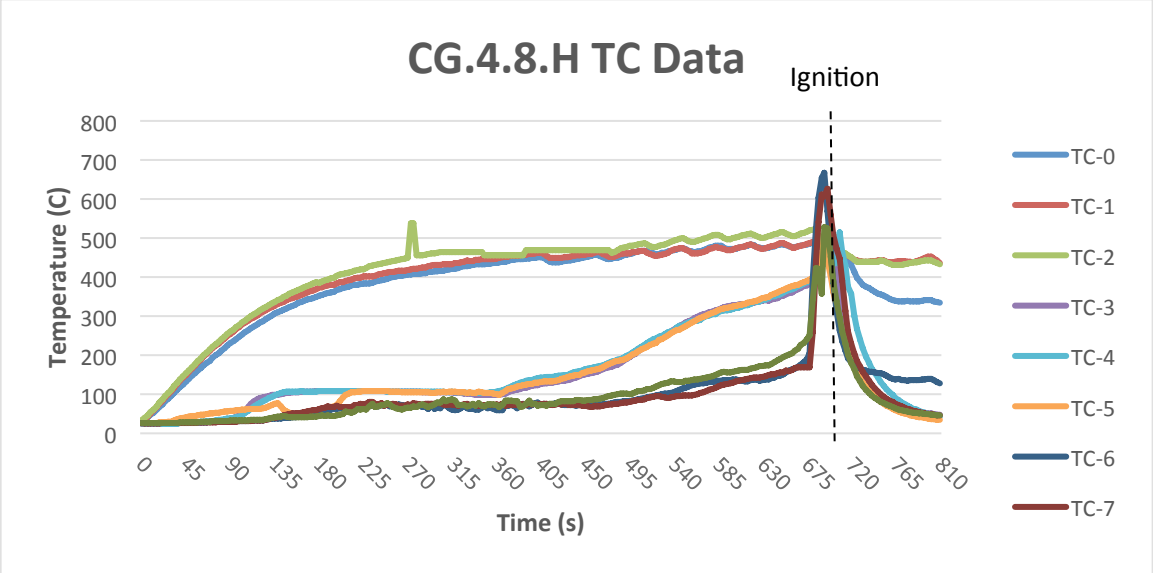
No Test Conducted

Test Id	Fuel	Diameter	Setting	Time (min:sec)	Ignition (Yes/No)	Time to Ignition (min:sec)

CG.4.8.M	Canola Oil	8”	Medium	25:00	No	
Comment	No Ignition.					



Test Id	Fuel	Diameter	Setting	Time (min:sec)	Ignition (Yes/No)	Time to Ignition (min:sec)
CG.4.8.H	Canola Oil	8”	High	11:26	Yes	11:26
Comment						

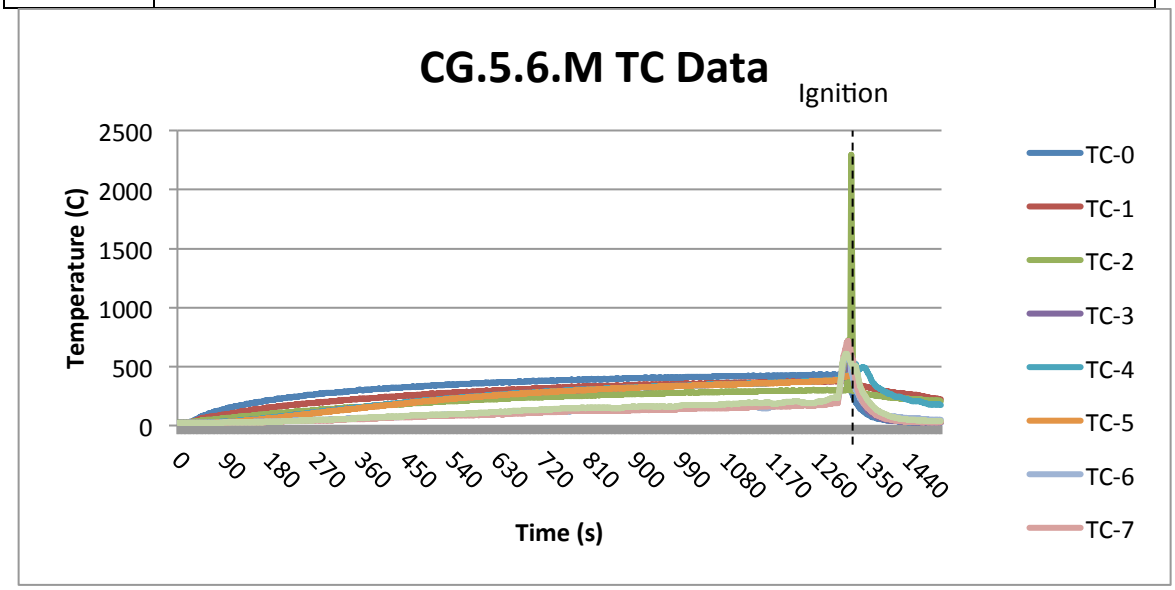


Test Id	Fuel	Diameter	Setting	Time (min:sec)	Ignition (Yes/No)	Time to Ignition (min:sec)

CG.5.6.L	Vegetable Oil	6”	Low	No test	No	
Comment	No test was conducted based on low heat output on low setting.					

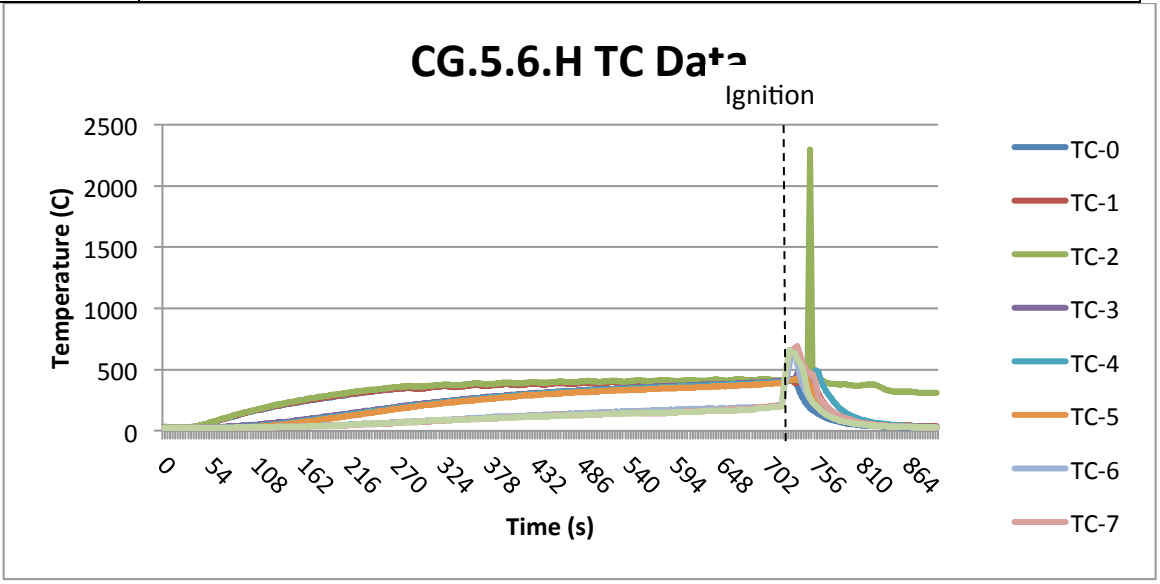
No Test Conducted

Test Id	Fuel	Diameter	Setting	Time (min:sec)	Ignition (Yes/No)	Time to Ignition (min:sec)
CG.5.6.M	Vegetable Oil	6”	Medium	21:29	Yes	21:29
Comment						



Test Id	Fuel	Diameter	Setting	Time (min:sec)	Ignition (Yes/No)	Time to Ignition (min:sec)
CG.5.6.H	Vegetable Oil	6”	High	11:32	Yes	11:32

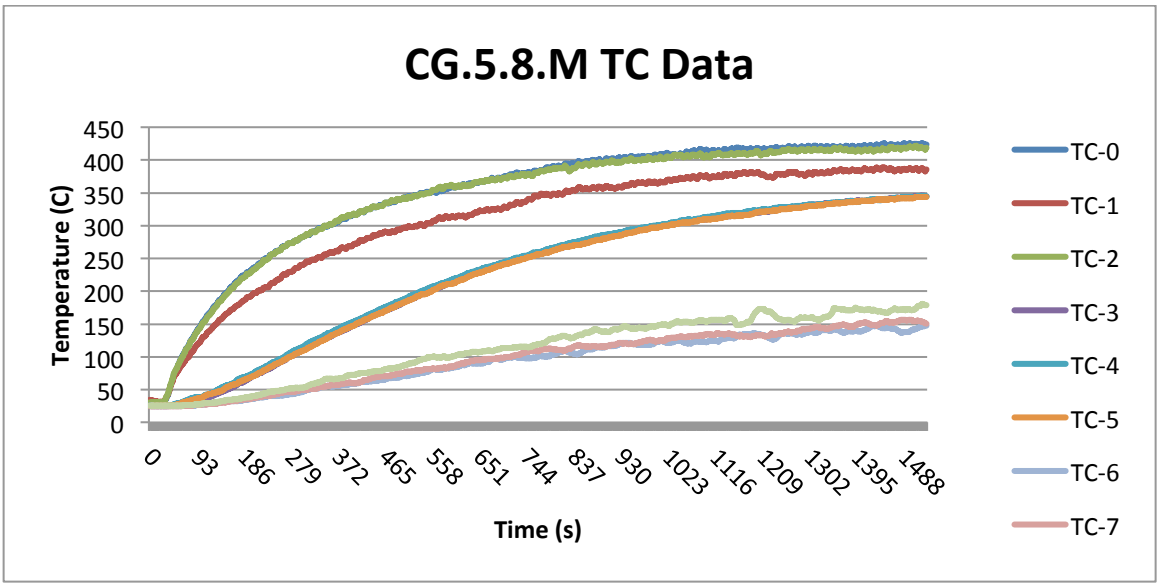
Comment	



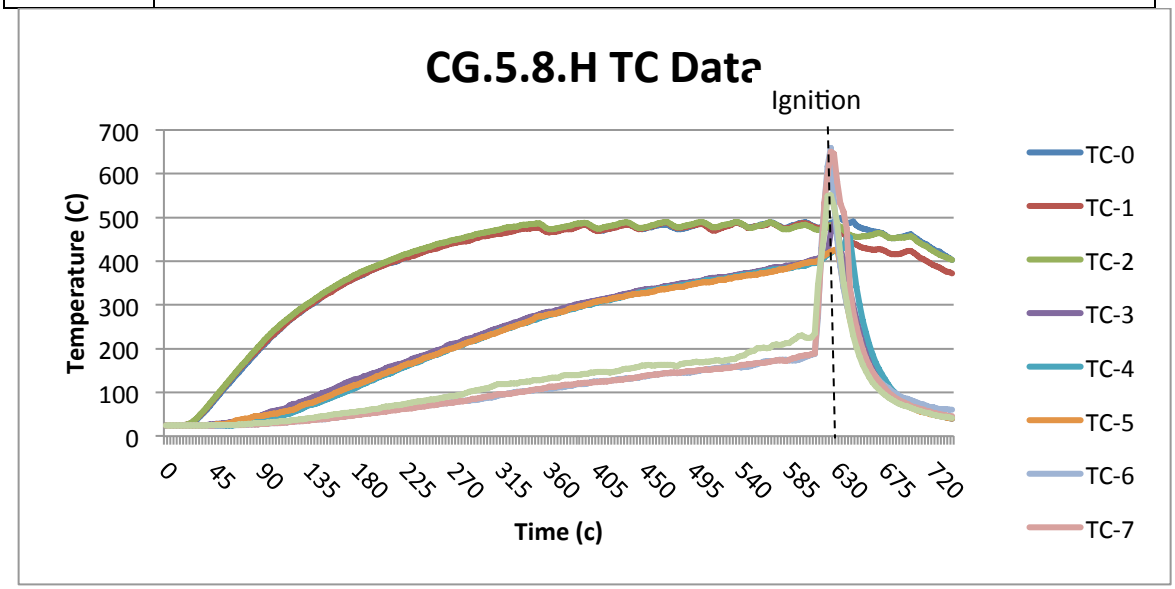
Test Id	Fuel	Diameter	Setting	Time (min:sec)	Ignition (Yes/No)	Time to Ignition (min:sec)
CG.5.8.L	Vegetable Oil	8”	Low	No test	No	
Comment	No test was conducted based on low heat output on low setting.					

No Test Conducted

Test Id	Fuel	Diameter	Setting	Time (min:sec)	Ignition (Yes/No)	Time to Ignition (min:sec)
CG.5.8.M	Vegetable Oil	8”	Medium	25:00	No	
Comment						



Test Id	Fuel	Diameter	Setting	Time (min:sec)	Ignition (Yes/No)	Time to Ignition (min:sec)
CG.5.8.H	Vegetable Oil	8”	High	10:26	Yes	10:26
Comment						

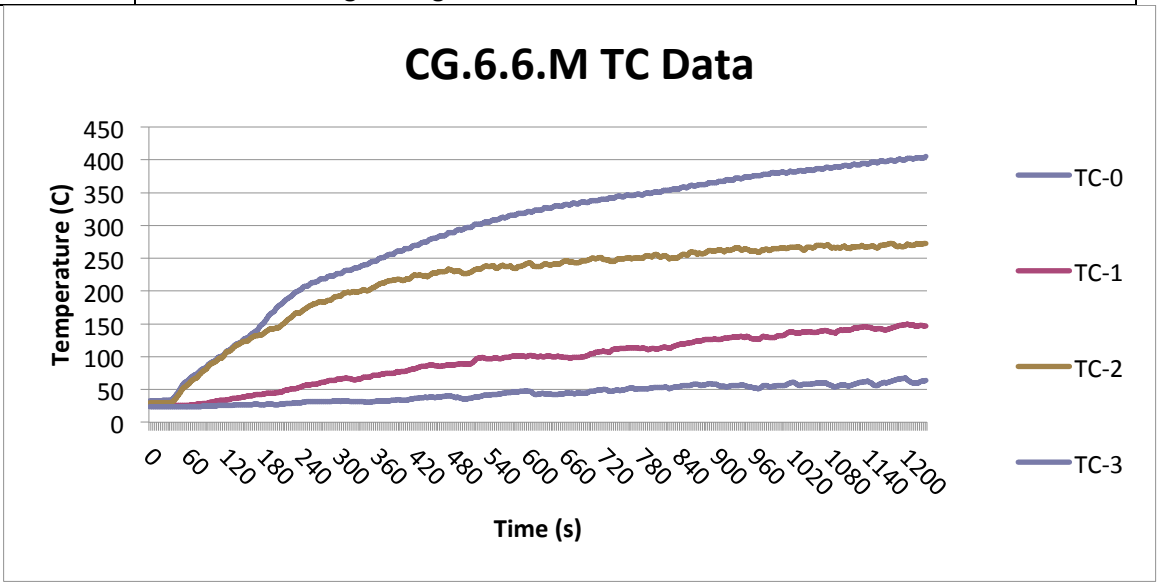


Test Id	Fuel	Diameter	Setting	Time (min:sec)	Ignition (Yes/No)	Time to Ignition (min:sec)
CG.6.6.L	Nylon spatula	6”	Low	No Test	No	
Comment	No test was conducted on low setting based on no ignition results from test					

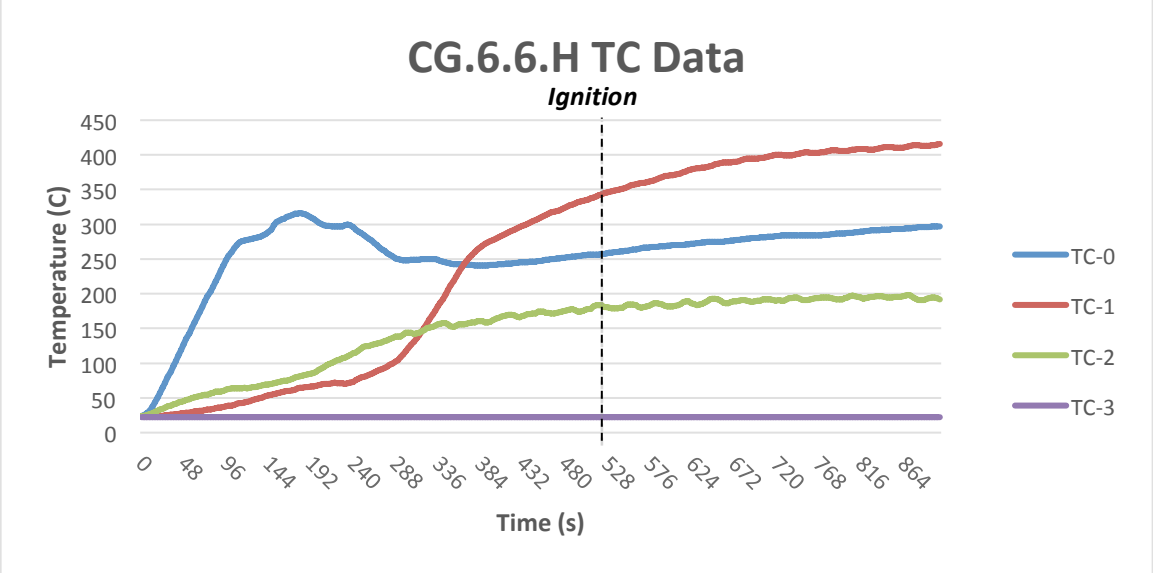
	conducted on medium setting.

No Test Conducted

Test Id	Fuel	Diameter	Setting	Time (min:sec)	Ignition (Yes/No)	Time to Ignition (min:sec)
CG.6.6.M	Nylon spatula	6”	Medium	15:00	No	
Comment	No ignition. Material only melted and off gassed during testing. A heavy smoke was noted during testing.					



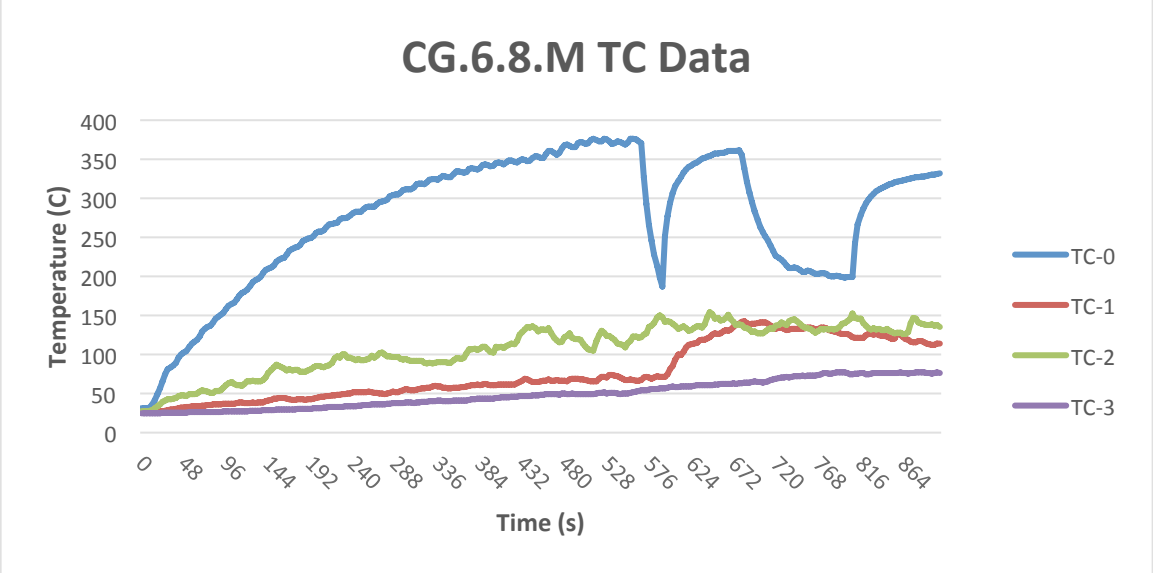
Test Id	Fuel	Diameter	Setting	Time (min:sec)	Ignition (Yes/No)	Time to Ignition (min:sec)
CG.6.6.H	Nylon spatula	6”	High	8:34	Yes	8:34
Comment	Material melted and off gassed prior to ignition. Heavy smoke was noted prior to and following ignition of material.					



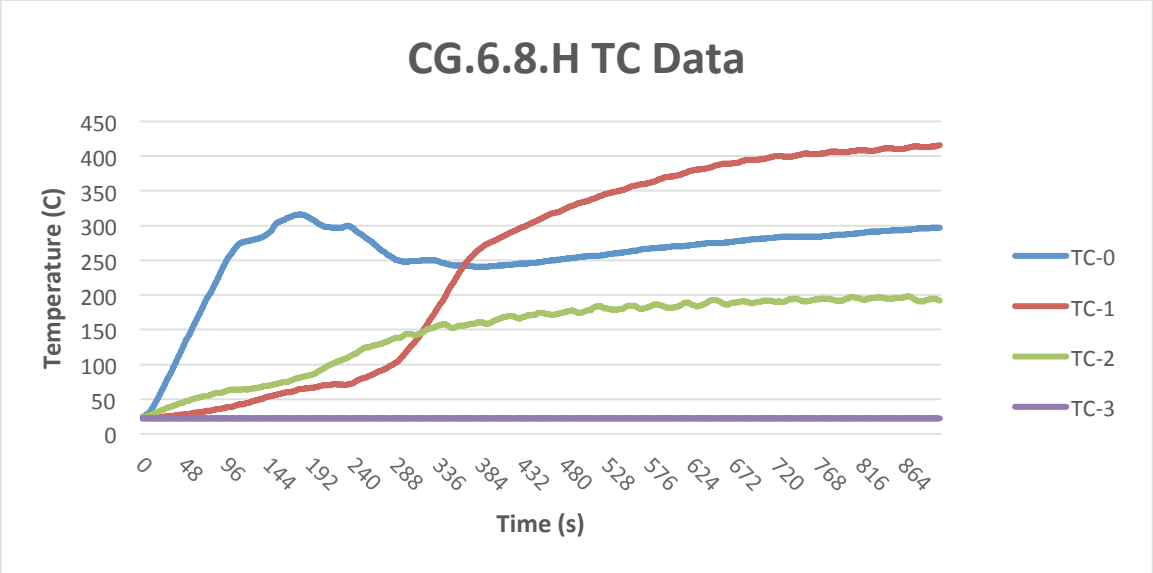
Test Id	Fuel	Diameter	Setting	Time (min:sec)	Ignition (Yes/No)	Time to Ignition (min:sec)
CG.6.8.L	Nylon spatula	8”	Low	No Test	No	
Comment	No test was conducted on low setting based on no ignition results from test conducted on medium setting.					

No Test Conducted

Test Id	Fuel	Diameter	Setting	Time (min:sec)	Ignition (Yes/No)	Time to Ignition (min:sec)
CG.6.8.M	Nylon spatula	8”	Medium	15:00	No	
Comment	No ignition. Material only melted and off gassed during testing. A heavy smoke was noted during testing.					



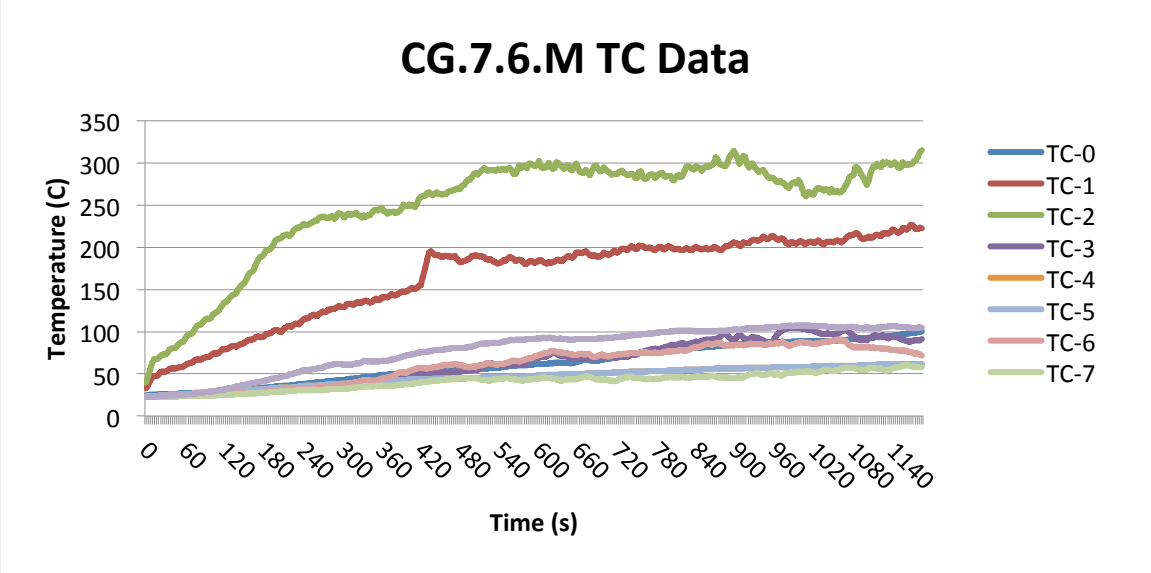
Test Id	Fuel	Diameter	Setting	Time (min:sec)	Ignition (Yes/No)	Time to Ignition (min:sec)
CG.6.8.H	Nylon spatula	8”	High	15:00	No	
Comment	Material melted and off gassed prior to ignition. Heavy smoke was noted prior to and following ignition of material.					



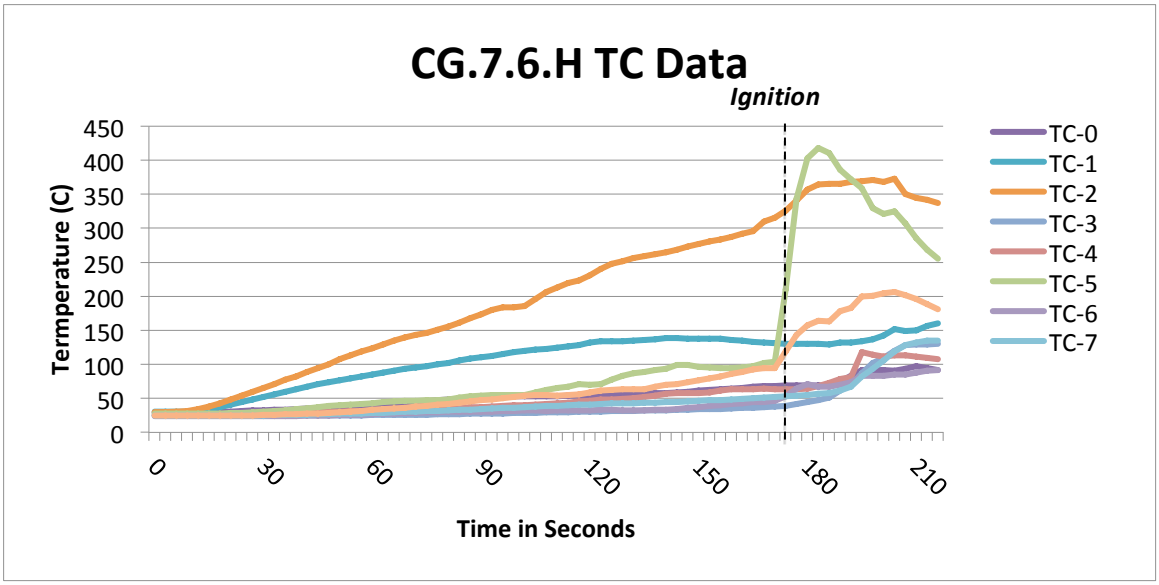
Test Id	Fuel	Diameter	Setting	Time (min:sec)	Ignition (Yes/No)	Time to Ignition (min:sec)
CG.7.6.L	Toaster	6”	Low	No test	No	
Comment	No test was conducted on low setting based on no ignition results from test conducted on medium setting.					

No Test Conducted

Test Id	Fuel	Diameter	Setting	Time (min:sec)	Ignition (Yes/No)	Time to Ignition (min:sec)
CG.7.6.M	Toaster	6”	Medium	20:00	No	
Comment	No ignition. Some mass loss and melting was noted during testing. Significant smoke was noted during testing.					



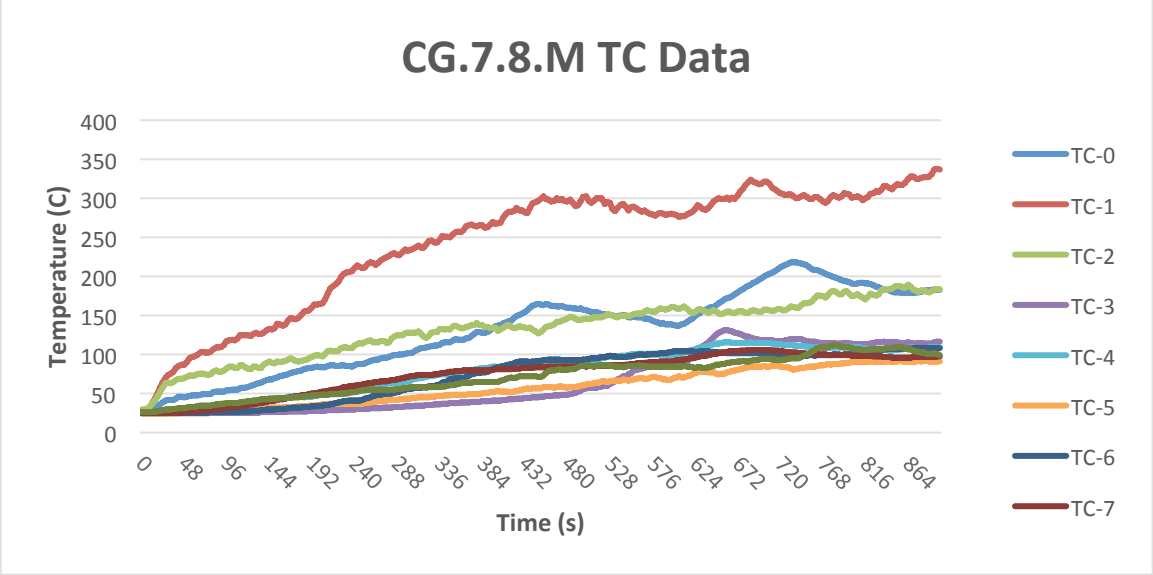
Test Id	Fuel	Diameter	Setting	Time (min:sec)	Ignition (Yes/No)	Time to Ignition (min:sec)
CG.7.6.H	Toaster	6”	High	2:49	Yes	2:49
Comment	Melting and off gassing was noted within seconds of starting test. Heavy smoke was noted prior to and following ignition. Flame height reached 8-10 inch heights within seconds after ignition and could have increased if not suppressed.					



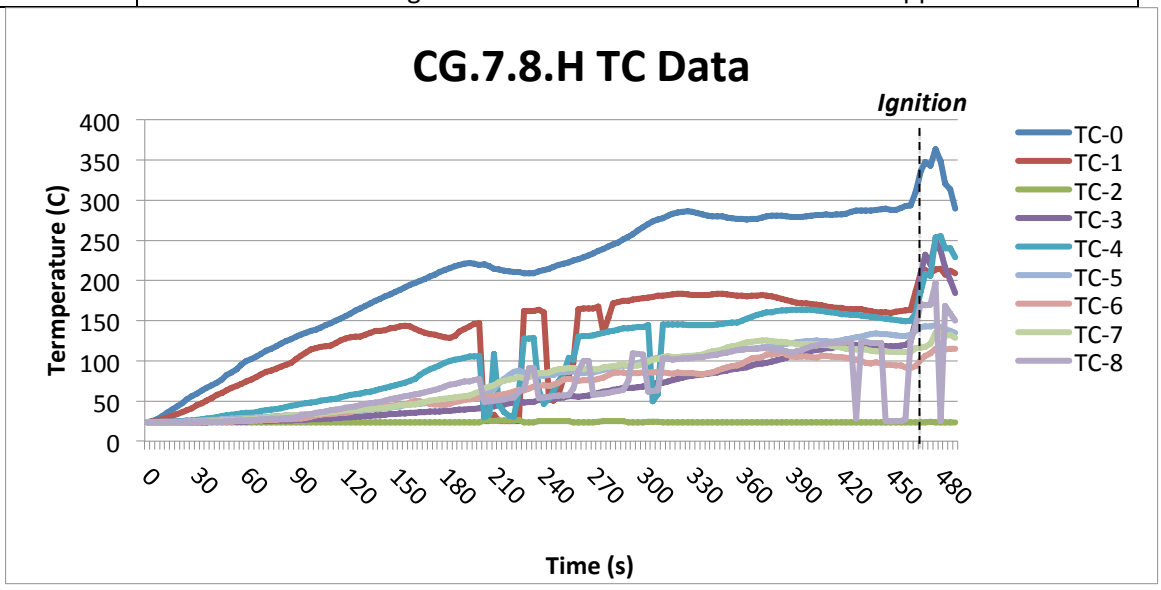
Test Id	Fuel	Diameter	Setting	Time (min:sec)	Ignition (Yes/No)	Time to Ignition (min:sec)
CG.7.8.L	Toaster	8”	Low	No test	No	
Comment	No test was conducted on low setting based on no ignition results from test conducted on medium setting.					

No Test Conducted

Test Id	Fuel	Diameter	Setting	Time (min:sec)	Ignition (Yes/No)	Time to Ignition (min:sec)
CG.7.8.M	Toaster	8”	Medium	20:00	No	
Comment	No ignition. Some mass loss and melting was noted during testing. Significant smoke was noted during testing.					



Test Id	Fuel	Diameter	Setting	Time (min:sec)	Ignition (Yes/No)	Time to Ignition (min:sec)
CG.7.8.H	Toaster	8”	High	7:48	Yes	7:48
Comment	Melting and off gassing was noted within seconds of starting test. Heavy smoke was noted prior to and following ignition. Flame height reached 8-10 inch heights within seconds after ignition and could have increased if not suppressed.					



Test Id	Fuel	Diameter	Setting	Time (min:sec)	Ignition (Yes/No)	Time to Ignition (min:sec)
CG.8.6.L	Food Storage	6”	Low	No test	No	

	Container					
Comment	No test was conducted based on other test conducted on low setting.					

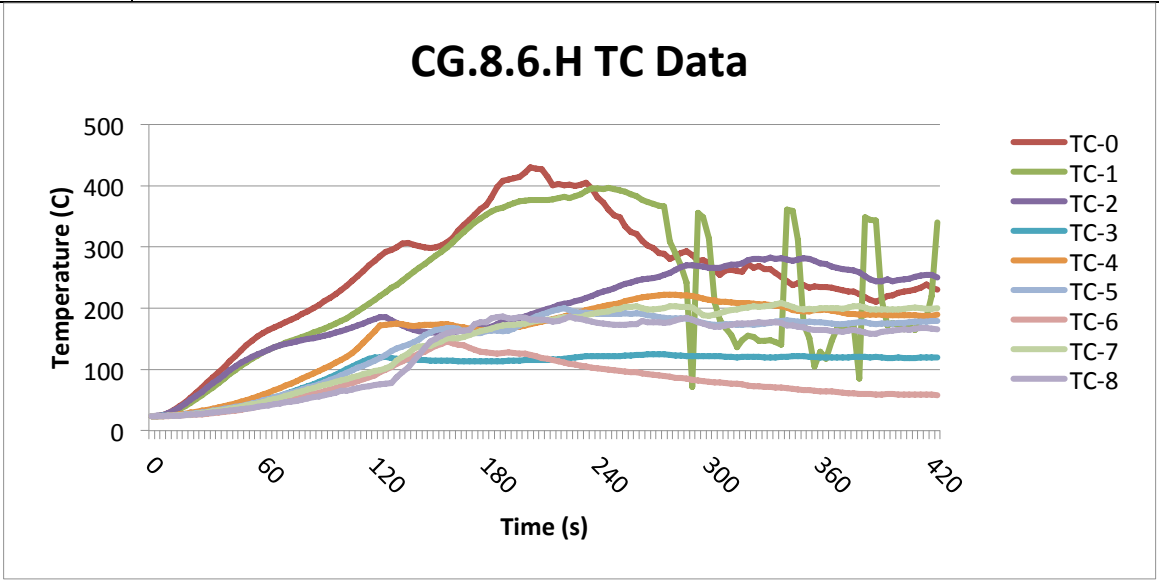
No Test Conducted

Test Id	Fuel	Diameter	Setting	Time (min:sec)	Ignition (Yes/No)	Time to Ignition (min:sec)
CG.8.6.M	Food Storage Container	6”	Medium	No test	No	
Comment	No test was conducted based on results from 8 inch heating element test resulting in no ignition.					

No Test Conducted

Test Id	Fuel	Diameter	Setting	Time (min:sec)	Ignition (Yes/No)	Time to Ignition (min:sec)
CG.8.6.H	Food Storage Container	6”	High	6:30	No	

Comment	Significant mass loss, melting, and off gassing was noted during test. Test stopped after temperatures began to decrease from loss of materials mass.

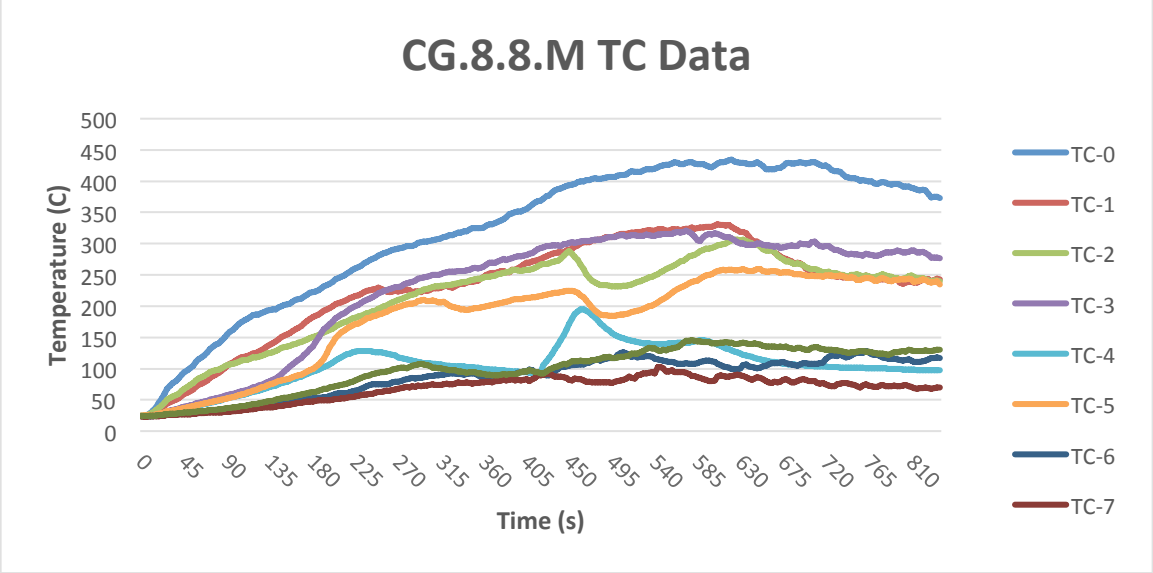


Test Id	Fuel	Diameter	Setting	Time (min:sec)	Ignition (Yes/No)	Time to Ignition (min:sec)
CG.8.8.L	Food Storage Container	8”	Low	No test	No	
Comment	No test was conducted based on other test conducted on low setting.					

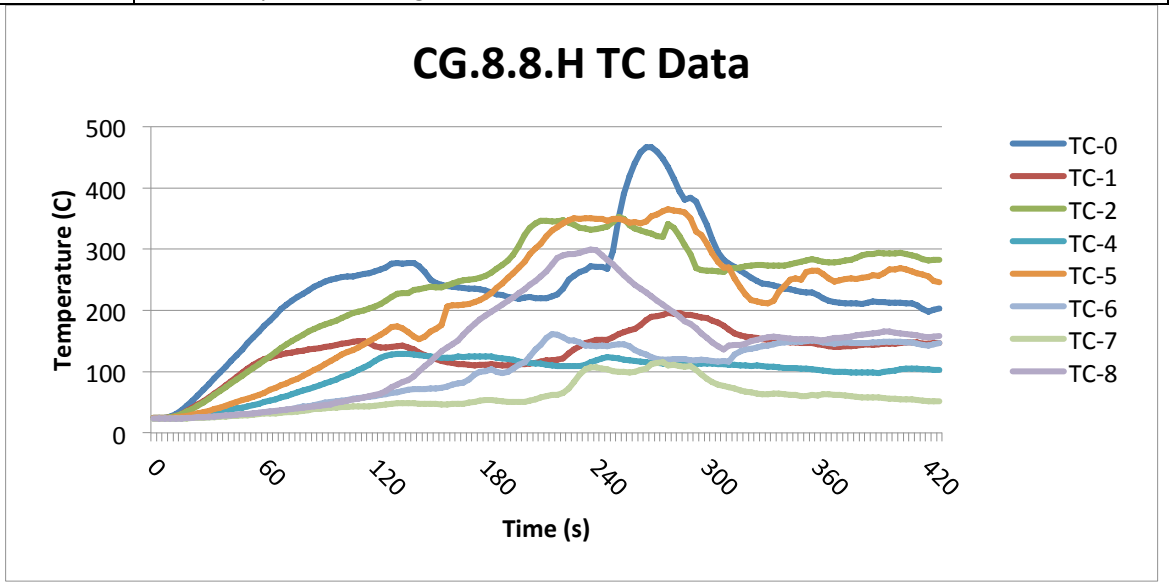
No Test Conducted

Test Id	Fuel	Diameter	Setting	Time (min:sec)	Ignition (Yes/No)	Time to Ignition (min:sec)
CG.8.8.M	Food Storage Container	8”	Medium	6:30	No	
Comment	Significant mass loss, melting, and off gassing was noted during test. Test stopped					

	after temperatures began to decrease from loss of materials mass.



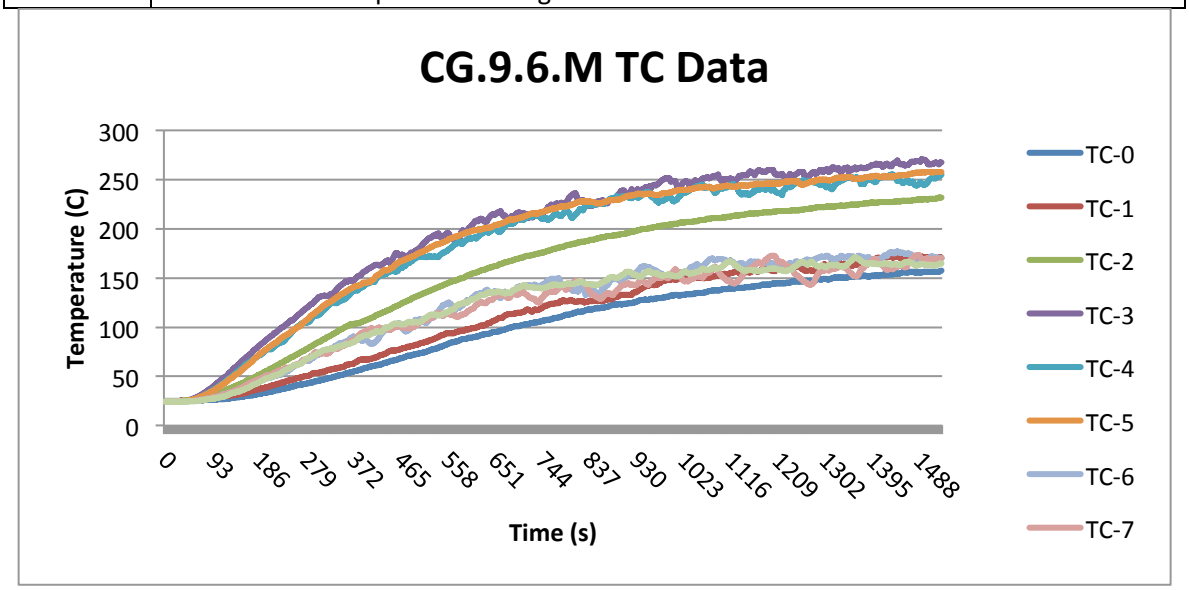
Test Id	Fuel	Diameter	Setting	Time (min:sec)	Ignition (Yes/No)	Time to Ignition (min:sec)
CG.8.8.H	Food Storage Container	8”	High	7:00	No	
Comment	Significant mass loss, melting, and off gassing was noted during test. Test stopped after temperatures began to decrease from loss of materials mass.					



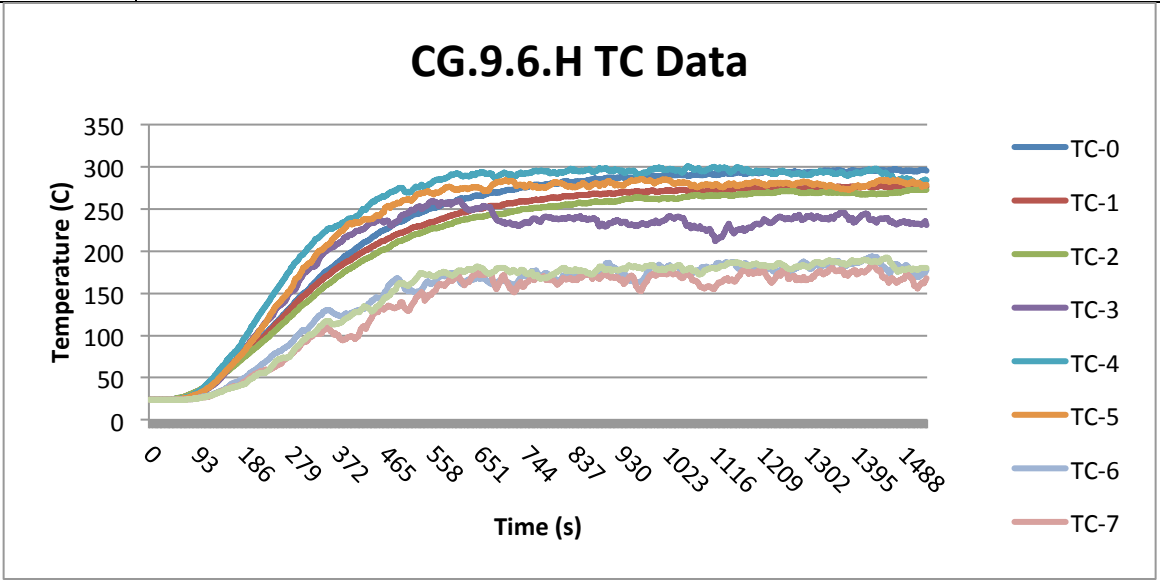
Test Id	Fuel	Diameter	Setting	Time (min:sec)	Ignition (Yes/No)	Time to Ignition (min:sec)
CG.9.6.L	Corn Oil	6”	Low	No Test	No	
Comment	No test was conducted on low setting based on no ignition from both medium and high settings for 6 inch heating element.					

No Test Conducted

Test Id	Fuel	Diameter	Setting	Time (min:sec)	Ignition (Yes/No)	Time to Ignition (min:sec)
CG.9.6.M	Corn Oil	6”	Medium	25:00	No	
Comment	Fuel shows some potential for ignition.					



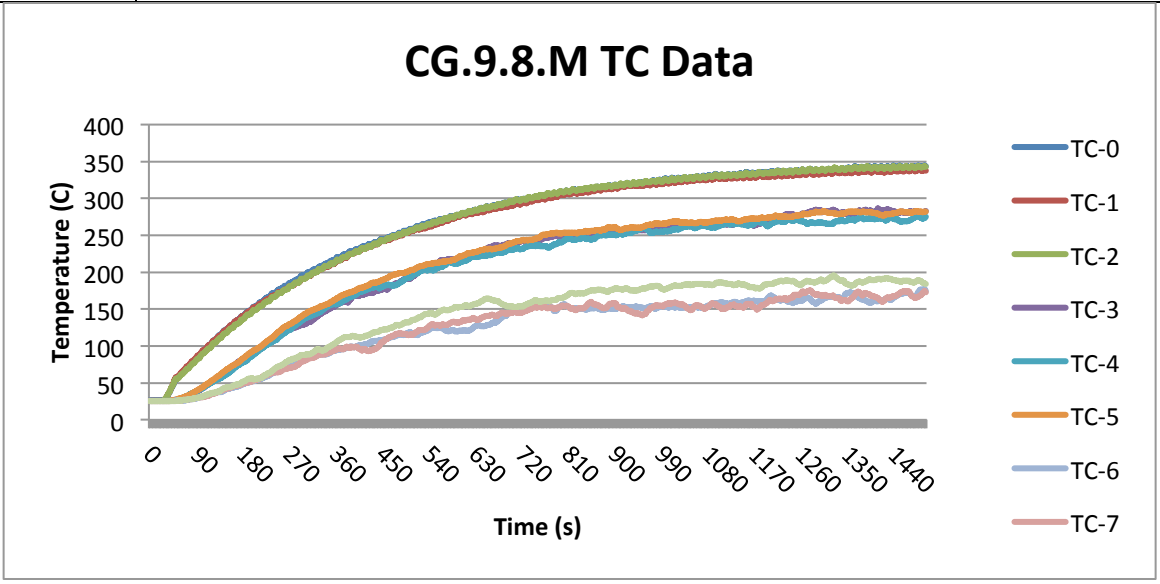
Test Id	Fuel	Diameter	Setting	Time (min:sec)	Ignition (Yes/No)	Time to Ignition (min:sec)
CG.9.6.H	Corn Oil	6”	High	25:00	No	
Comment	Fuel shows some potential for ignition.					



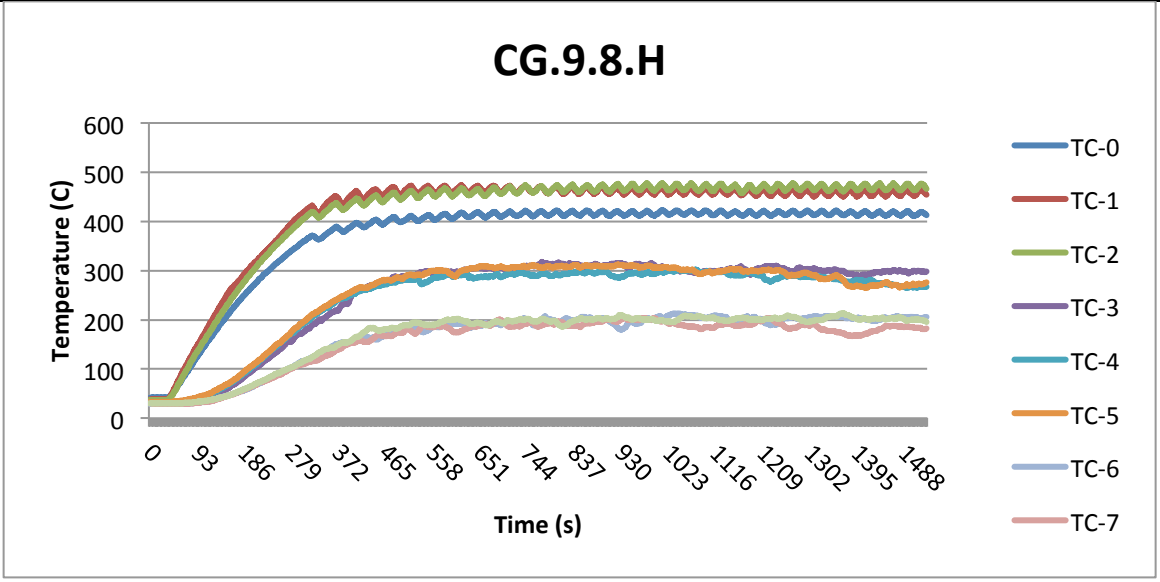
Test Id	Fuel	Diameter	Setting	Time (min:sec)	Ignition (Yes/No)	Time to Ignition (min:sec)
CG.9.8.L	Corn Oil	8”	Low	No Test	No	
Comment	No test was conducted on low setting based on no ignition from both medium and high settings for 8” inch heating element.					

No Test Conducted

Test Id	Fuel	Diameter	Setting	Time (min:sec)	Ignition (Yes/No)	Time to Ignition (min:sec)
CG.9.8.M	Corn Oil	8”	Medium	30:00	No	
Comment	Fuel shows some potential for ignition.					

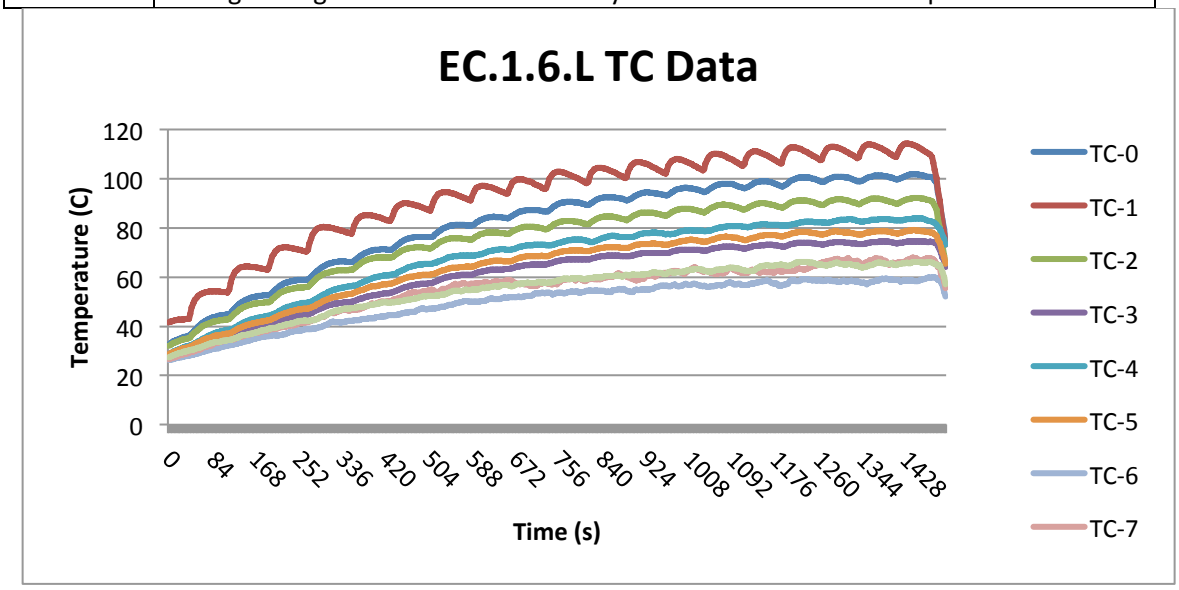


Test Id	Fuel	Diameter	Setting	Time (min:sec)	Ignition (Yes/No)	Time to Ignition (min:sec)
CG.9.8.H	Corn Oil	8”	High	25:00	No	
Comment	Fuel shows some potential for ignition.					

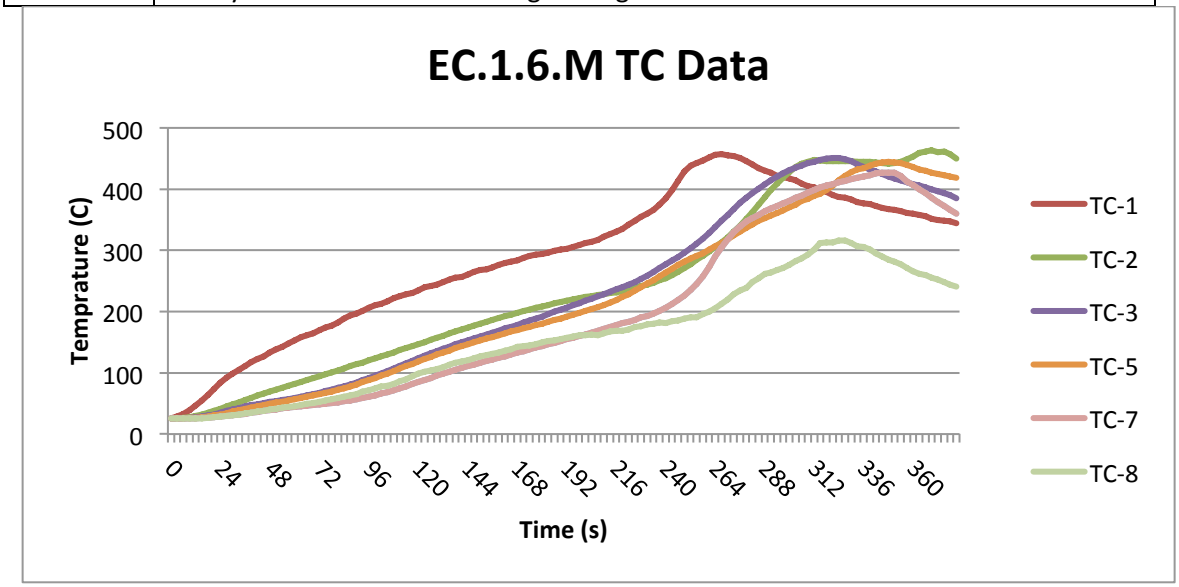


Appendix E – Electric Coil Cooktop Range Results

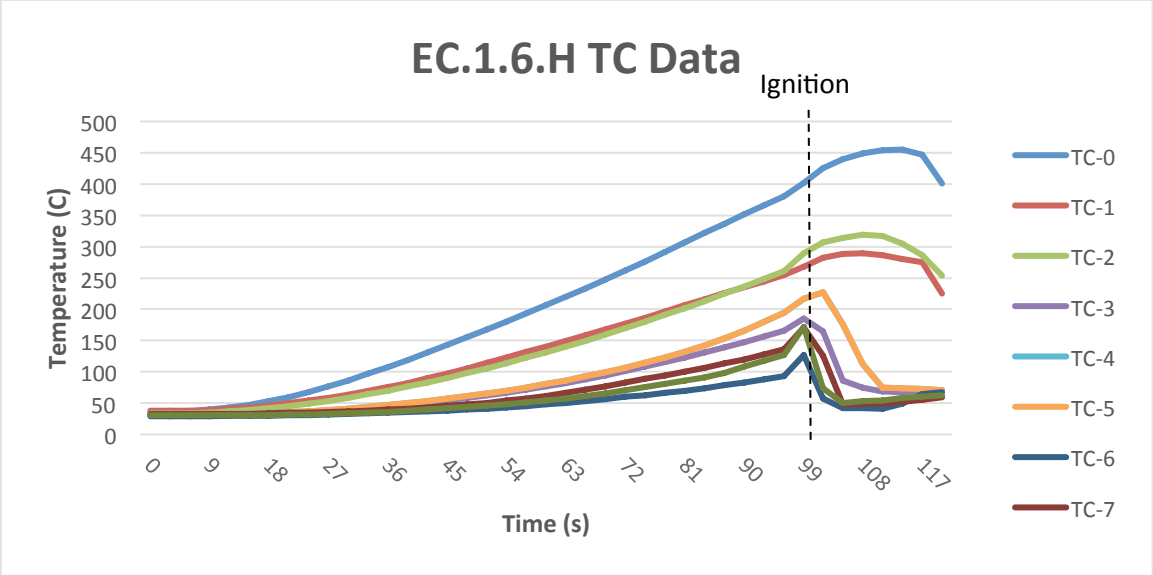
Test Id	Fuel	Diameter	Setting	Time (min:sec)	Ignition (Yes/No)	Time to Ignition (min:sec)
EC.1.6.L	Cardboard	6”	Low	25:00	No	
Comment	No signs of ignition. Material was only warm to touch after completion of test.					



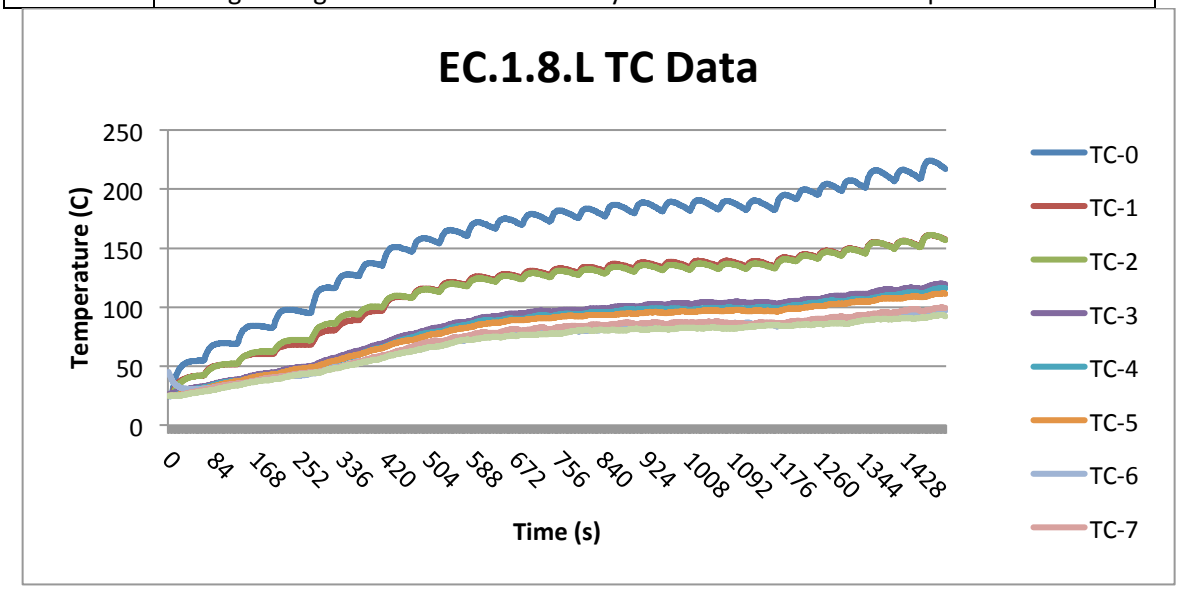
Test Id	Fuel	Diameter	Setting	Time (min:sec)	Ignition (Yes/No)	Time to Ignition (min:sec)
EC.1.6.M	Cardboard	6”	Medium	6:30	No	
Comment	Test was stopped after material had lost all mass due to smoldering combustion. Heavy smoke was noted during testing.					



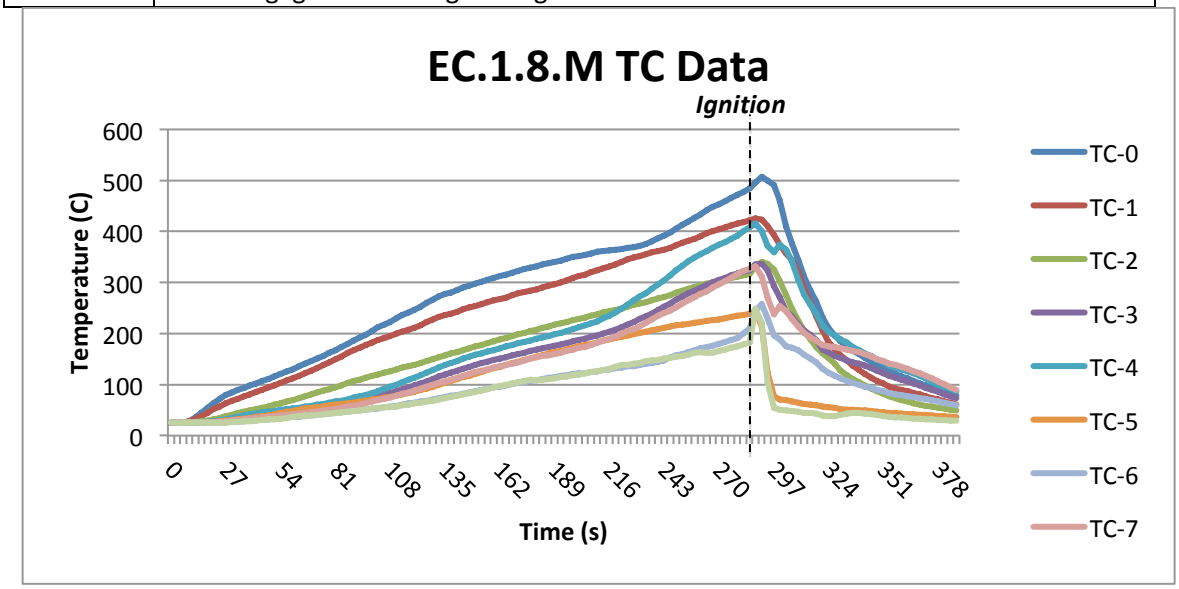
Test Id	Fuel	Diameter	Setting	Time (min:sec)	Ignition (Yes/No)	Time to Ignition (min:sec)
EC.1.6.H	Cardboard	6”	High	1:39	Yes	1:39
Comment	Material lost some mass prior to ignition. Material began smoking within seconds after starting test.					



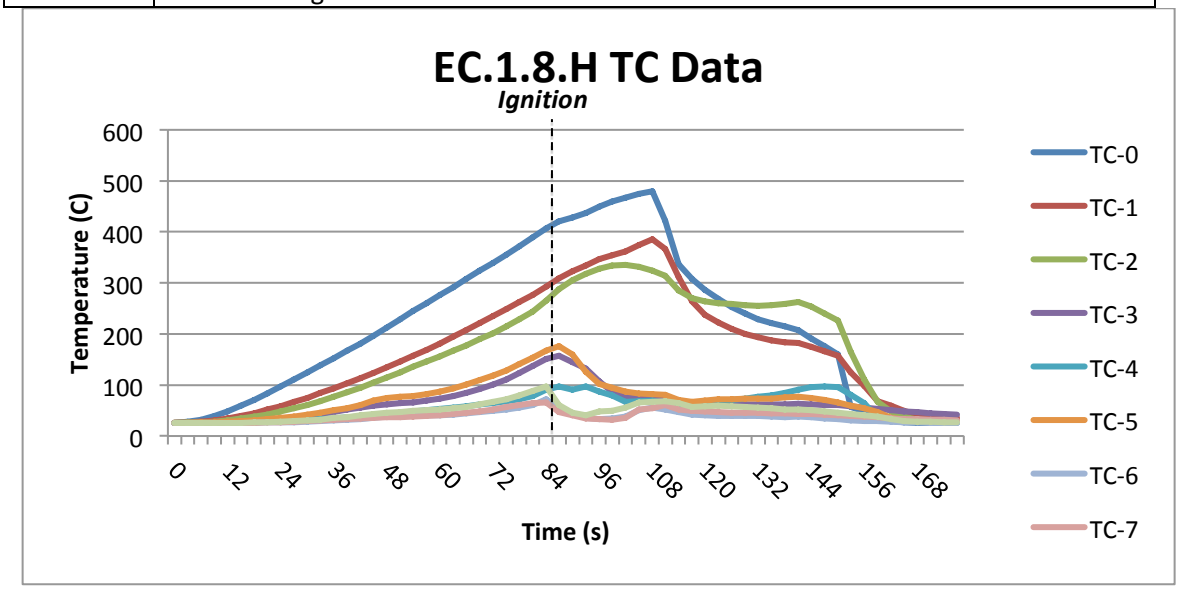
Test Id	Fuel	Diameter	Setting	Time (min:sec)	Ignition (Yes/No)	Time to Ignition (min:sec)
EC.1.8.L	Cardboard	8”	Low	25:00	No	
Comment	No signs of ignition. Material was only warm to touch after completion of test.					



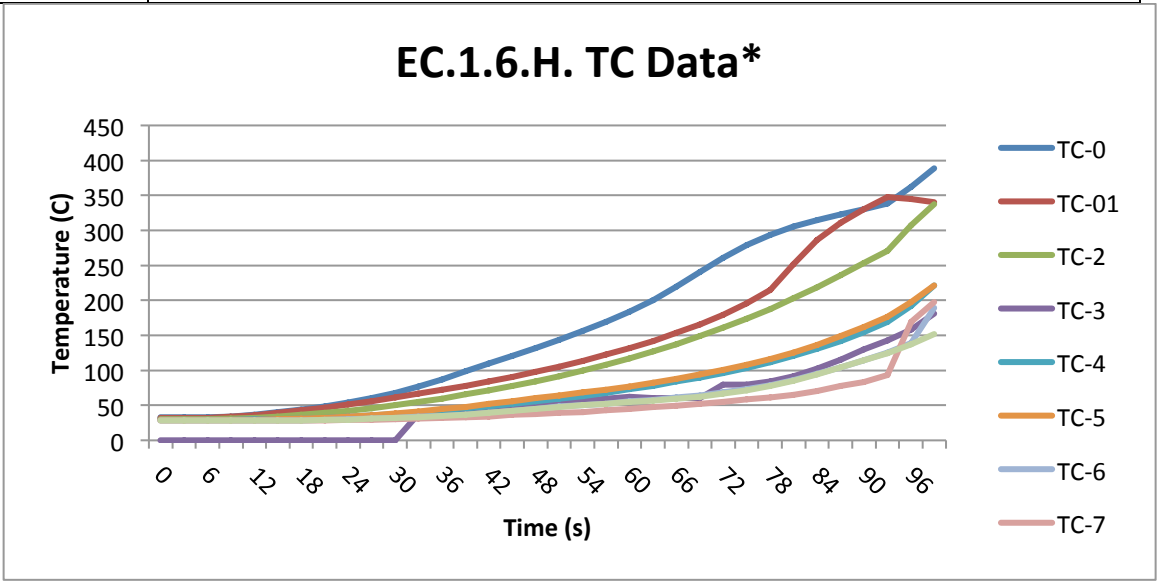
Test Id	Fuel	Diameter	Setting	Time (min:sec)	Ignition (Yes/No)	Time to Ignition (min:sec)
EC.1.8.M	Cardboard	8”	Medium	4:32	Yes	4:32
Comment	Material lost some mass prior to ignition. Heavy smoke was noted prior to and following ignition during testing.					



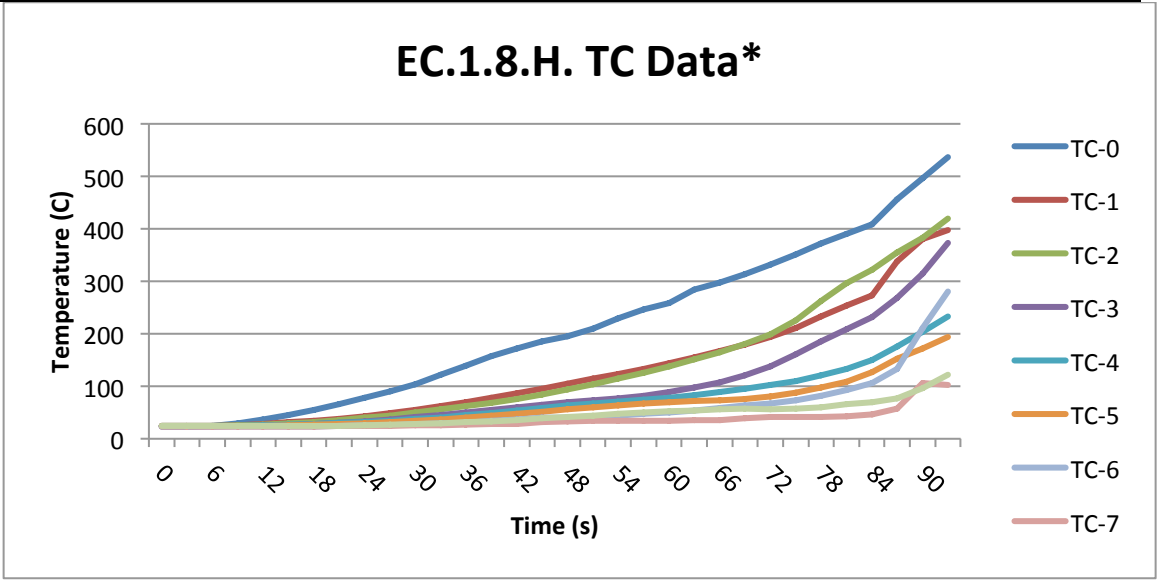
Test Id	Fuel	Diameter	Setting	Time (min:sec)	Ignition (Yes/No)	Time to Ignition (min:sec)
EC.1.8.H	Cardboard	8”	High	1:24	Yes	1:24
Comment	Material lost some mass prior to ignition. Material began smoking within seconds after starting test.					



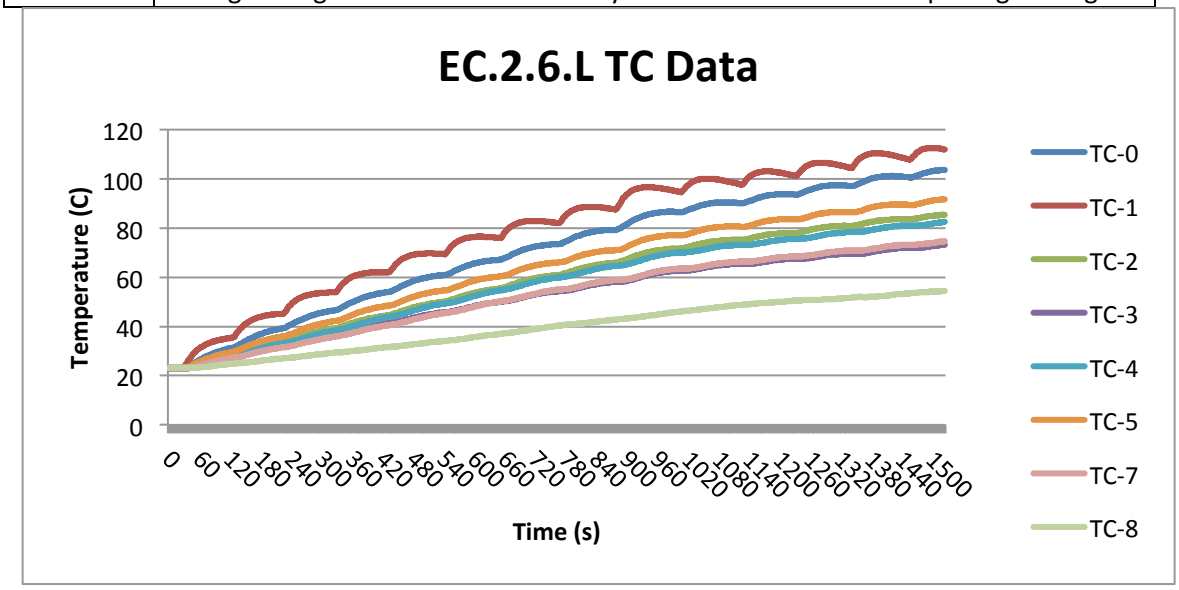
Test Id	Fuel	Diameter	Setting	Time (min:sec)	Ignition (Yes/No)	Time to Ignition (min:sec)
EC.1.6.H.*	Cardboard	6”	High	2:06	No	2:06
Comment	Material began to lose mass and smoke prior to ignition. Test was stopped after ignition.					



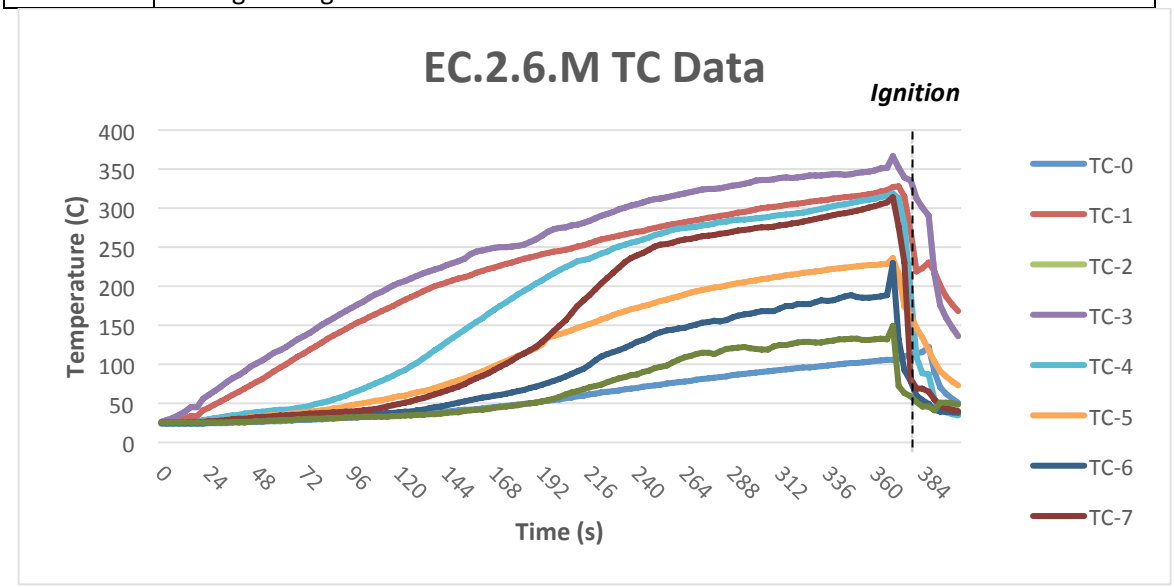
Test Id	Fuel	Diameter	Setting	Time (min:sec)	Ignition (Yes/No)	Time to Ignition (min:sec)
EC.1.8.H.*	Cardboard	8”	High	1:20	No	1:20
Comment	Material began to lose mass and smoke prior to ignition. Test was stopped after ignition.					



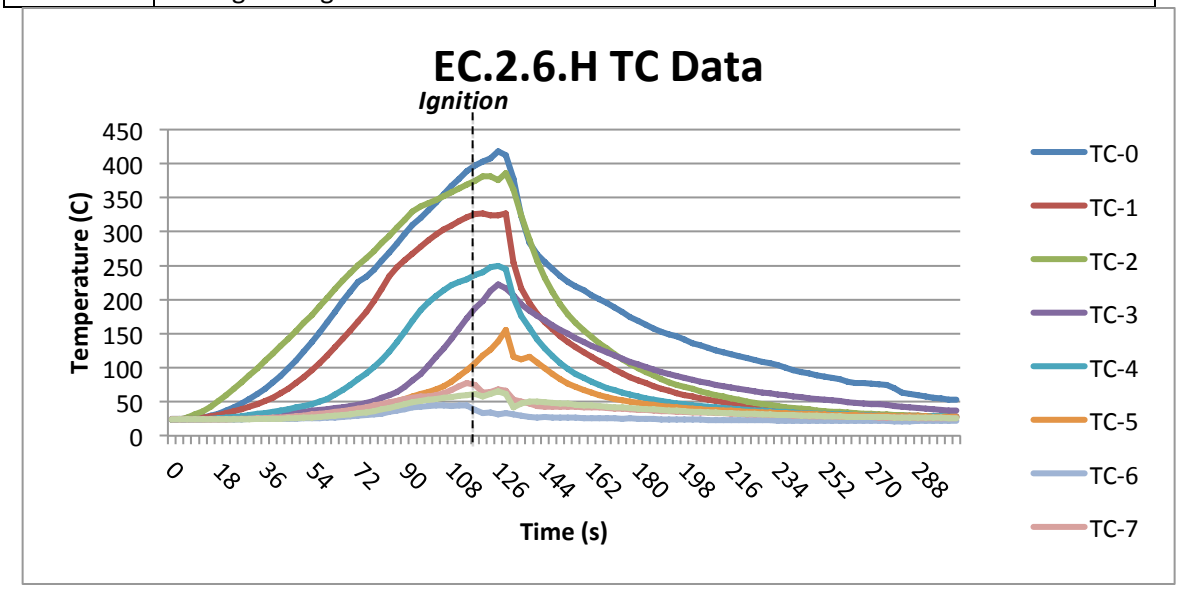
Test Id	Fuel	Diameter	Setting	Time (min:sec)	Ignition (Yes/No)	Time to Ignition (min:sec)
EC.2.6.L	Dish Towel	6”	Low	25:00	No	
Comment	No signs of ignition. Material was only warm to touch after completing testing.					



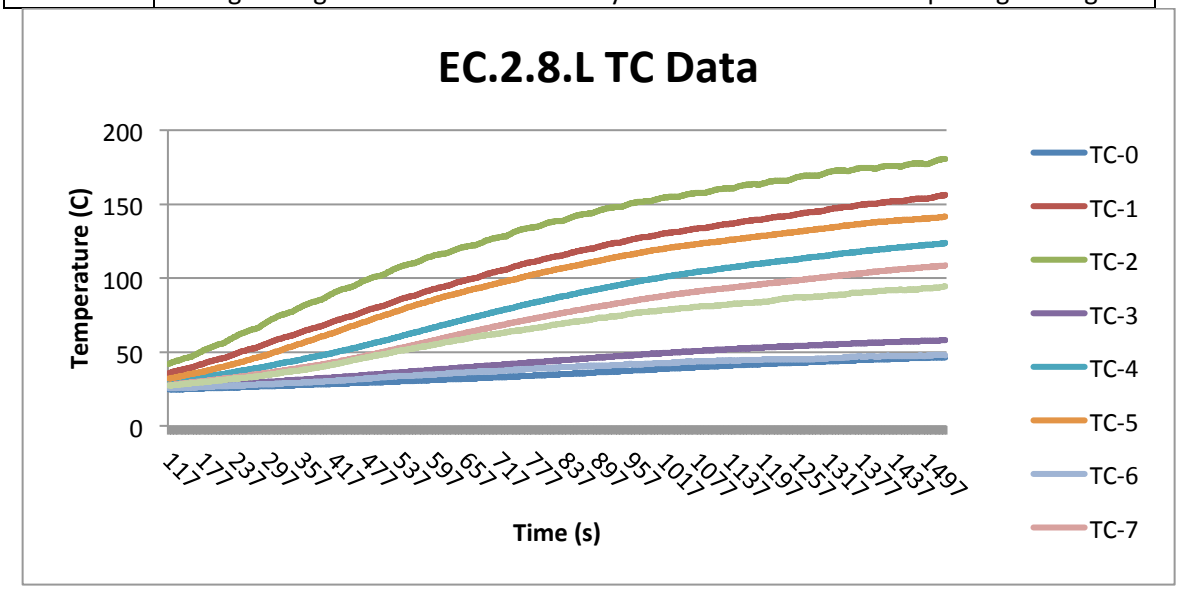
Test Id	Fuel	Diameter	Setting	Time (min:sec)	Ignition (Yes/No)	Time to Ignition (min:sec)
EC.2.6.M	Dish Towel	6”	Medium	6:15	Yes	6:15
Comment	Material began to lose mass and off gas prior to ignition. Heavy smoke was noted during testing.					



Test Id	Fuel	Diameter	Setting	Time (min:sec)	Ignition (Yes/No)	Time to Ignition (min:sec)
EC.2.6.H	Dish Towel	6”	High	1:52	Yes	1:52
Comment	Material began to lose mass and off gas prior to ignition. Heavy smoke was noted during testing.					

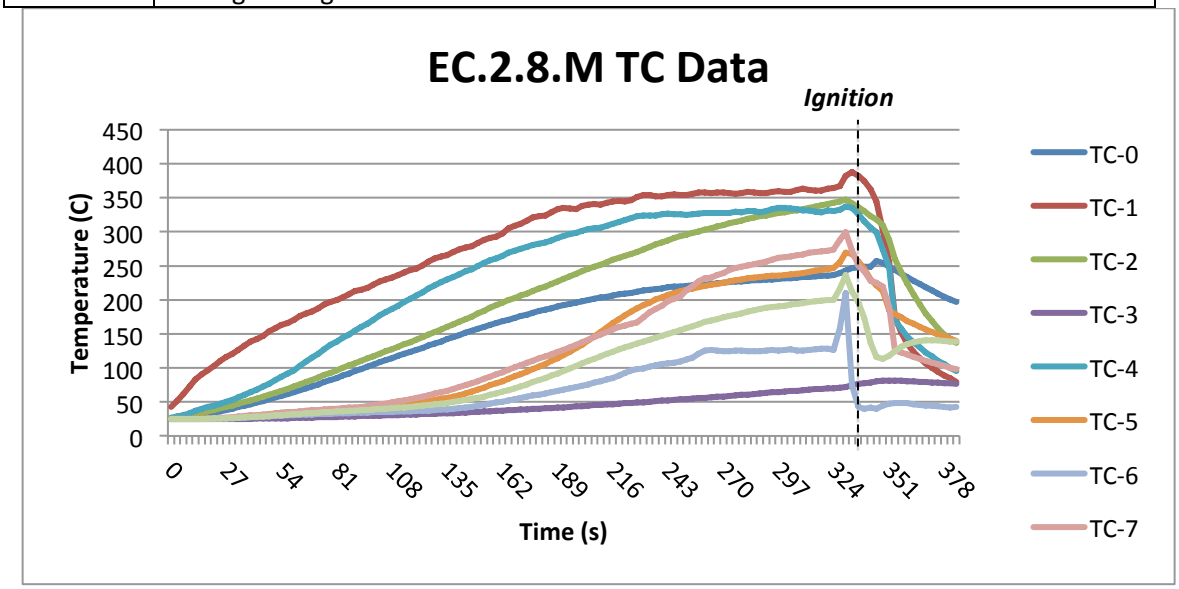


Test Id	Fuel	Diameter	Setting	Time (min:sec)	Ignition (Yes/No)	Time to Ignition (min:sec)
EC.2.8.L	Dish Towel	8”	Low	25:00	No	
Comment	No signs of ignition. Material was only warm to touch after completing testing.					

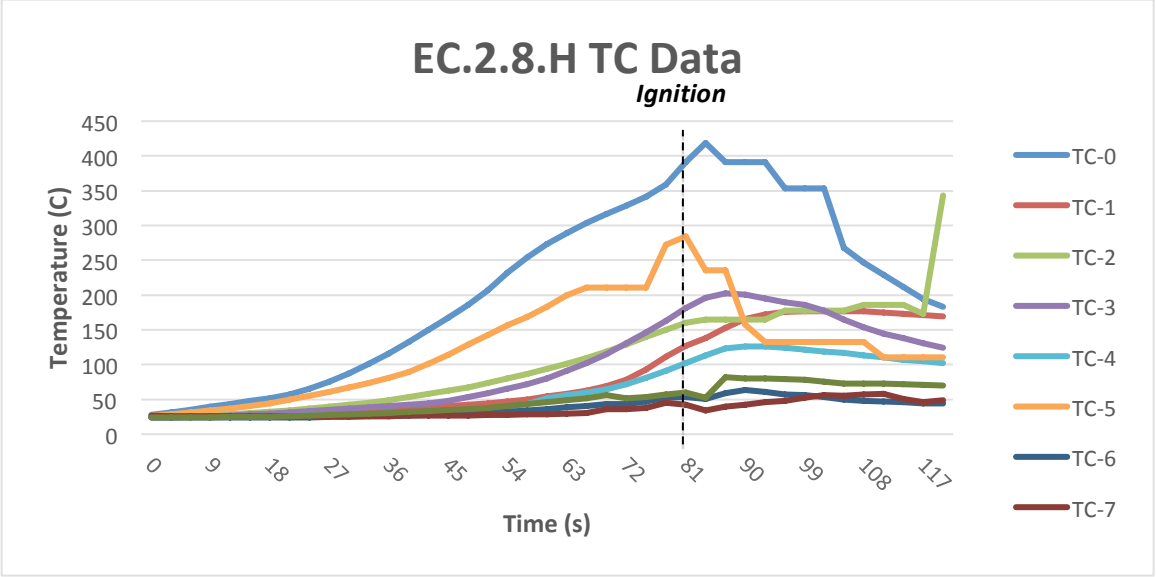


Test Id	Fuel	Diameter	Setting	Time	Ignition	Time to Ignition

				(min:sec)	(Yes/No)	(min:sec)
EC.2.8.M	Dish Towel	8”	Medium	5:32	Yes	5:32
Comment	Material began to lose mass and off gas prior to ignition. Heavy smoke was noted during testing.					

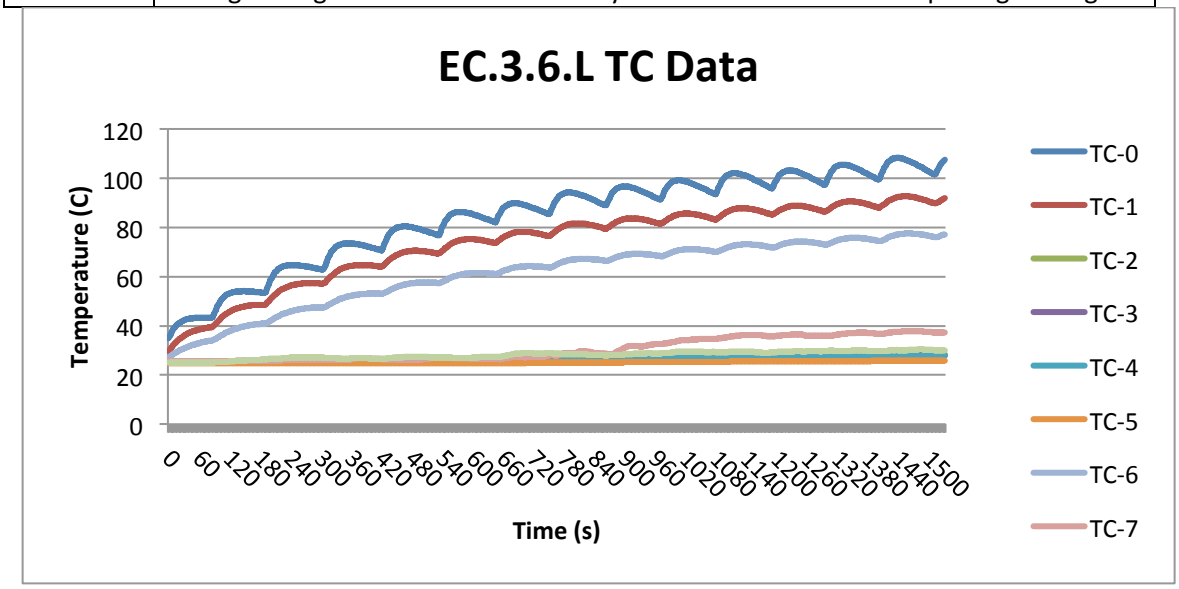


Test Id	Fuel	Diameter	Setting	Time (min:sec)	Ignition (Yes/No)	Time to Ignition (min:sec)
EC.2.8.H	Dish Towel	8”	High	1:20	Yes	1:20
Comment	Material began to lose mass and off gas prior to ignition. Heavy smoke was noted during testing.					

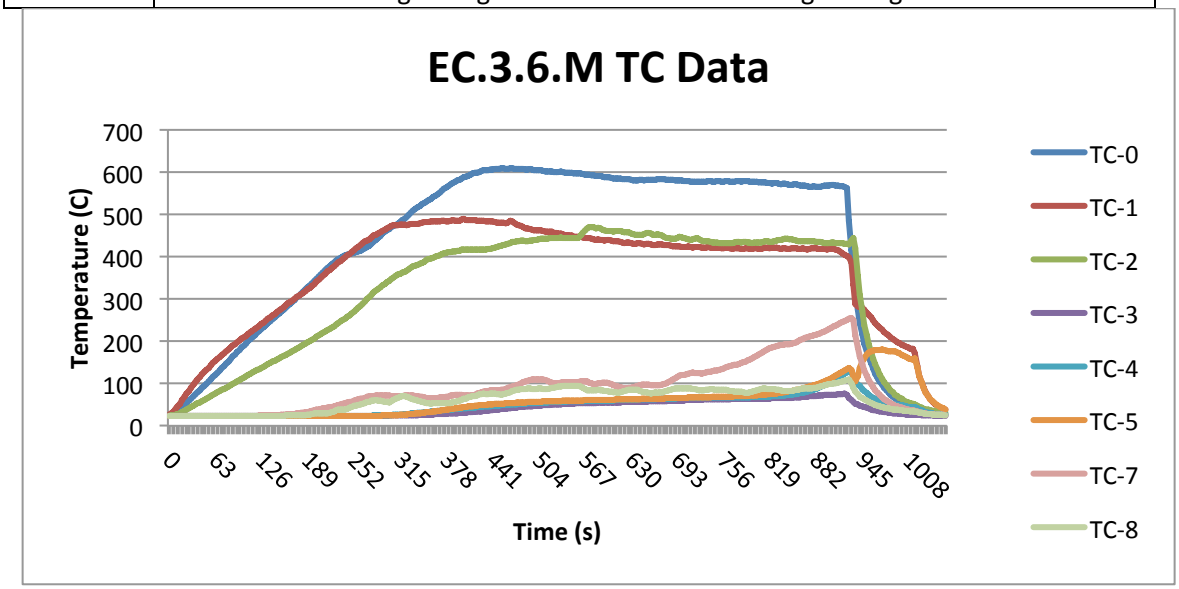


Test Id	Fuel	Diameter	Setting	Time	Ignition	Time to Ignition

				(min:sec)	(Yes/No)	(min:sec)
EC.3.6.L	Paper Towel	6”	Low	25:00	No	
Comment	No signs of ignition. Material was only warm to touch after completing testing.					



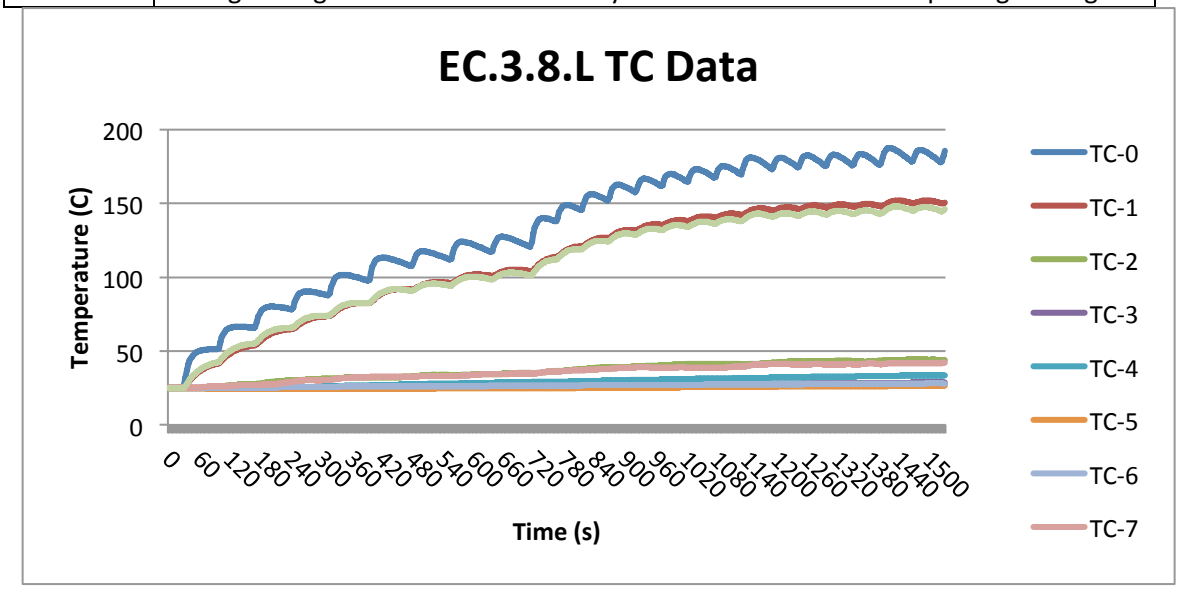
Test Id	Fuel	Diameter	Setting	Time (min:sec)	Ignition (Yes/No)	Time to Ignition (min:sec)
EC.3.6.M	Paper Towel	6”	Medium	15:00	No	
Comment	No ignition. Material had significant mass loss as a result of smoldering combustion. Some glowing embers were noted during testing.					



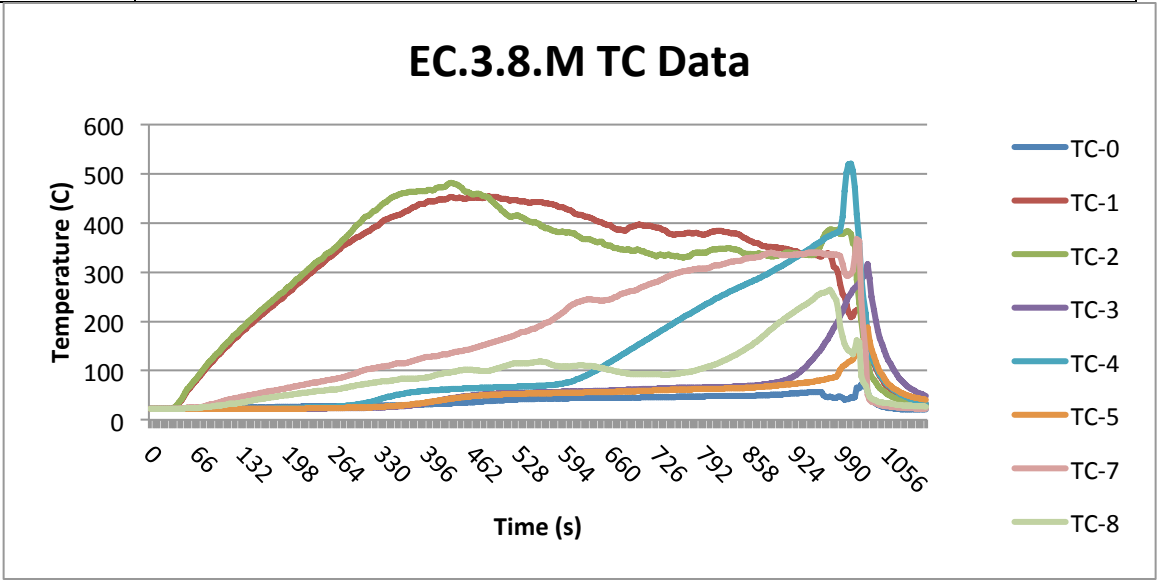
Test Id	Fuel	Diameter	Setting	Time (min:sec)	Ignition (Yes/No)	Time to Ignition (min:sec)
EC.3.6.H	Paper Towel	6”	High	1:29	Yes	1:29
Comment	Material began to signs of ignition within seconds after starting test. Material began to smoke within minutes after starting test. No Graph recorded.					

No Graph

Test Id	Fuel	Diameter	Setting	Time (min:sec)	Ignition (Yes/No)	Time to Ignition (min:sec)
EC.3.8.L	Paper Towel	8”	Low	35:00	No	
Comment	No signs of ignition. Material was only warm to touch after completing testing.					



Test Id	Fuel	Diameter	Setting	Time (min:sec)	Ignition (Yes/No)	Time to Ignition (min:sec)
EC.3.8.M	Paper Towel	8”	Medium	15:00	No	
Comment	No ignition. Material had significant mass loss as a result of smoldering combustion. Some glowing embers were noted during testing.					



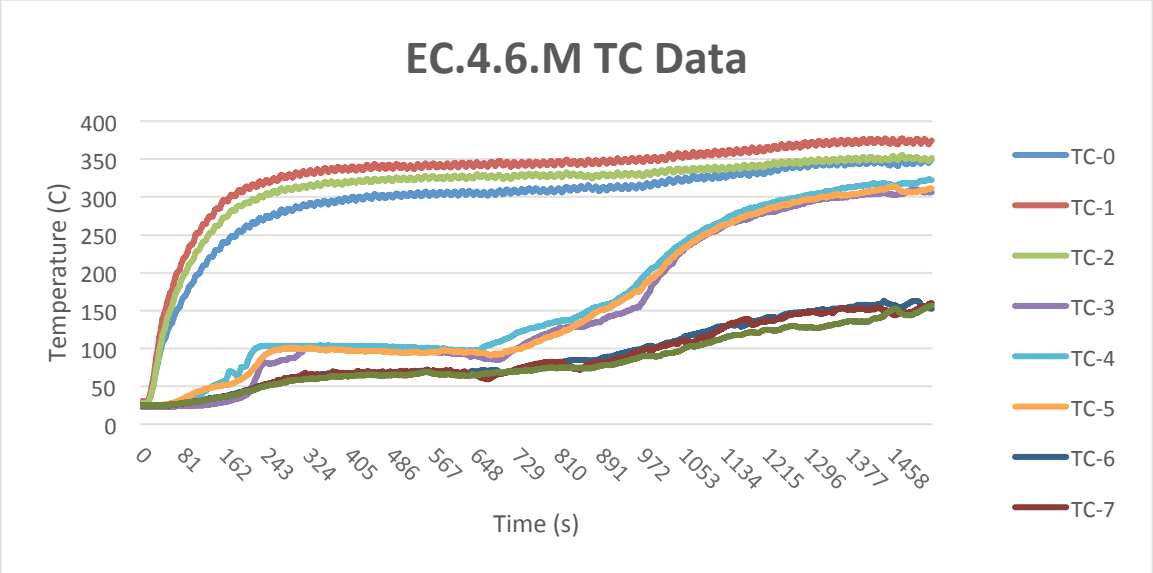
Test Id	Fuel	Diameter	Setting	Time (min:sec)	Ignition (Yes/No)	Time to Ignition (min:sec)
EC.3.8.H	Paper Towel	8”	High	1:36	Yes	1:36
Comment	Material began to signs of ignition within seconds after starting test. Material began to smoke within minutes after starting test. No Graph recorded.					

No Graph

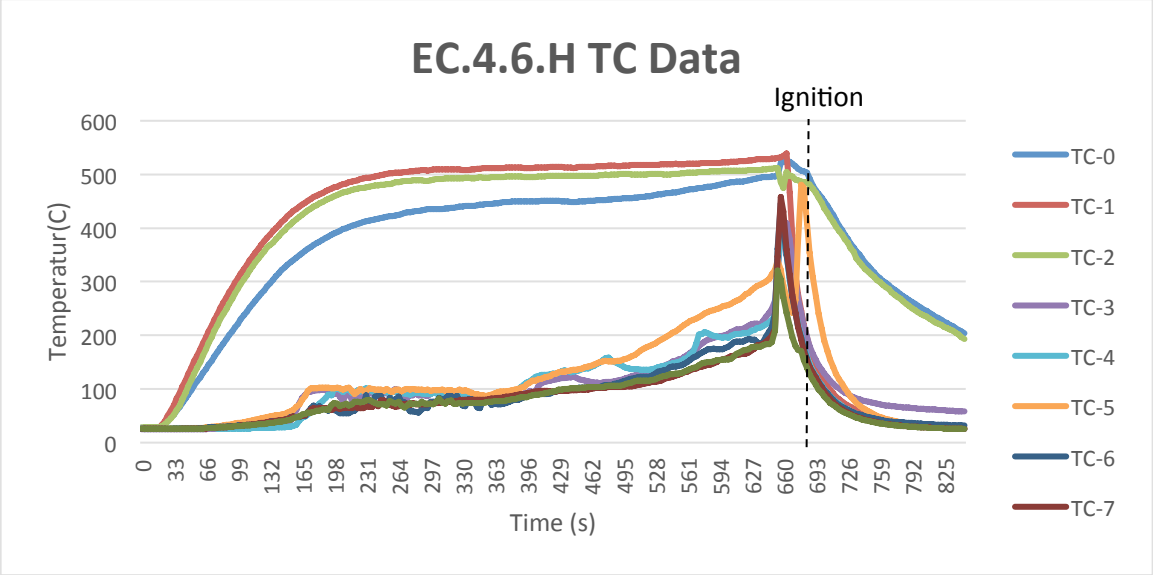
Test Id	Fuel	Diameter	Setting	Time (min:sec)	Ignition (Yes/No)	Time to Ignition (min:sec)
EC.4.6.L	Canola Oil	6”	Low	No test	No	
Comment	No test conducted on low setting based on low heat output on low setting.					

No Test Conducted

Test Id	Fuel	Diameter	Setting	Time (min:sec)	Ignition (Yes/No)	Time to Ignition (min:sec)
EC.4.6.M	Canola Oil	6”	Medium	25:00	No	
Comment	Material boiled and released vapors during testing. A pungent odor was noted during testing.					



Test Id	Fuel	Diameter	Setting	Time (min:sec)	Ignition (Yes/No)	Time to Ignition (min:sec)
EC.4.6.H	Canola Oil	6”	High	11:32	Yes	11:32
Comment						

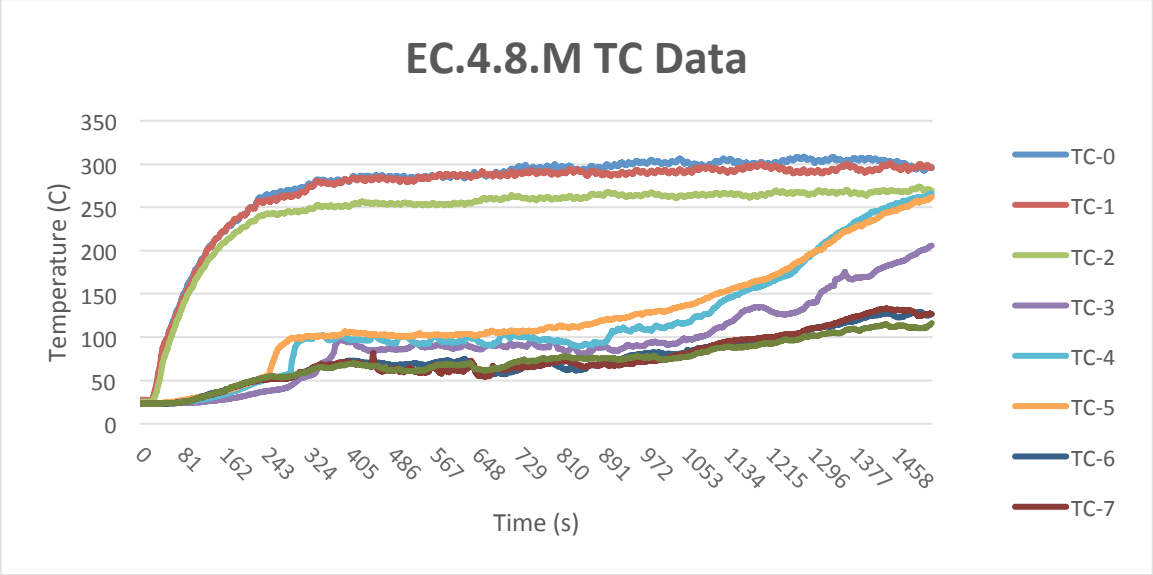


Test Id	Fuel	Diameter	Setting	Time (min:sec)	Ignition (Yes/No)	Time to Ignition (min:sec)
EC.4.8.L	Canola Oil	8”	Low	No Test	No	
Comment	No test conducted on low setting based on low heat output on low setting.					

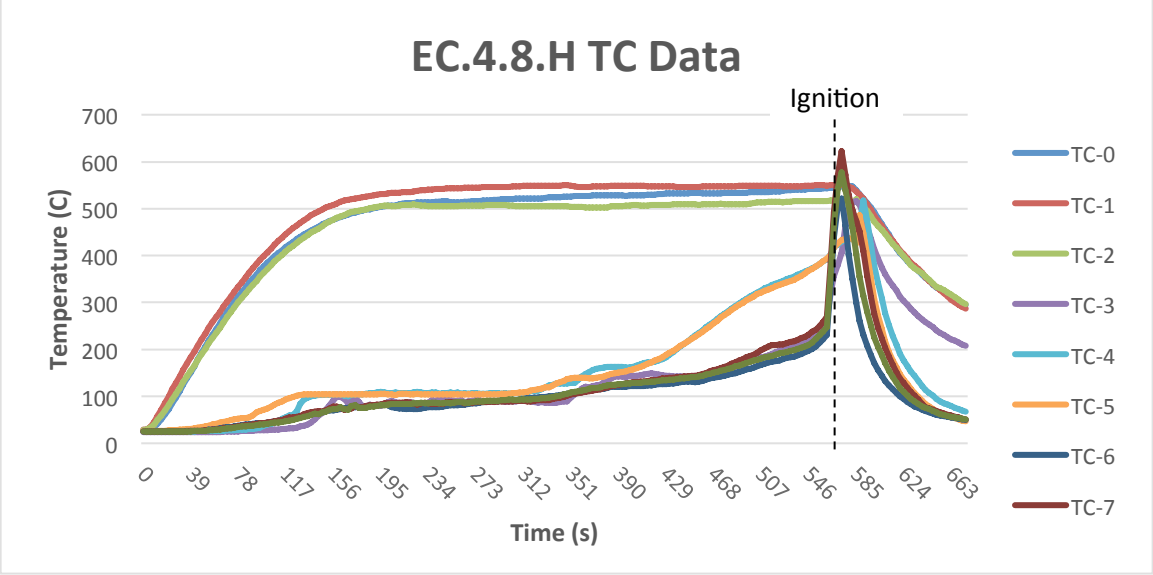
No Test Conducted

Test Id	Fuel	Diameter	Setting	Time	Ignition	Time to Ignition

				(min:sec)	(Yes/No)	(min:sec)
EC.4.8.M	Canola Oil	8”	Medium	25:00	No	
Comment	Material boiled and released vapors during testing. A pungent odor was noted during testing.					



Test Id	Fuel	Diameter	Setting	Time (min:sec)	Ignition (Yes/No)	Time to Ignition (min:sec)
EC.4.8.H	Canola Oil	8”	High	9:19	Yes	9:19
Comment	Material began to boil and release vapors prior to ignition. A strong pungent odor was noted during testing.					

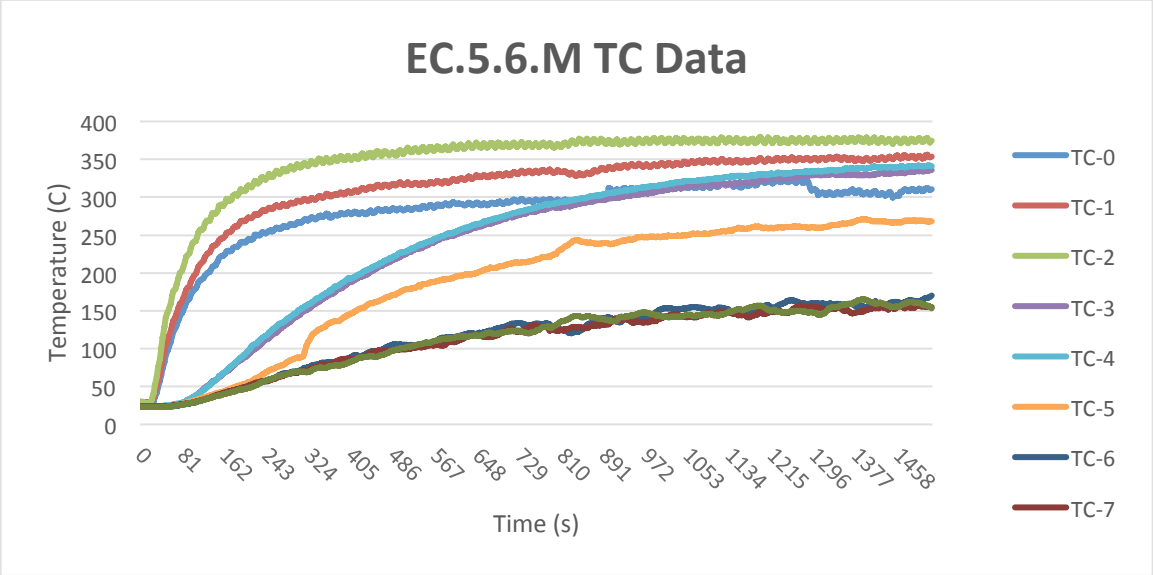


Test Id	Fuel	Diameter	Setting	Time	Ignition	Time to Ignition

				(min:sec)	(Yes/No)	(min:sec)
EC.5.6.L	Vegetable Oil	6”	Low	No test	No	
Comment	No test conducted on low setting based on low heat output on low setting.					

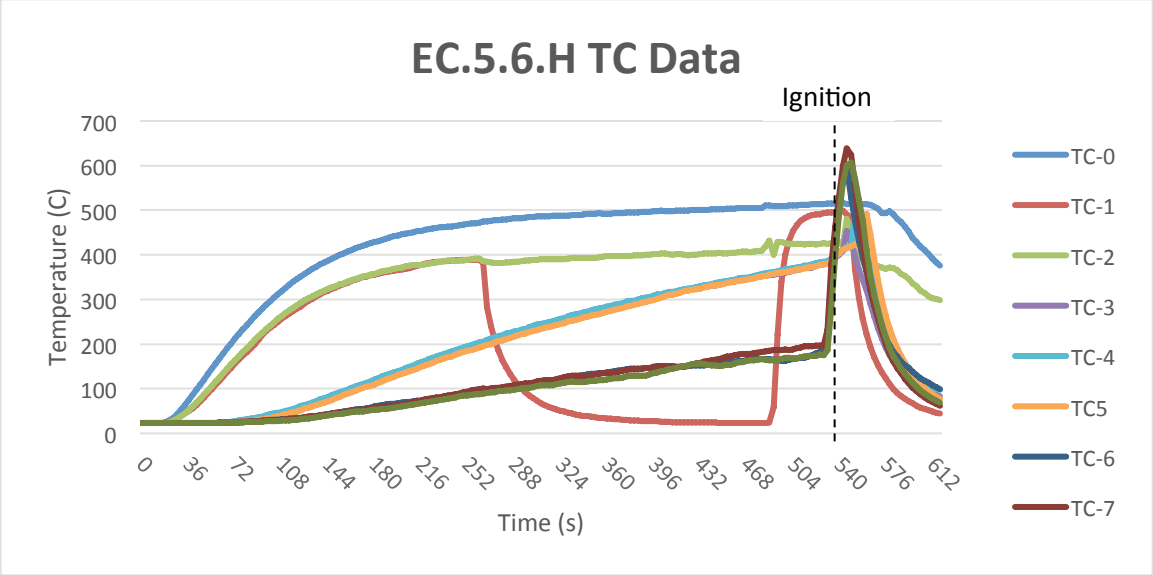
No Test Conducted

Test Id	Fuel	Diameter	Setting	Time (min:sec)	Ignition (Yes/No)	Time to Ignition (min:sec)
EC.5.6.M	Vegetable Oil	6”	Medium	25:00	No	
Comment	Material boiled, released vapors, and splattered outside of sauce pan during testing. A pungent odor was noted during testing.					



Test Id	Fuel	Diameter	Setting	Time	Ignition	Time to Ignition

				(min:sec)	(Yes/No)	(min:sec)
EC.5.6.H	Vegetable Oil	6”	High	8:32	Yes	8:32
Comment						

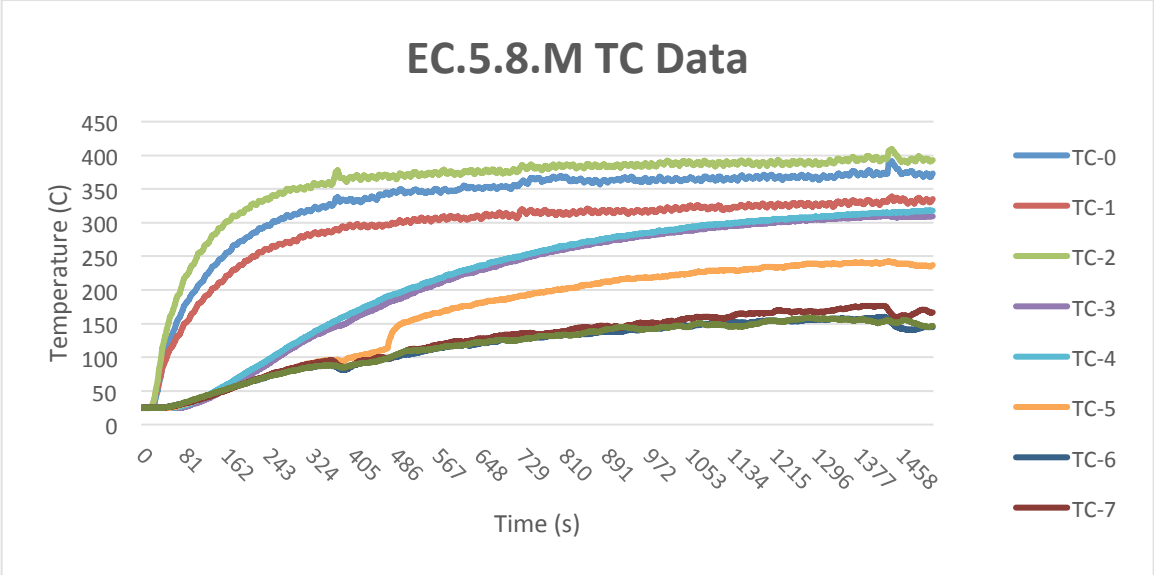


Test Id	Fuel	Diameter	Setting	Time (min:sec)	Ignition (Yes/No)	Time to Ignition (min:sec)
EC.5.8.L	Vegetable Oil	8”	Low	No test	No	
Comment	No test conducted on low setting based on low heat output on low setting.					

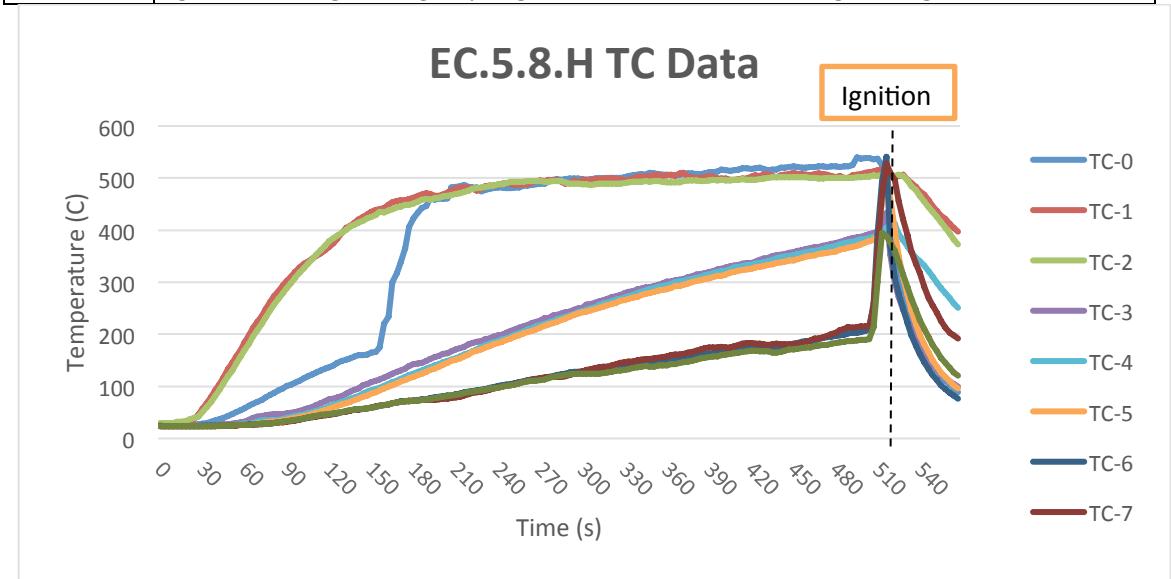
No Test Conducted

Test Id	Fuel	Diameter	Setting	Time (min:sec)	Ignition (Yes/No)	Time to Ignition (min:sec)

EC.5.8.M	Vegetable Oil	8”	Medium	25:00	No	
Comment	Material boiled, released vapors, and splattered outside of sauce pan during testing. A pungent odor was noted during testing.					



Test Id	Fuel	Diameter	Setting	Time (min:sec)	Ignition (Yes/No)	Time to Ignition (min:sec)
EC.5.8.H	Vegetable Oil	8”	High	8:10	Yes	8:10
Comment	Material boiled, released vapors, and splattered outside of sauce pan prior to ignition during testing. A pungent odor was noted during testing.					

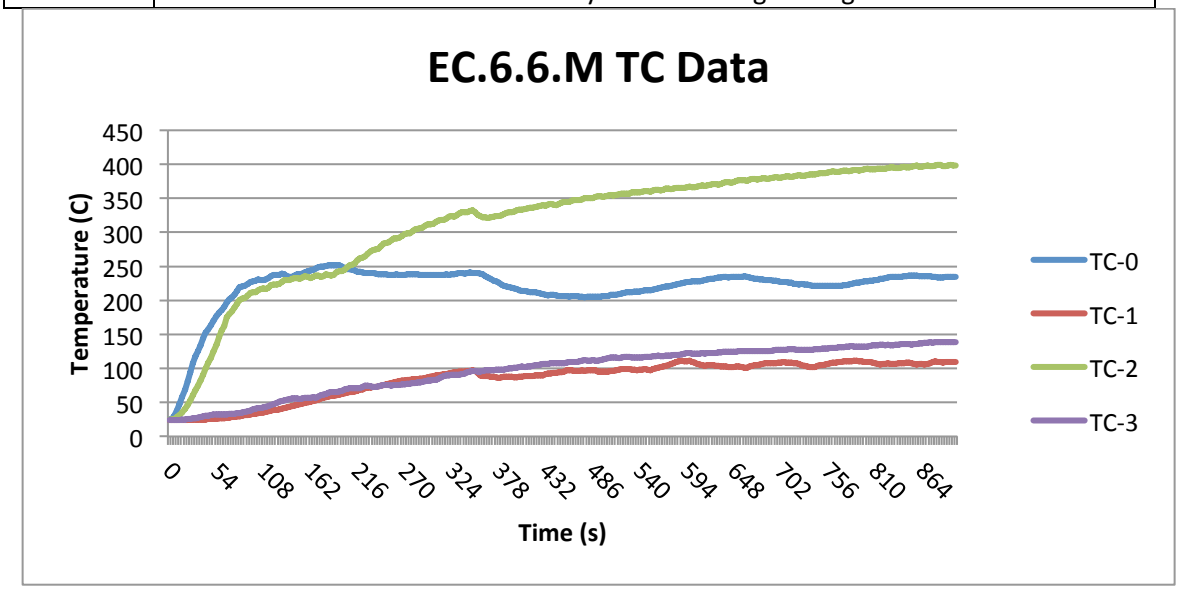


Test Id	Fuel	Diameter	Setting	Time (min:sec)	Ignition (Yes/No)	Time to Ignition (min:sec)

EC.6.6.L	Nylon spatula	6”	Low	No Test	No	
Comment	No test was conducted on low setting based on no ignition results from medium setting.					

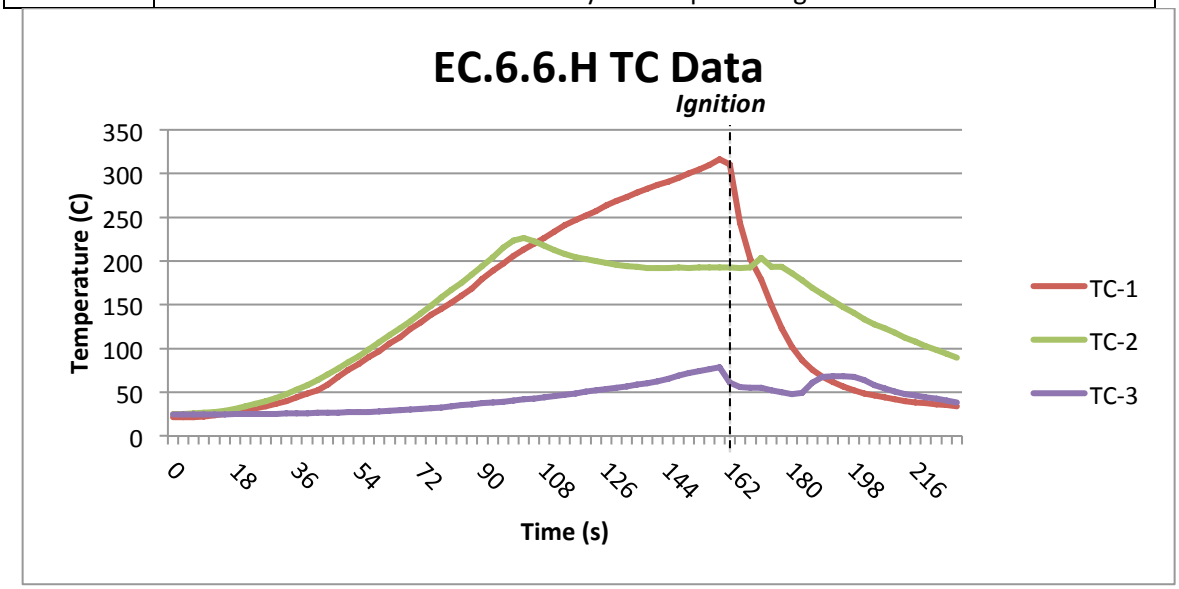
No Test Conducted

Test Id	Fuel	Diameter	Setting	Time (min:sec)	Ignition (Yes/No)	Time to Ignition (min:sec)
EC.6.6.M	Nylon spatula	6”	Medium	15:00	No	
Comment	Material melted and released heavy smoke during testing.					



Test Id	Fuel	Diameter	Setting	Time (min:sec)	Ignition (Yes/No)	Time to Ignition (min:sec)

EC.6.6.H	Nylon spatula	6”	High	2:39	Yes	2:39
Comment	Material melted and released heavy smoke prior to ignition.					

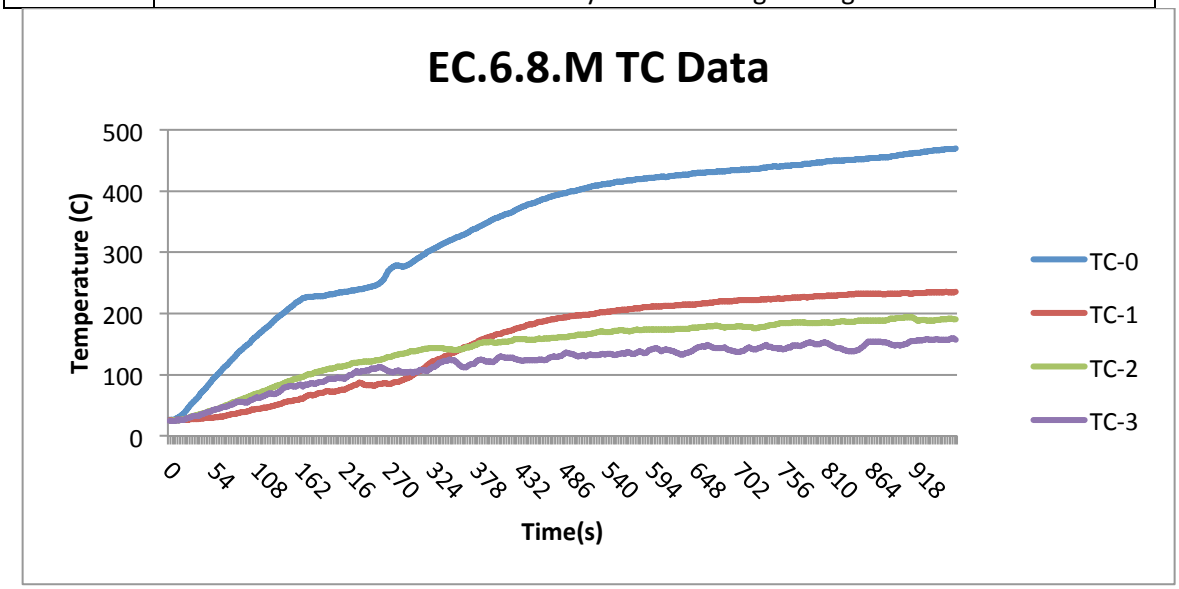


Test Id	Fuel	Diameter	Setting	Time (min:sec)	Ignition (Yes/No)	Time to Ignition (min:sec)
EC.6.8.L	Nylon spatula	8”	Low	No Test	No	
Comment	No test was conducted on low setting based on no ignition results from medium setting.					

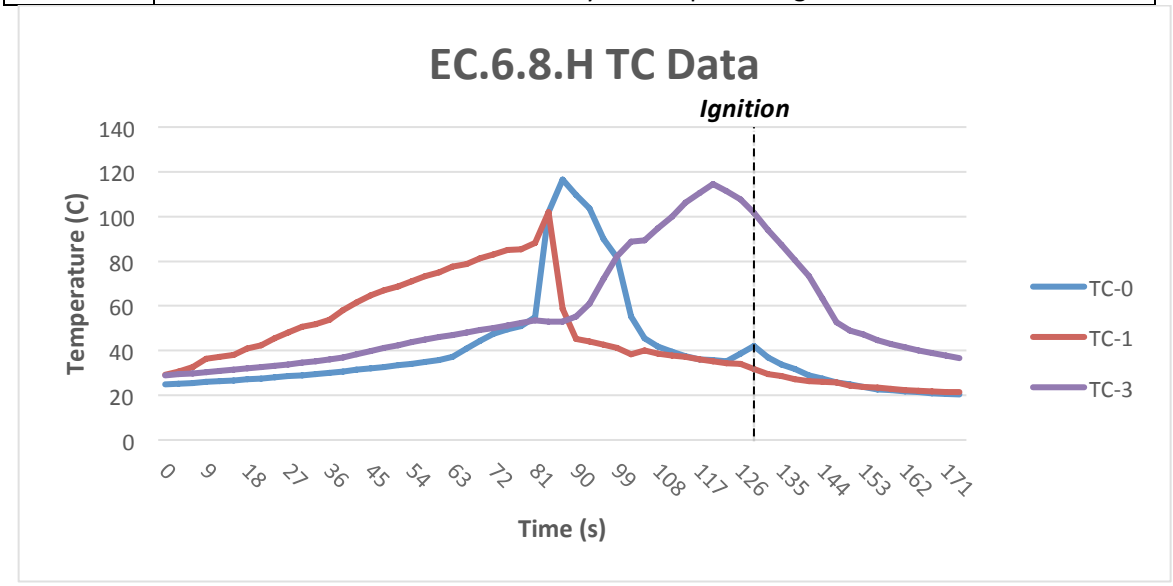
No Test Conducted

Test Id	Fuel	Diameter	Setting	Time (min:sec)	Ignition (Yes/No)	Time to Ignition (min:sec)

EC.6.8.M	Nylon spatula	8”	Medium	15:00	No	
Comment	Material melted and released heavy smoke during testing.					



Test Id	Fuel	Diameter	Setting	Time (min:sec)	Ignition (Yes/No)	Time to Ignition (min:sec)
EC.6.8.H	Nylon spatula	8”	High	2:07	Yes	2:07
Comment	TC 2 was removed do to utensil melting and TC lost connection with material. Material melted and released heavy smoke prior to ignition.					

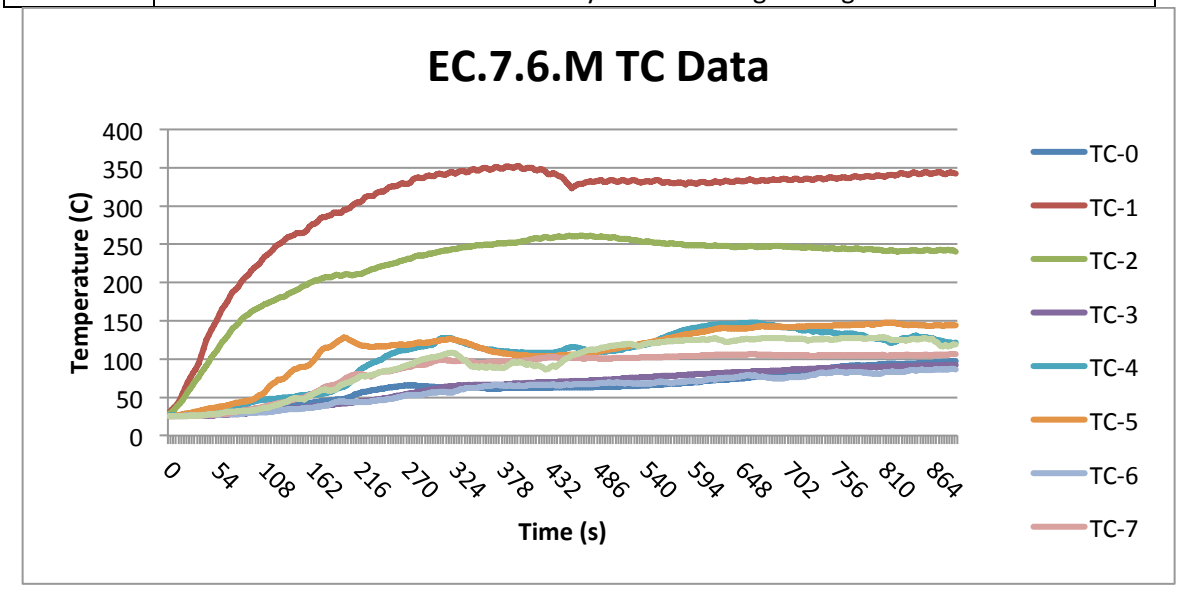


Test Id	Fuel	Diameter	Setting	Time	Ignition	Time to Ignition

				(min:sec)	(Yes/No)	(min:sec)
EC.7.6.L	Toaster	6”	Low	No test	No	
Comment	No test was conducted on low setting as a result of no ignition on medium setting.					

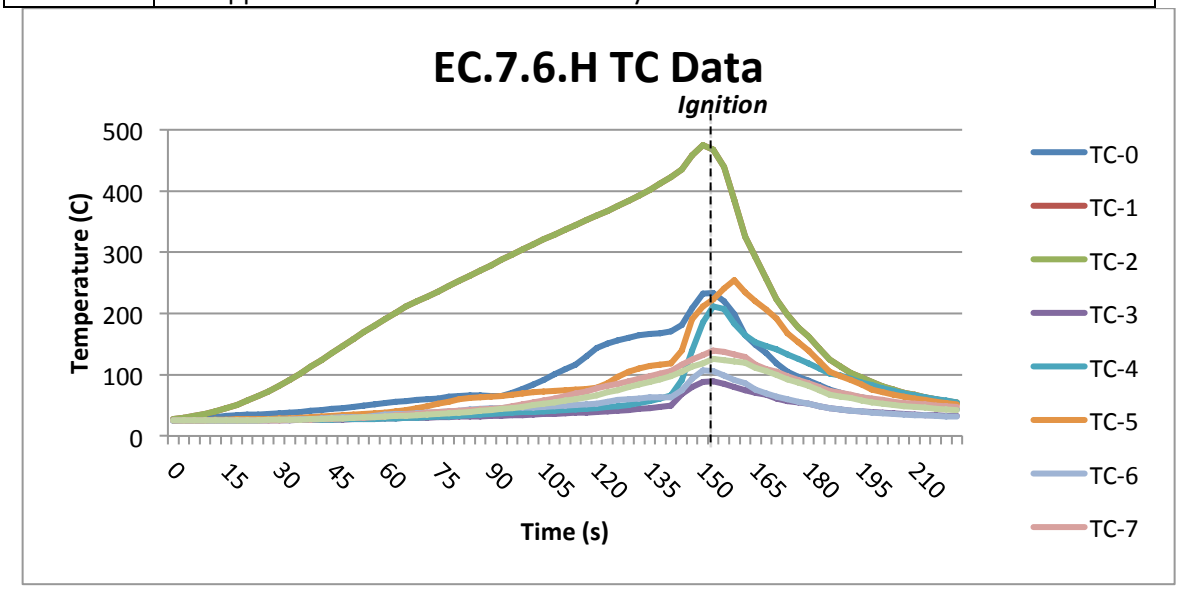
No Test Conducted

Test Id	Fuel	Diameter	Setting	Time (min:sec)	Ignition (Yes/No)	Time to Ignition (min:sec)
EC.7.6.M	Toaster	6”	Medium	15:00	No	
Comment	Material melted and released heavy smoke during testing.					



Test Id	Fuel	Diameter	Setting	Time	Ignition	Time to Ignition

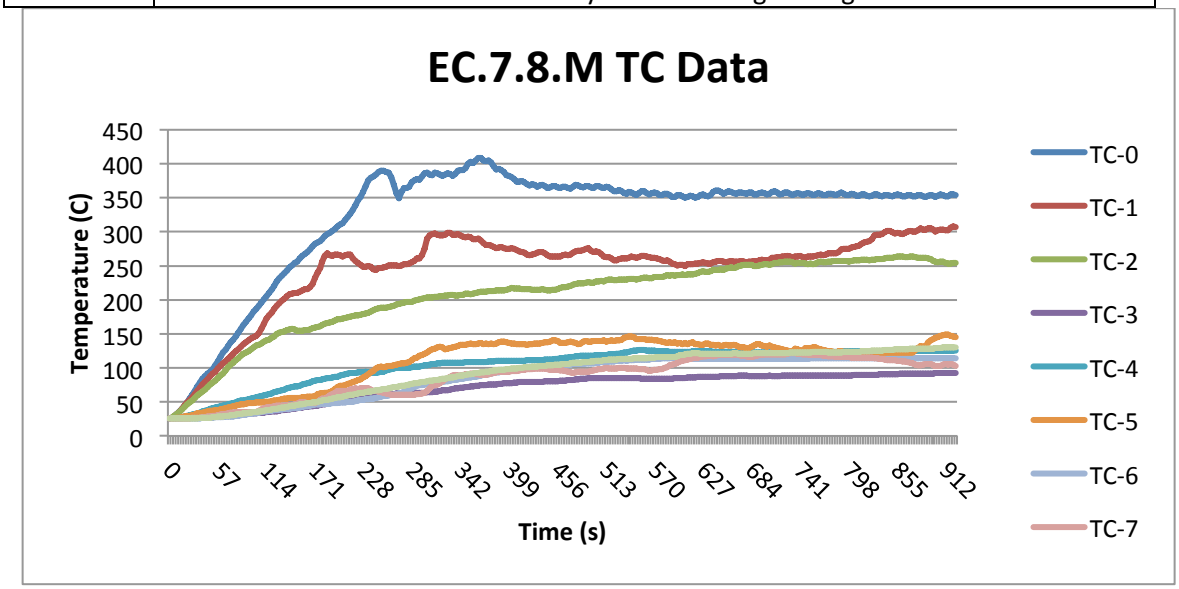
				(min:sec)	(Yes/No)	(min:sec)
EC.7.6.H	Toaster	6”	High	2:30	Yes	2:30
Comment	Material ignited and quickly grew in intensity within seconds of ignition and prior to suppression. Material released heavy smoke within seconds of start of test.					



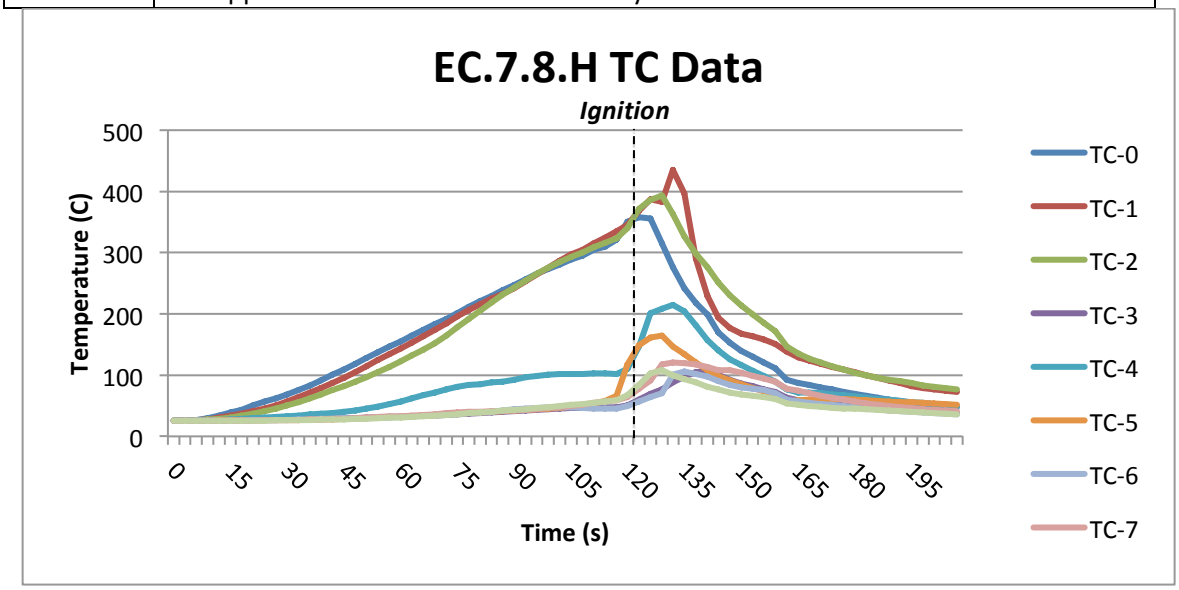
Test Id	Fuel	Diameter	Setting	Time (min:sec)	Ignition (Yes/No)	Time to Ignition (min:sec)
EC.7.8.L	Toaster	8”	Low	No test	No	
Comment	No test was conducted on low setting as a result of no ignition on medium setting.					

No Test Conducted

Test Id	Fuel	Diameter	Setting	Time (min:sec)	Ignition (Yes/No)	Time to Ignition (min:sec)
EC.7.8.M	Toaster	8”	Medium	15:00	No	
Comment	Material melted and released heavy smoke during testing.					

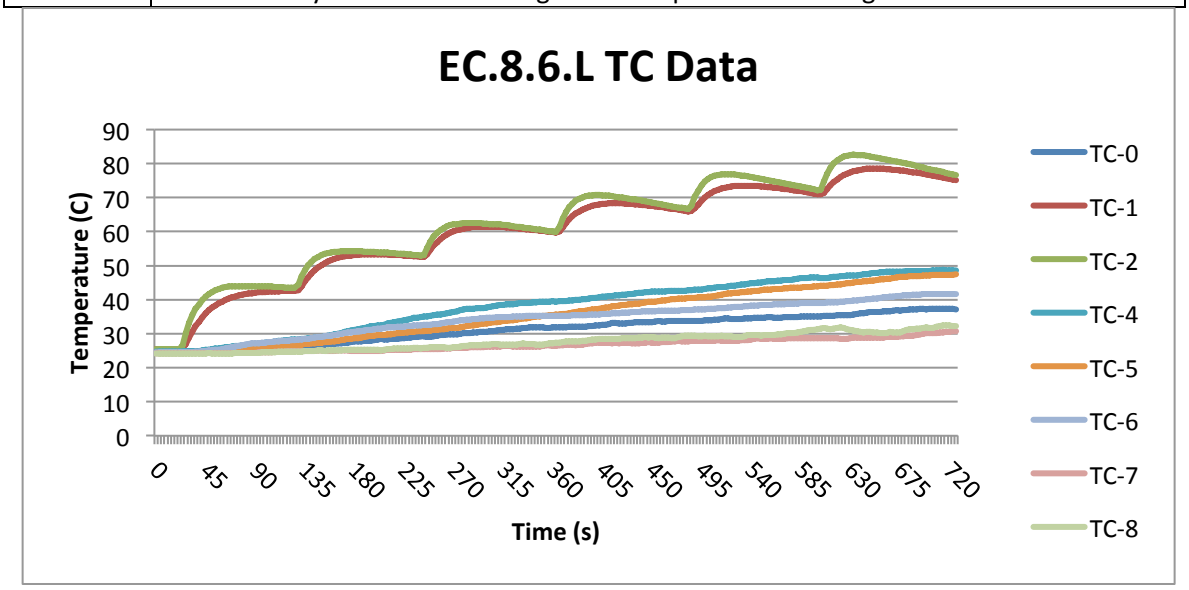


Test Id	Fuel	Diameter	Setting	Time (min:sec)	Ignition (Yes/No)	Time to Ignition (min:sec)
EC.7.8.H	Toaster	8”	High	2:00	Yes	2:00
Comment	Material ignited and quickly grew in intensity within seconds of ignition and prior to suppression. Material released heavy smoke within seconds of start of test.					

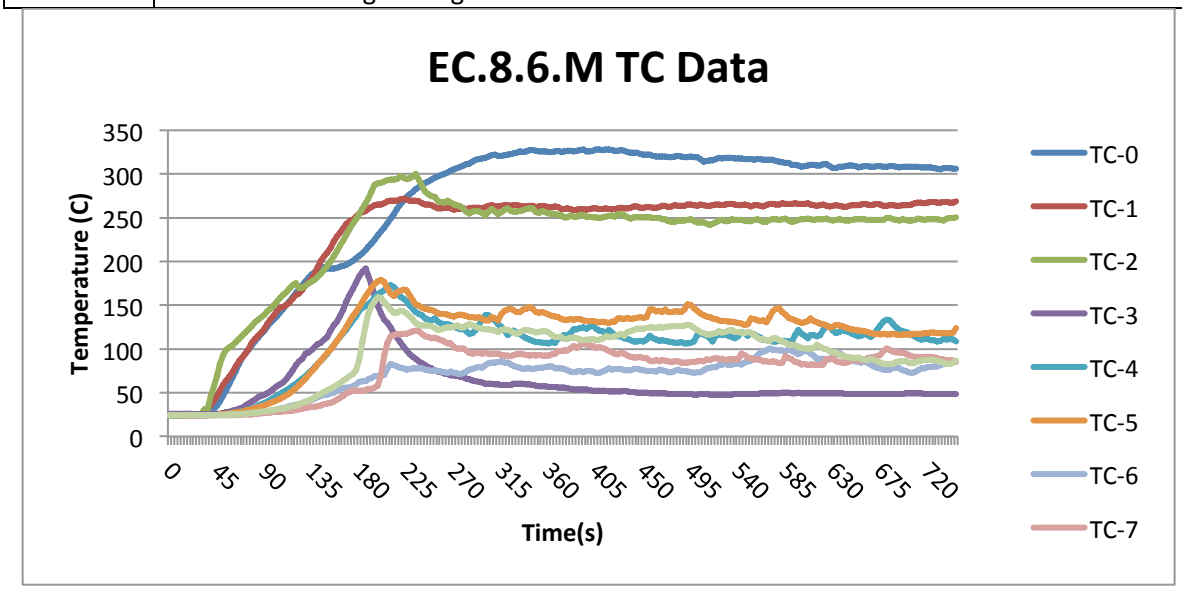


Test Id	Fuel	Diameter	Setting	Time	Ignition	Time to

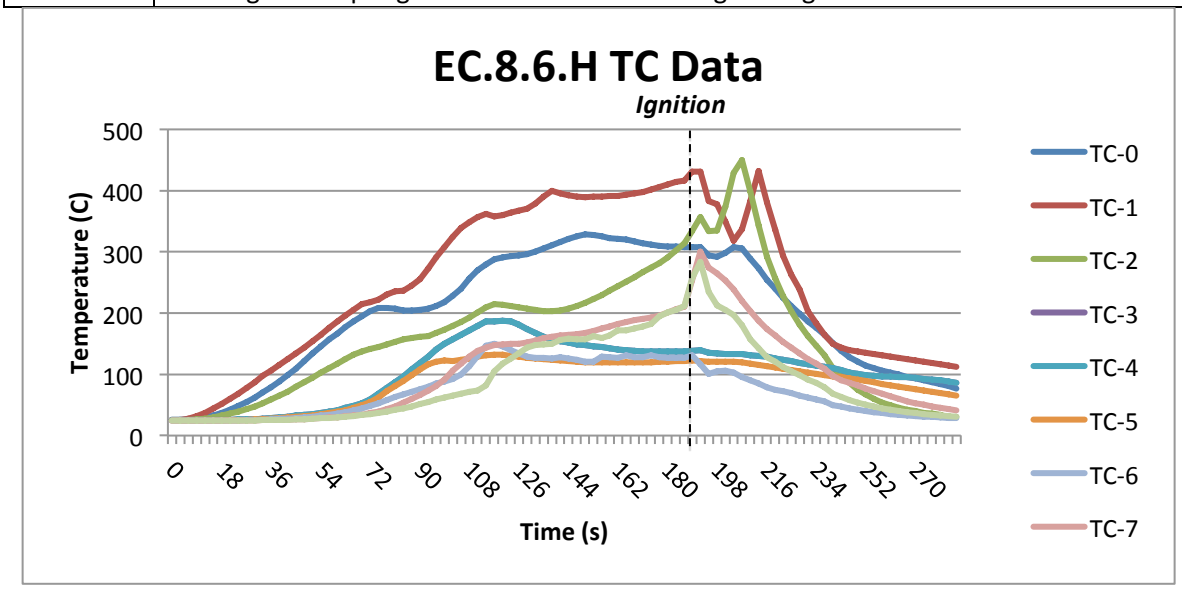
				(min:sec)	(Yes/No)	Ignition (min:sec)
EC.8.6.L	Food Storage Container	6”	Low	12:00	No	
Comment	Material only had minor melting after completion of testing.					



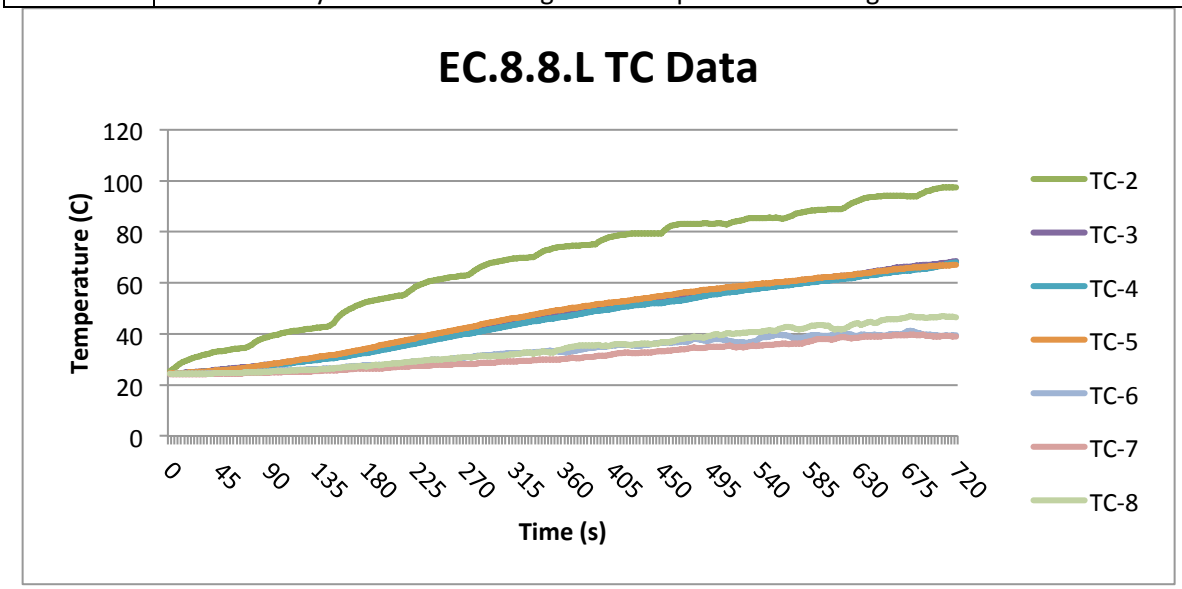
Test Id	Fuel	Diameter	Setting	Time (min:sec)	Ignition (Yes/No)	Time to Ignition (min:sec)
EC.8.6.M	Food Storage Container	6”	Medium	12:00	No	
Comment	Material melted, lost mass, and released heavy smoke during test. A pungent odor was noted during testing.					



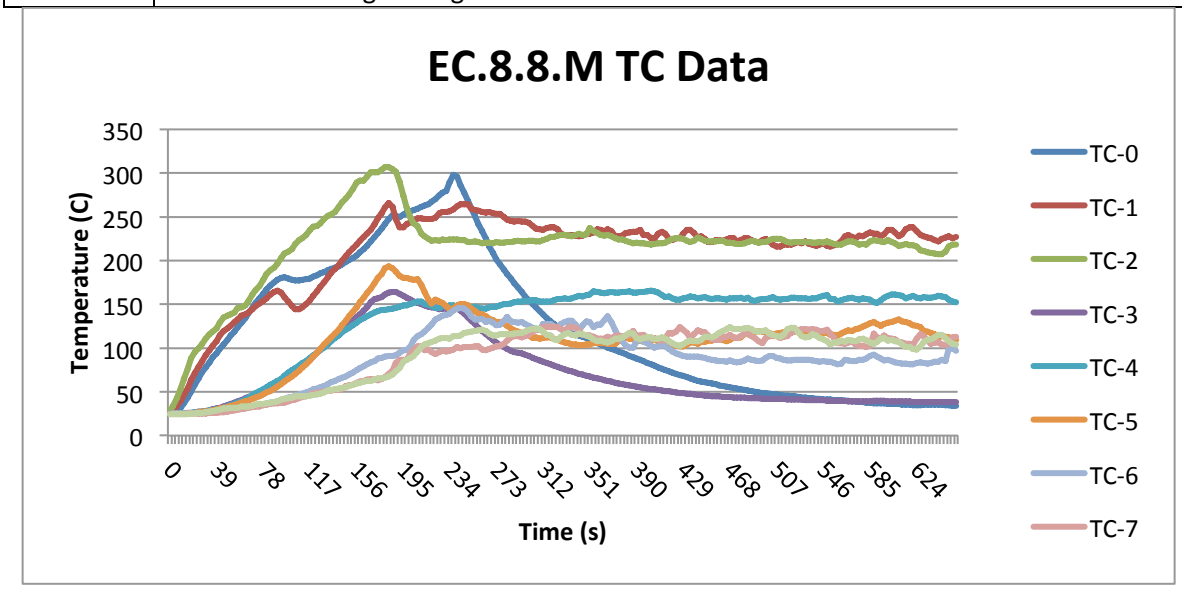
Test Id	Fuel	Diameter	Setting	Time (min:sec)	Ignition (Yes/No)	Time to Ignition (min:sec)
EC.8.6.H	Food Storage Container	6”	High	3:05	Yes	3:05
Comment	Material began to melt and release heavy smoke within about 30-45 seconds after starting test. A pungent odor was noted during testing.					



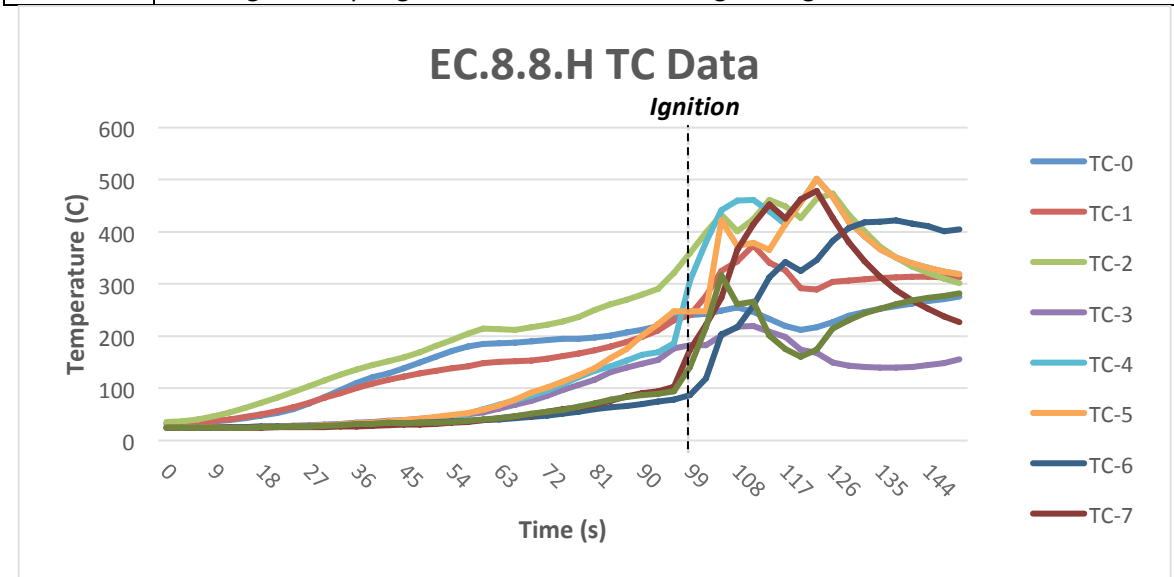
Test Id	Fuel	Diameter	Setting	Time (min:sec)	Ignition (Yes/No)	Time to Ignition (min:sec)
EC.8.8.L	Food Storage Container	8”	Low	12:00	No	
Comment	Material only had minor melting after completion of testing.					



Test Id	Fuel	Diameter	Setting	Time (min:sec)	Ignition (Yes/No)	Time to Ignition (min:sec)
EC.8.8.M	Food Storage Container	8”	Medium	12:00	No	
Comment	Material melted, lost mass, and released heavy smoke during test. A pungent odor was noted during testing.					



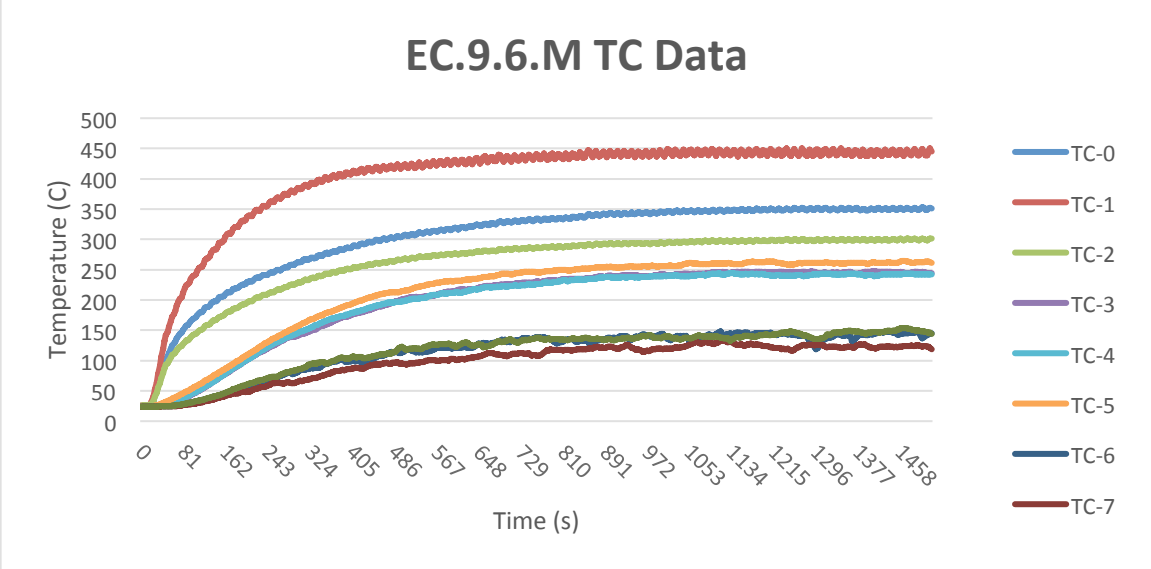
Test Id	Fuel	Diameter	Setting	Time (min:sec)	Ignition (Yes/No)	Time to Ignition (min:sec)
EC.8.8.H	Food Storage Container	8”	High	1:36	Yes	1:36
Comment	Material began to melt and release heavy smoke within about 30-45 seconds after starting test. A pungent odor was noted during testing.					



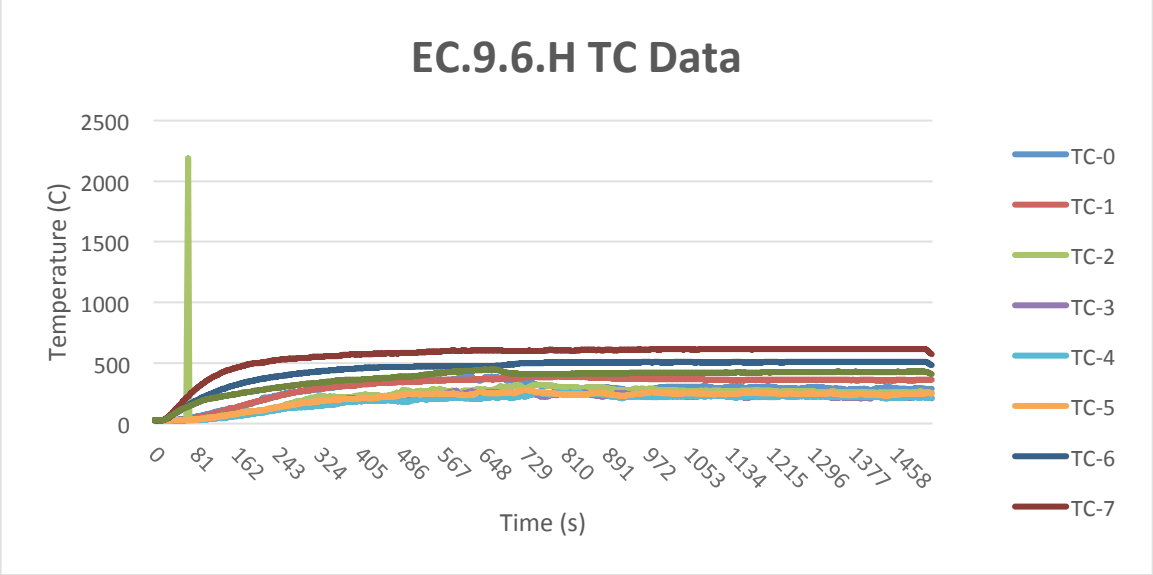
Test Id	Fuel	Diameter	Setting	Time (min:sec)	Ignition (Yes/No)	Time to Ignition (min:sec)
EC.9.6.L	Corn Oil	6”	Low	No Test	No	
Comment	No test was conducted based on no ignition from both medium and high settings for the 6 inch heating element.					

No Test Conducted

Test Id	Fuel	Diameter	Setting	Time (min:sec)	Ignition (Yes/No)	Time to Ignition (min:sec)
EC.9.6.M	Corn Oil	6”	Medium	25:00	No	
Comment	Fuel shows some potential for ignition.					



Test Id	Fuel	Diameter	Setting	Time (min:sec)	Ignition (Yes/No)	Time to Ignition (min:sec)
EC.9.6.H	Corn Oil	6”	High	25:00	No	
Comment	Fuel shows some potential for ignition.					

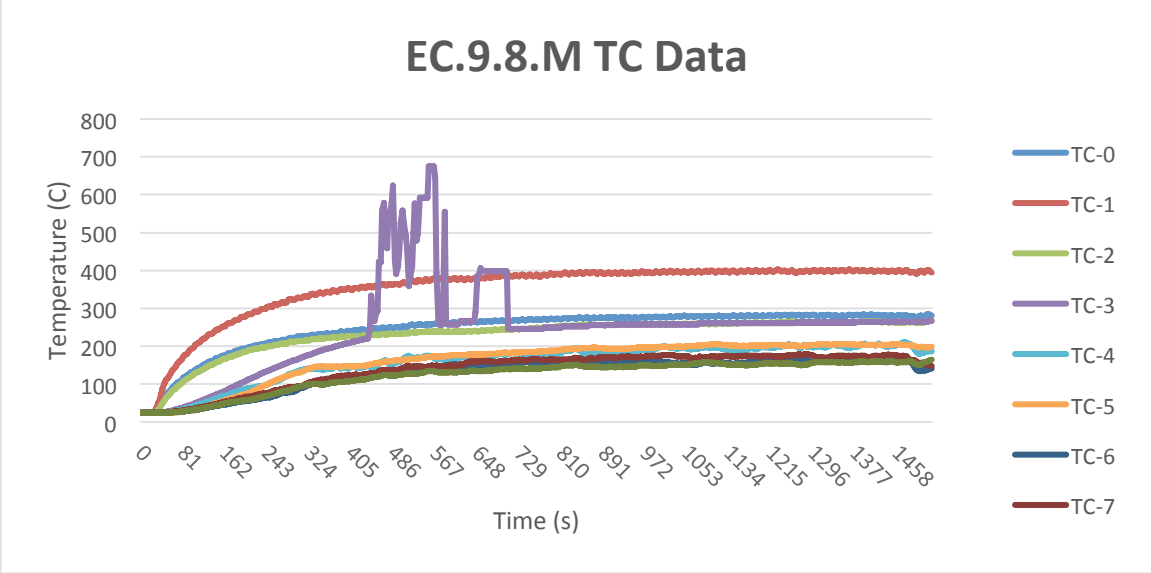


Test Id	Fuel	Diameter	Setting	Time (min:sec)	Ignition (Yes/No)	Time to Ignition (min:sec)
EC.9.8.L	Corn Oil	8”	Low	No Test	No	
Comment	No test was conducted on low setting based on no ignition on medium setting with 8 inch heating element.					

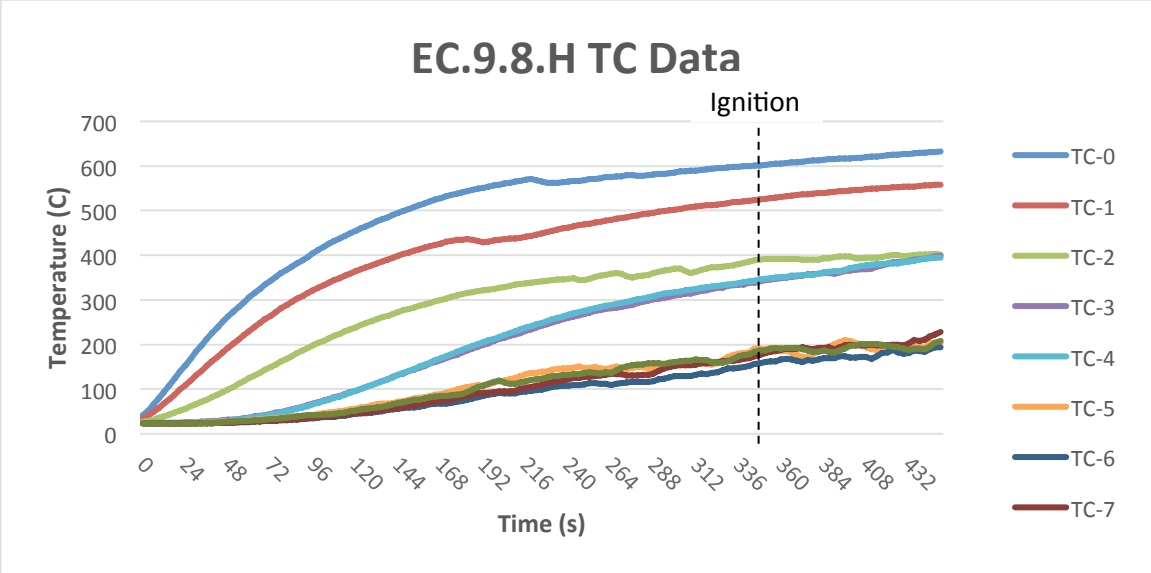
No Test Conducted

Test Id	Fuel	Diameter	Setting	Time (min:sec)	Ignition (Yes/No)	Time to Ignition

						(min:sec)
EC.9.8.M	Corn Oil	8”	Medium	25:00	No	
Comment	Fuel shows minimal potential for ignition.					

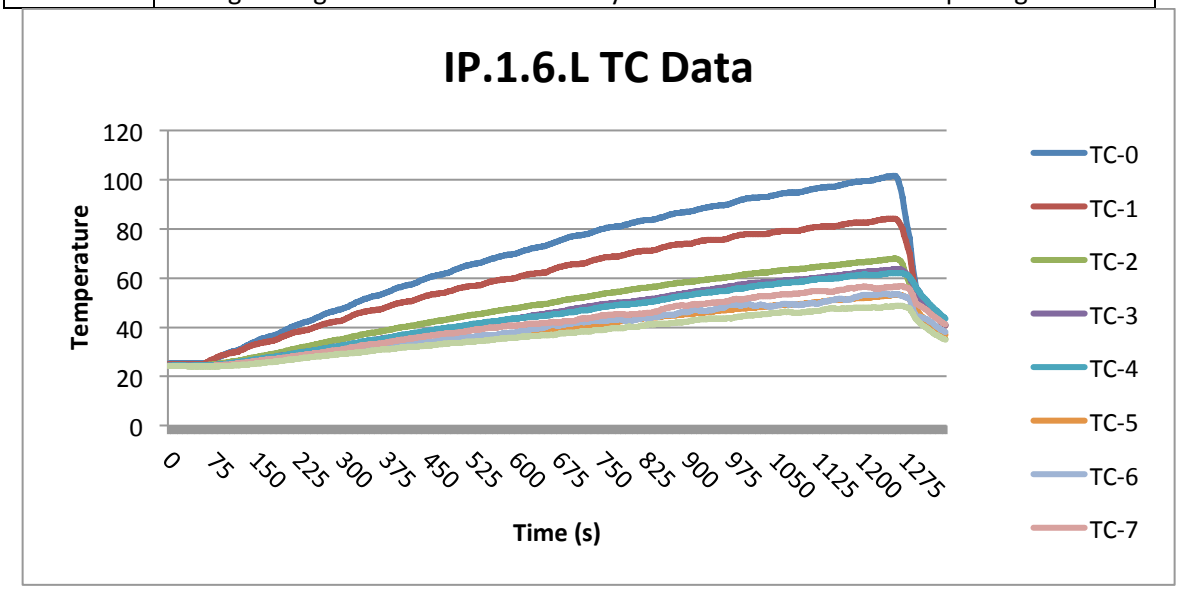


Test Id	Fuel	Diameter	Setting	Time (min:sec)	Ignition (Yes/No)	Time to Ignition (min:sec)
EC.9.8.H	Corn Oil	8”	High	5:36	Yes	5:36
Comment						

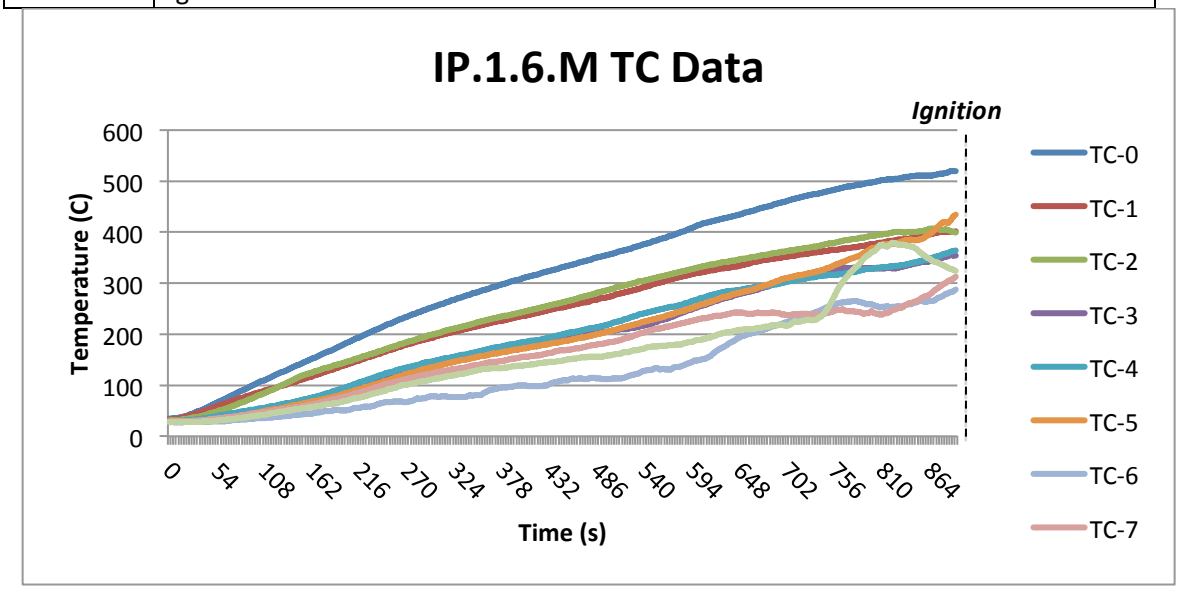


Appendix F – Electric Coil Cooktop Range with Cast Iron Plate

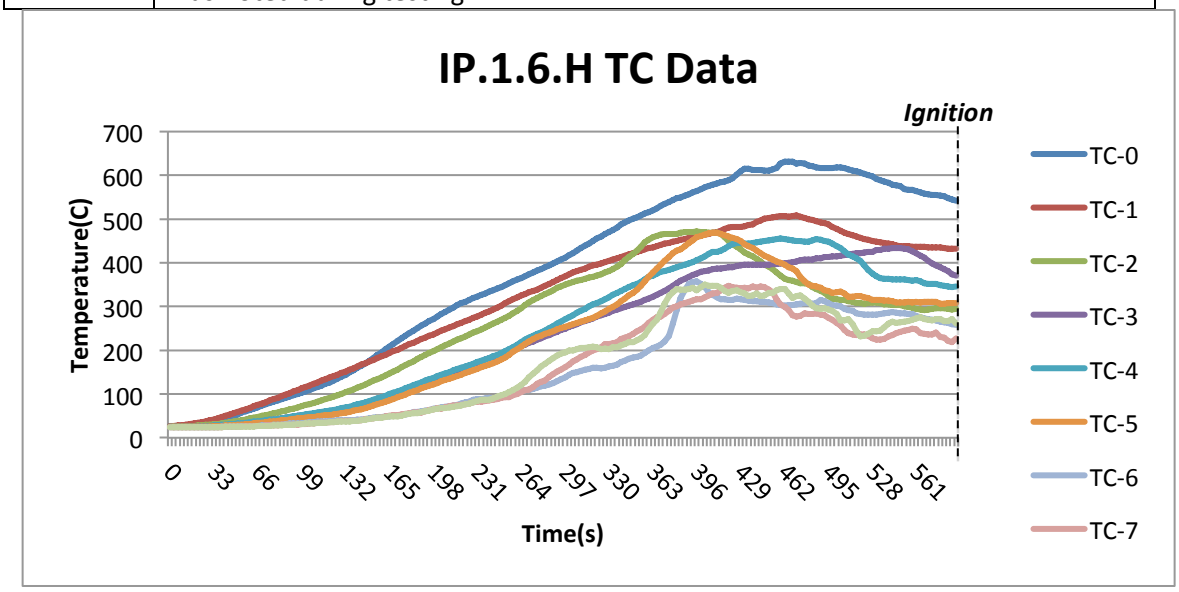
Test Id	Fuel	Diameter	Setting	Time (min:sec)	Ignition (Yes/No)	Time to Ignition (min:sec)
IP.1.6.L	Cardboard	6”	Low	20:00	No	
Comment	No signs of ignition. Material was only hot to the touch after completing the test.					



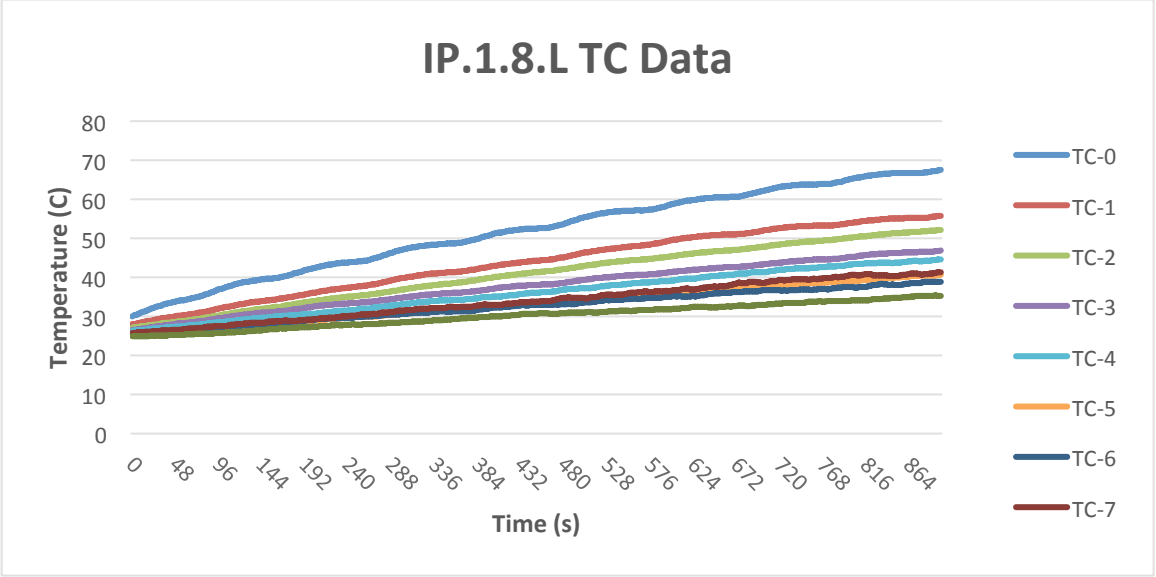
Test Id	Fuel	Diameter	Setting	Time (min:sec)	Ignition (Yes/No)	Time to Ignition (min:sec)
IP.1.6.M	Cardboard	6”	Medium	15:00	Yes	15:00
Comment	Material slowly lost mass due to smoldering combustion prior to ignition. Heavy smoke was noted after a few minutes of test starting and continued until ignition.					



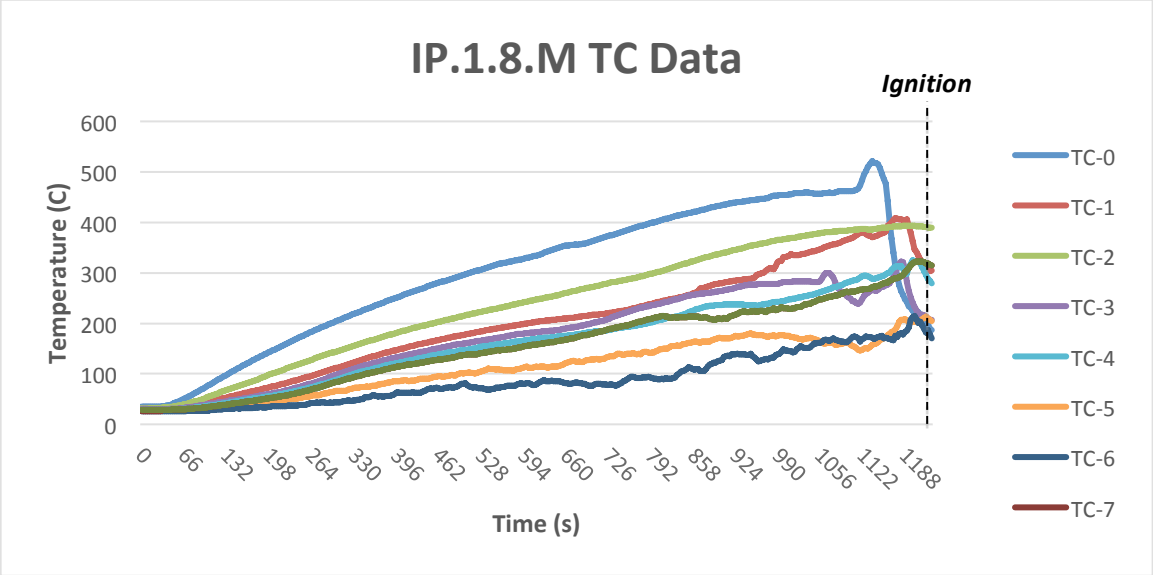
Test Id	Fuel	Diameter	Setting	Time (min:sec)	Ignition (Yes/No)	Time to Ignition (min:sec)
IP.1.6.H	Cardboard	6”	High	9:25	Yes	9:25
Comment	Material lost mass due to smoldering combustion prior to ignition. Heavy smoke was noted during testing.					



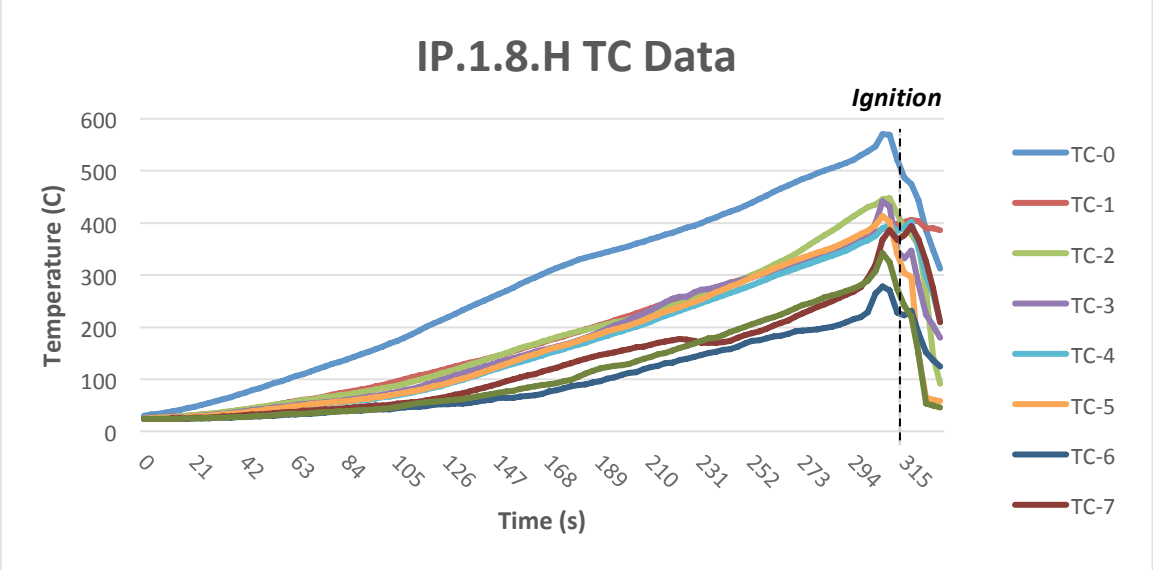
Test Id	Fuel	Diameter	Setting	Time (min:sec)	Ignition (Yes/No)	Time to Ignition (min:sec)
IP.1.8.L	Cardboard	8”	Low	20:00	No	
Comment	No signs of ignition. Material was only hot to the touch after completing the test.					



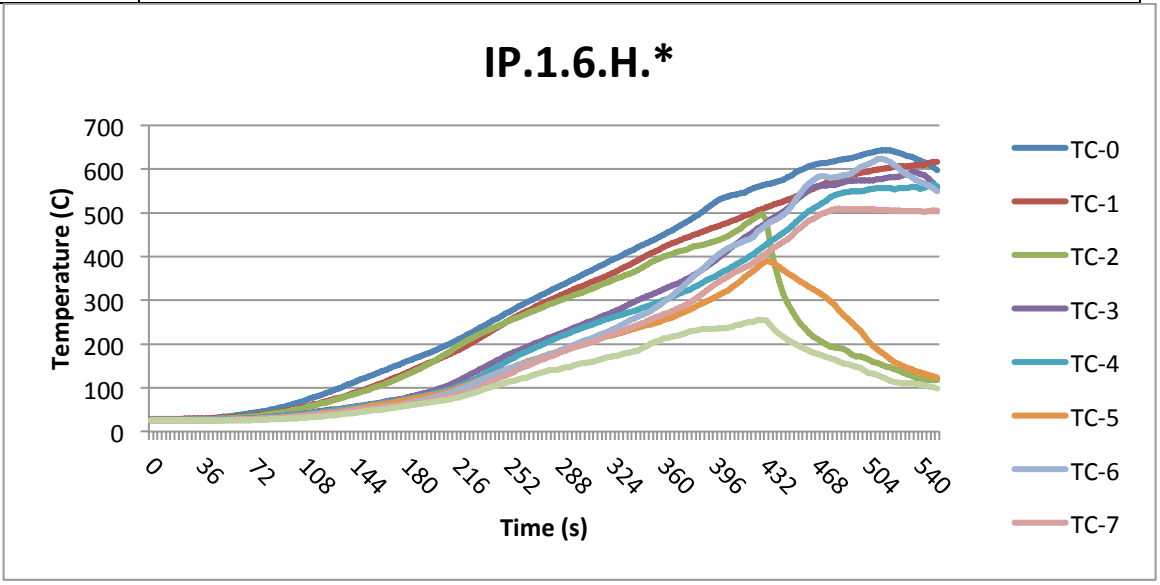
Test Id	Fuel	Diameter	Setting	Time (min:sec)	Ignition (Yes/No)	Time to Ignition (min:sec)
IP.1.8.M	Cardboard	8”	Medium	20:30	Yes	20:30
Comment	Material slowly lost mass due to smoldering combustion prior to ignition. Heavy smoke was noted after a few minutes of test starting and continued until ignition.					



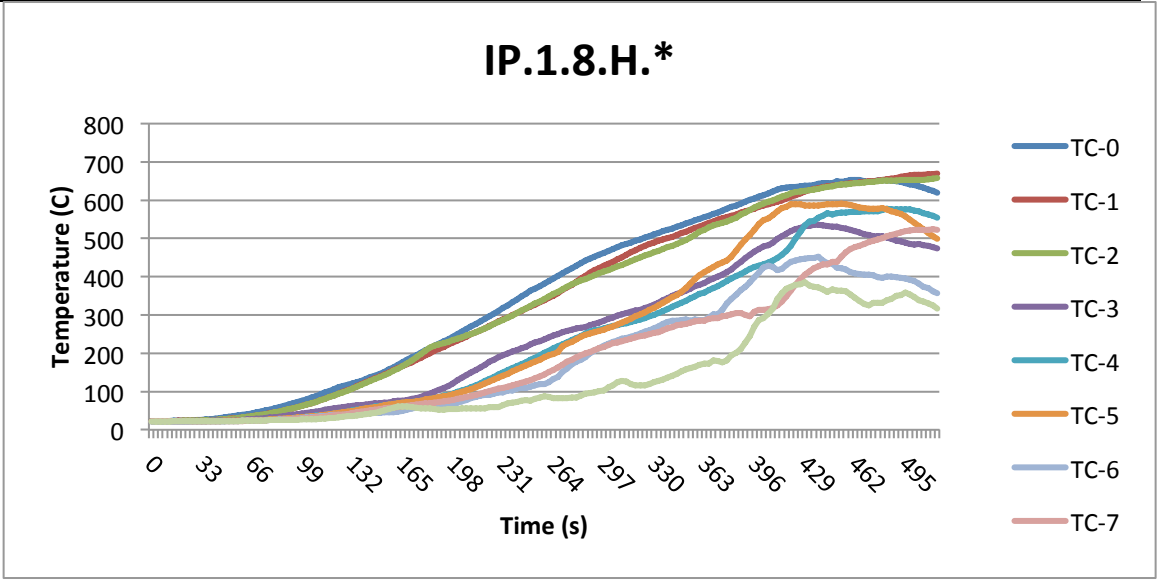
Test Id	Fuel	Diameter	Setting	Time (min:sec)	Ignition (Yes/No)	Time to Ignition (min:sec)
IP.1.8.H	Cardboard	8”	High	5:10	Yes	5:10
Comment	Material lost mass due to smoldering combustion prior to ignition. Heavy smoke was noted during testing.					



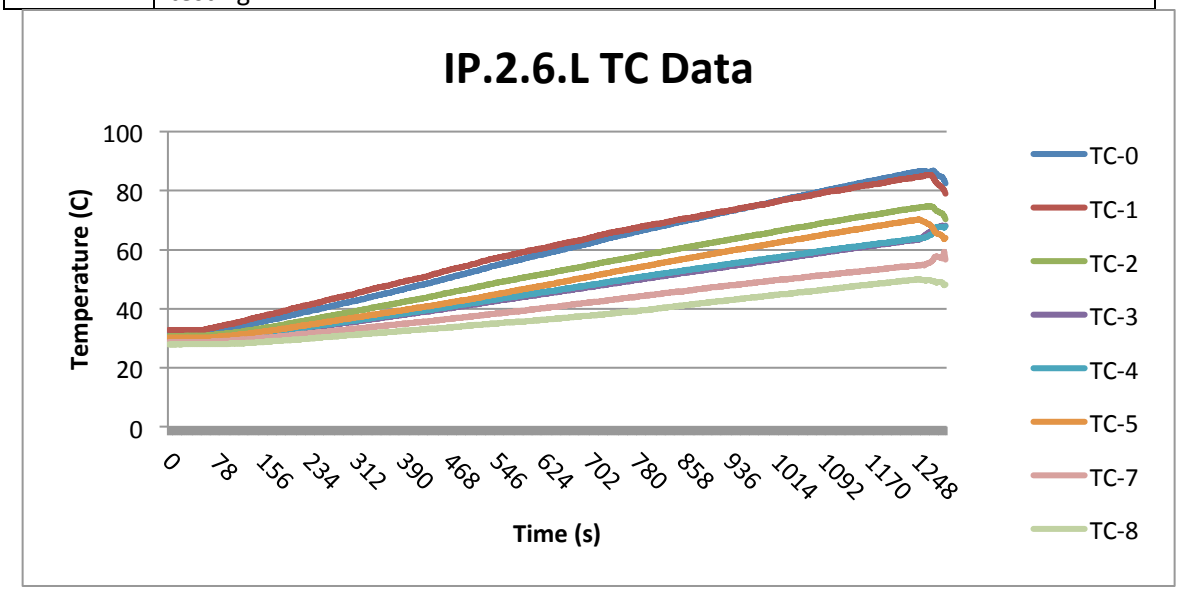
Test Id	Fuel	Diameter	Setting	Time (min:sec)	Ignition (Yes/No)	Time to Ignition (min:sec)
IP.1.6.H.*	Cardboard	6”	High	9:15	No	
Comment	Material lost mass due to smoldering combustion. Heavy smoke was noted during testing. Test was stopped after fuel mass was depleted and temperatures began to decrease.					



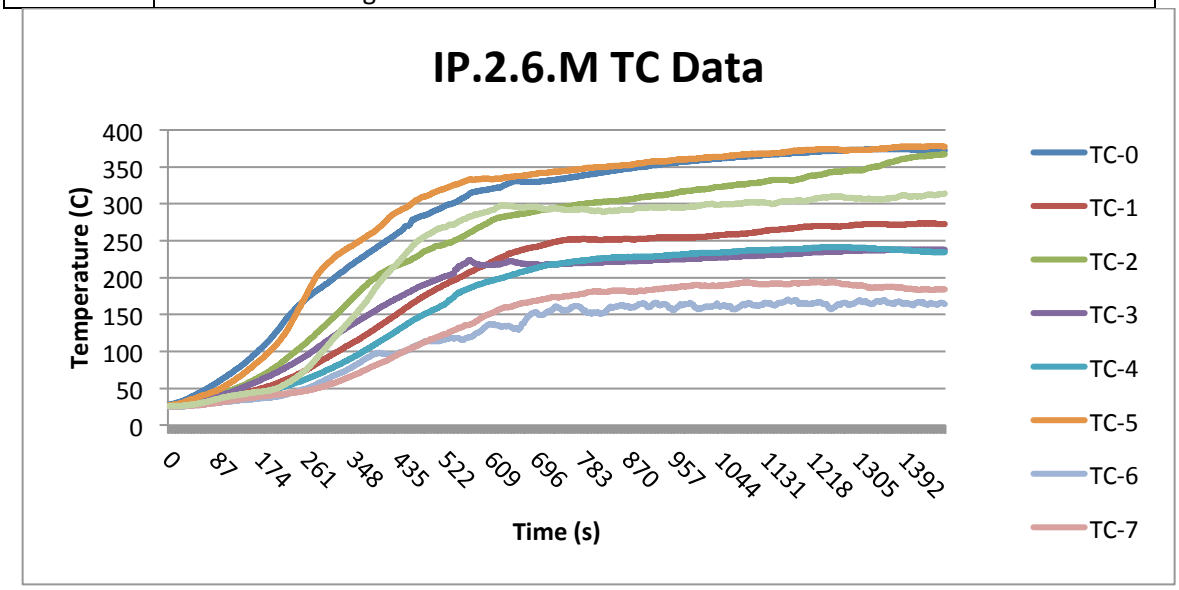
Test Id	Fuel	Diameter	Setting	Time (min:sec)	Ignition (Yes/No)	Time to Ignition (min:sec)
IP.1.8.H.*	Cardboard	8”	High	8:30	No	
Comment	Material lost mass due to smoldering combustion. Heavy smoke was noted during testing. Test was stopped after fuel mass was depleted and temperatures began to decrease.					



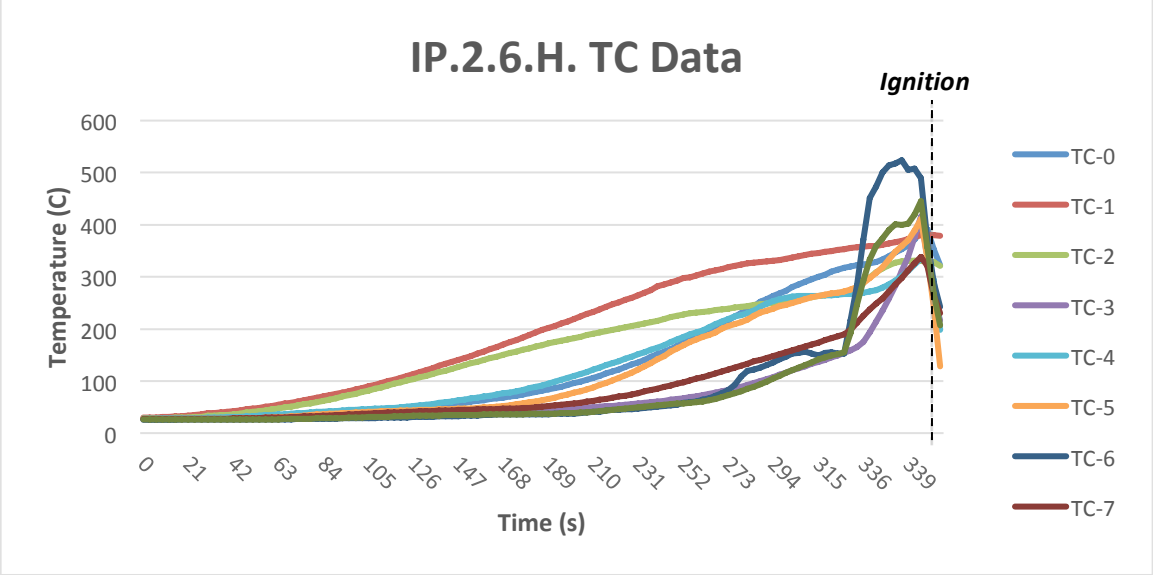
Test Id	Fuel	Diameter	Setting	Time (min:sec)	Ignition (Yes/No)	Time to Ignition (min:sec)
IP.2.6.L	Dish Towel	6”	Low	25:00	No	
Comment	No signs of ignition. Material was only warm to the touch after completing the testing.					



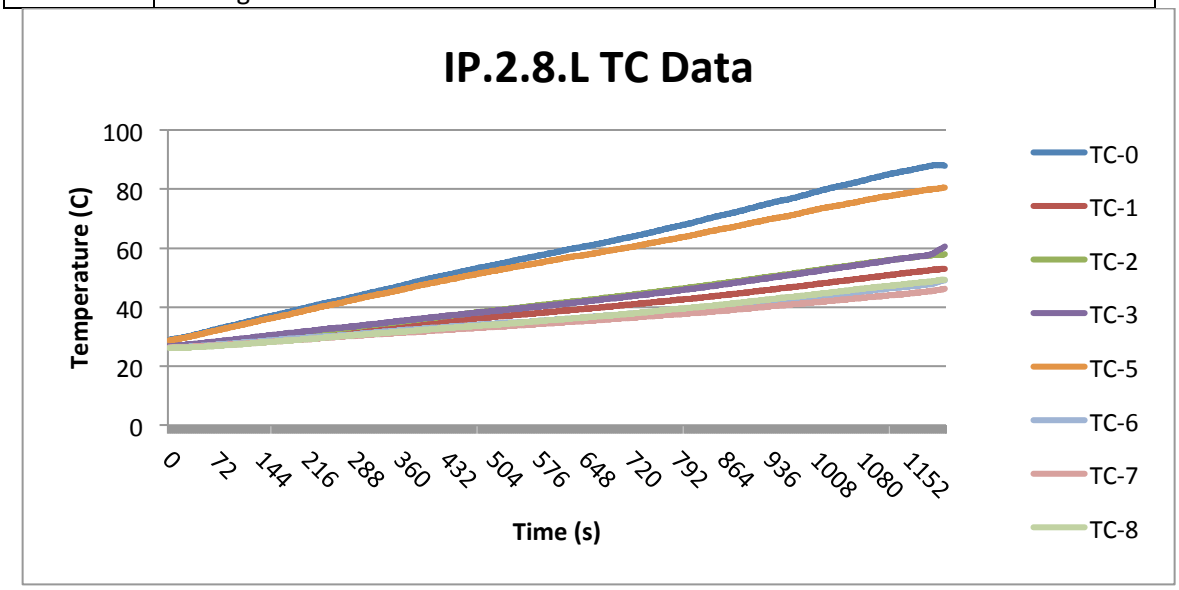
Test Id	Fuel	Diameter	Setting	Time (min:sec)	Ignition (Yes/No)	Time to Ignition (min:sec)
IP.2.6.M	Dish Towel	6”	Medium	25:00	No	
Comment	Towel shown signs of ignition but did not ignite during test. Heavy smoke release was noted during test.					



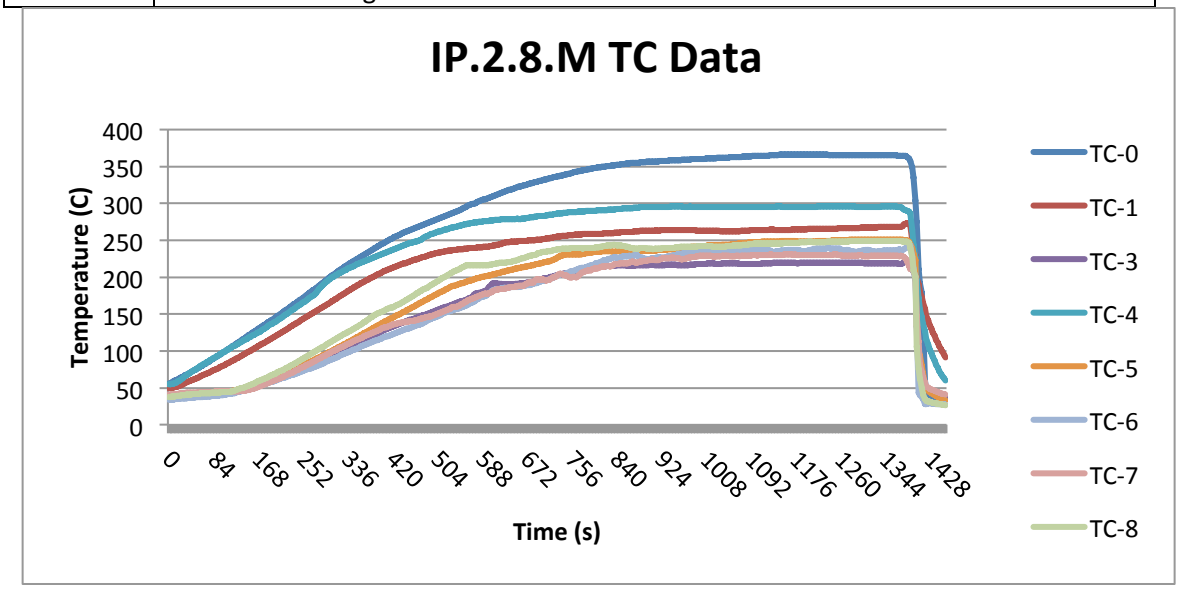
Test Id	Fuel	Diameter	Setting	Time (min:sec)	Ignition (Yes/No)	Time to Ignition (min:sec)
IP.2.6.H	Dish Towel	6”	High	5:46	Yes	5:46
Comment	Heavy smoke was noted within the first minute of testing. Material began to breakdown and discolors within a minute of test starting.					



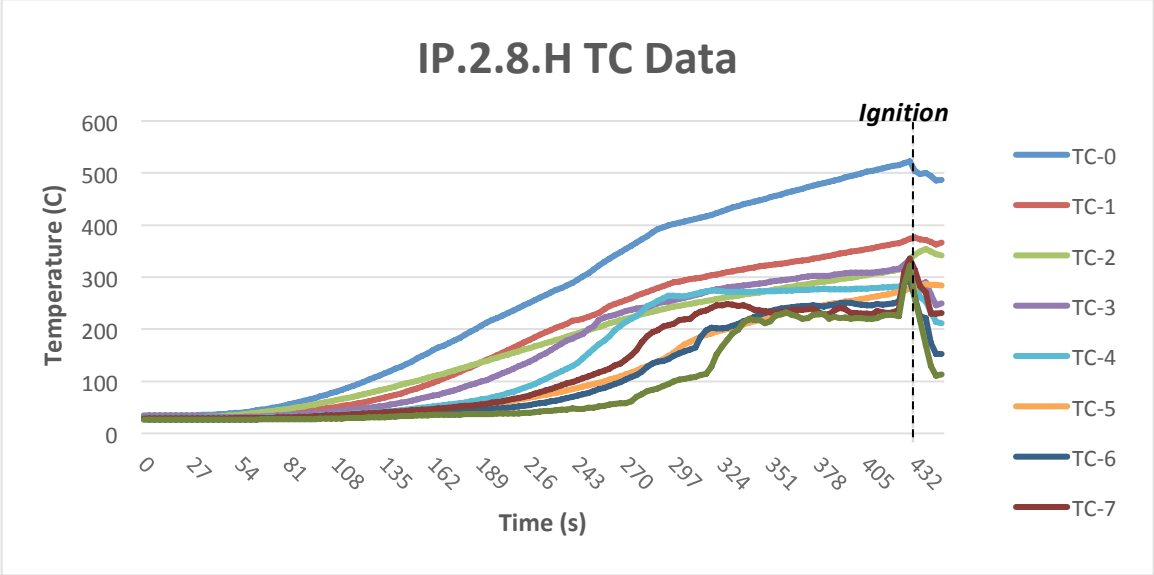
Test Id	Fuel	Diameter	Setting	Time (min:sec)	Ignition (Yes/No)	Time to Ignition (min:sec)
IP2.8.L	Dish Towel	8”	Low	25:00	No	
Comment	No signs of ignition. Material was only warm to the touch after completing the testing.					



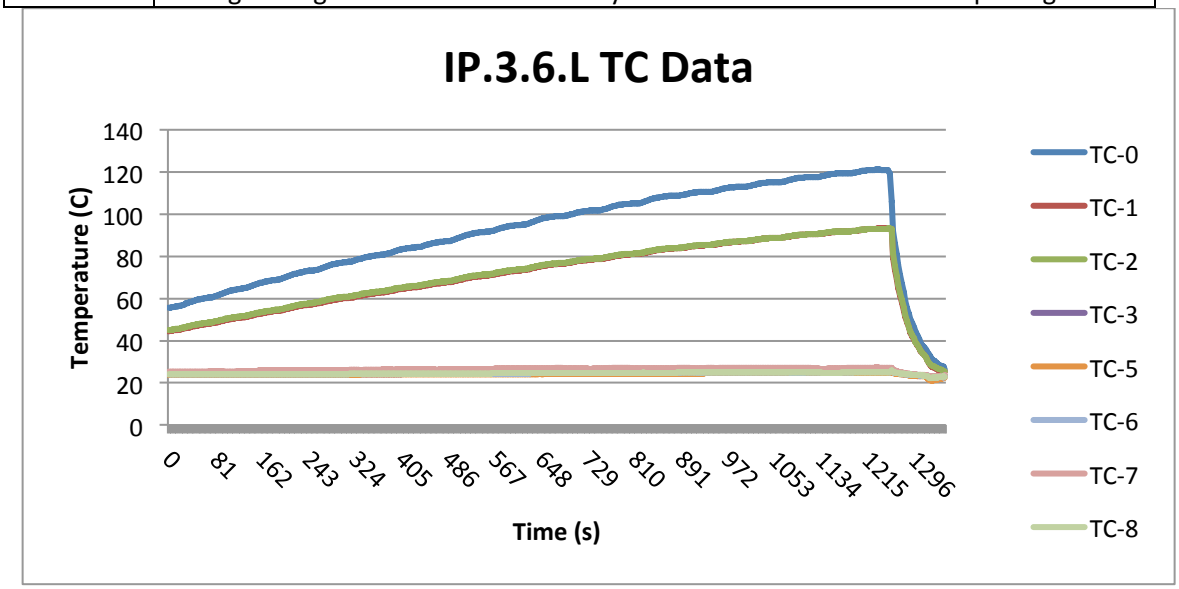
Test Id	Fuel	Diameter	Setting	Time (min:sec)	Ignition (Yes/No)	Time to Ignition (min:sec)
IP.2.8.M	Dish Towel	8”	Medium	25:00	No	
Comment	Towel shown signs of ignition but did not ignite during test. Heavy smoke release was noted during test.					



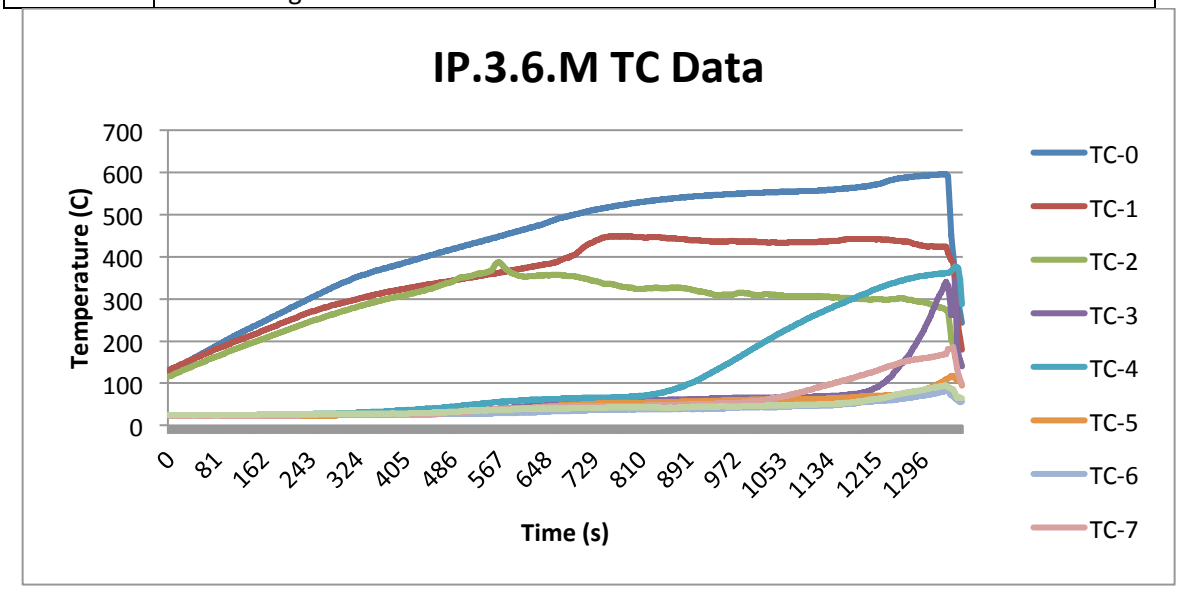
Test Id	Fuel	Diameter	Setting	Time (min:sec)	Ignition (Yes/No)	Time to Ignition (min:sec)
IP.2.8.H	Dish Towel	8”	High	6:55	Yes	6:55
Comment	Heavy smoke was noted within the first minute of testing. Material began to breakdown and discolors within a minute of test starting.					



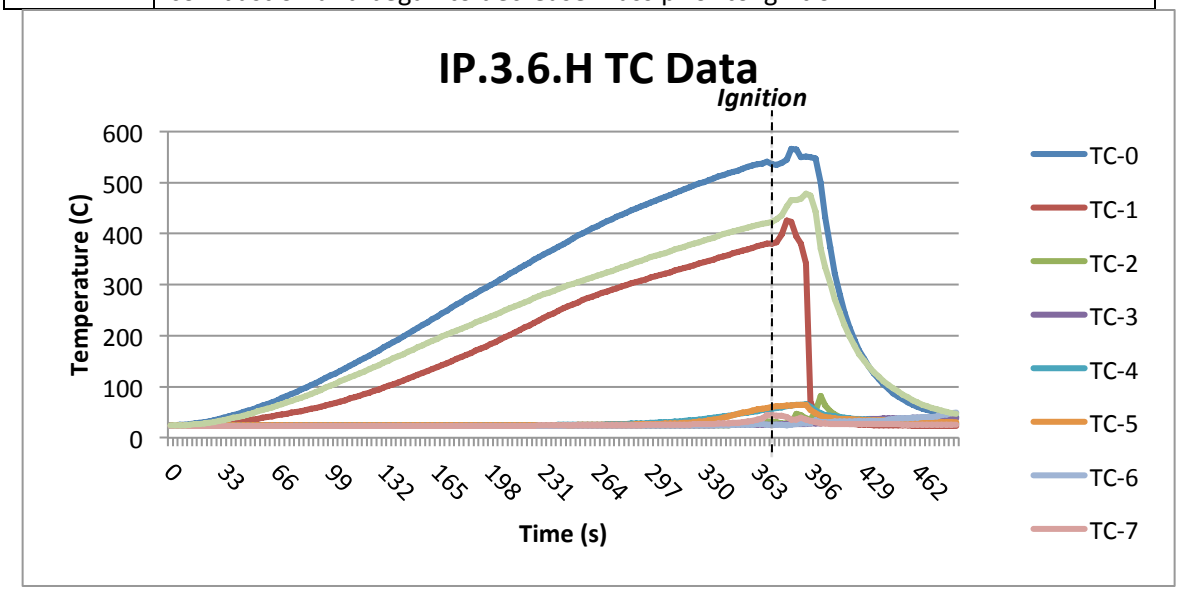
Test Id	Fuel	Diameter	Setting	Time (min:sec)	Ignition (Yes/No)	Time to Ignition (min:sec)
IP.3.6.L	Paper Towel	6”	Low	25:00	No	
Comment	No signs of ignition. Material was only warm to the touch after completing test.					



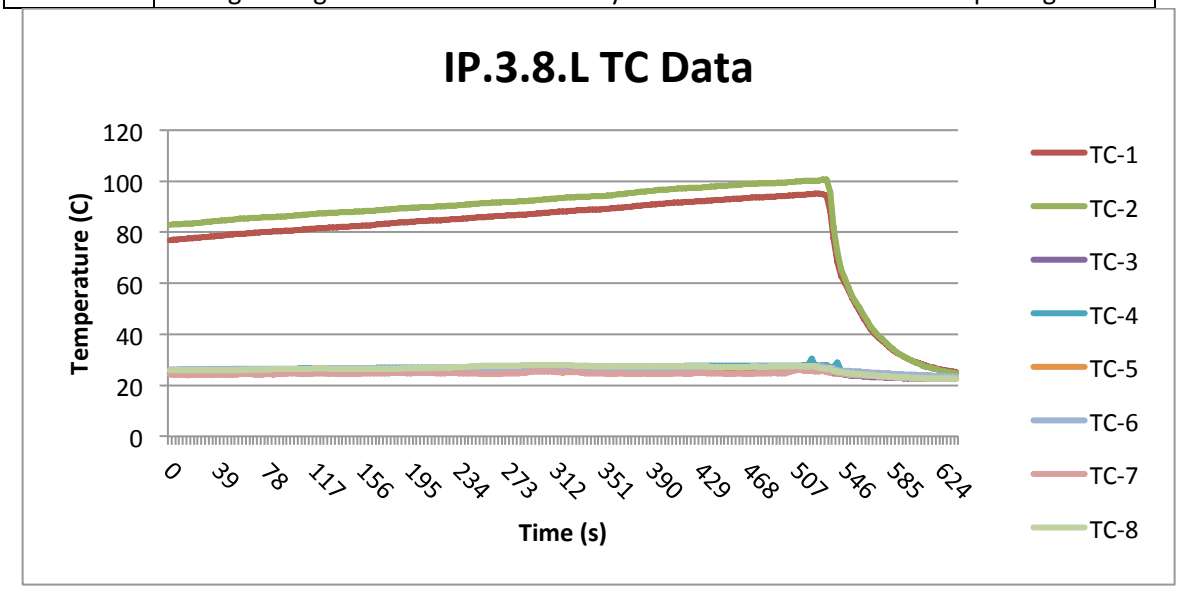
Test Id	Fuel	Diameter	Setting	Time (min:sec)	Ignition (Yes/No)	Time to Ignition (min:sec)
IP.3.6.M	Paper Towel	6”	Medium	25:00	No	
Comment	Heavy smoke was noted during test. Material lost most of its mass due to smoldering combustion.					



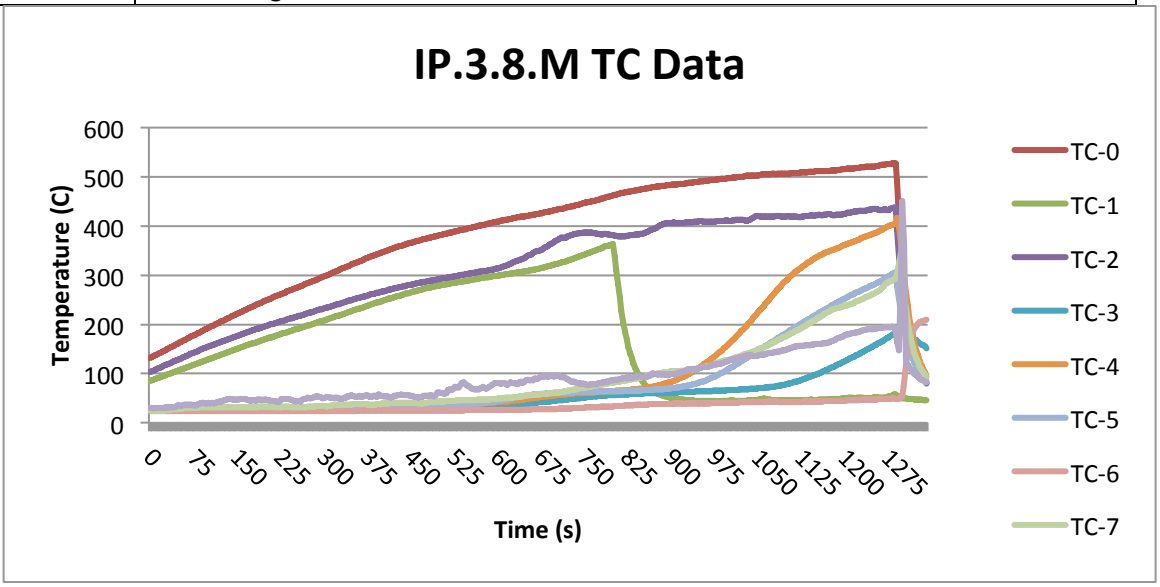
Test Id	Fuel	Diameter	Setting	Time (min:sec)	Ignition (Yes/No)	Time to Ignition (min:sec)
IP.3.6.H	Paper Towel	6”	High	6:04	Yes	6:04
Comment	Heavy smoke release was noted during test. Material underwent smoldering combustion and began to decrease mass prior to ignition.					



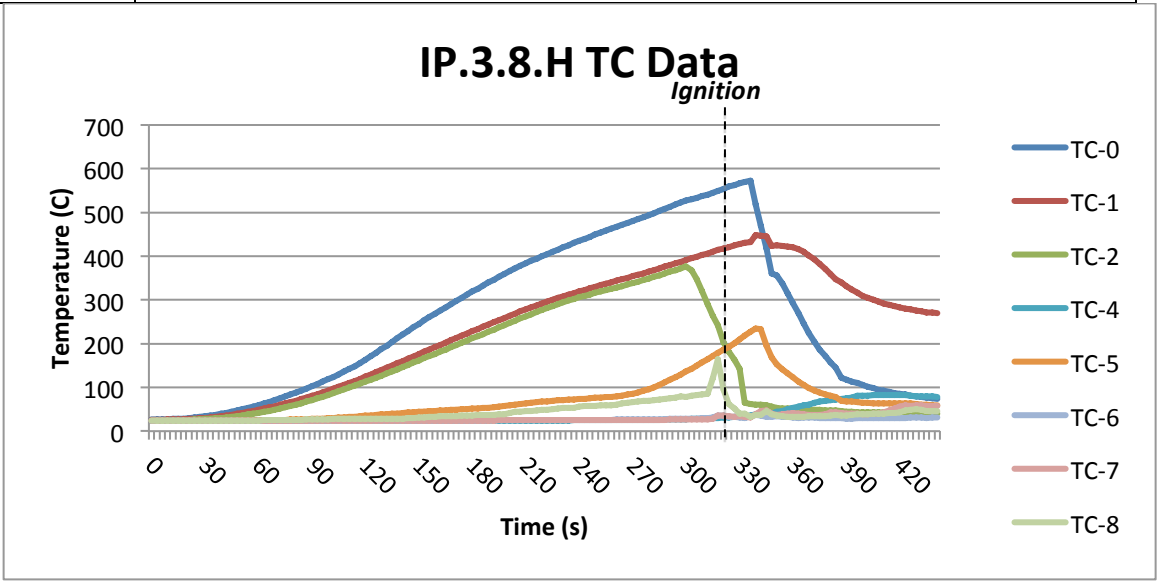
Test Id	Fuel	Diameter	Setting	Time (min:sec)	Ignition (Yes/No)	Time to Ignition (min:sec)
IP.3.8.L	Paper Towel	8”	Low	25:00	No	
Comment	No signs of ignition. Material was only warm to the touch after completing test.					



Test Id	Fuel	Diameter	Setting	Time (min:sec)	Ignition (Yes/No)	Time to Ignition (min:sec)
IP.3.8.M	Paper Towel	8”	Medium	25:00	No	
Comment	Heavy smoke was noted during test. Material lost most of its mass due to smoldering combustion.					



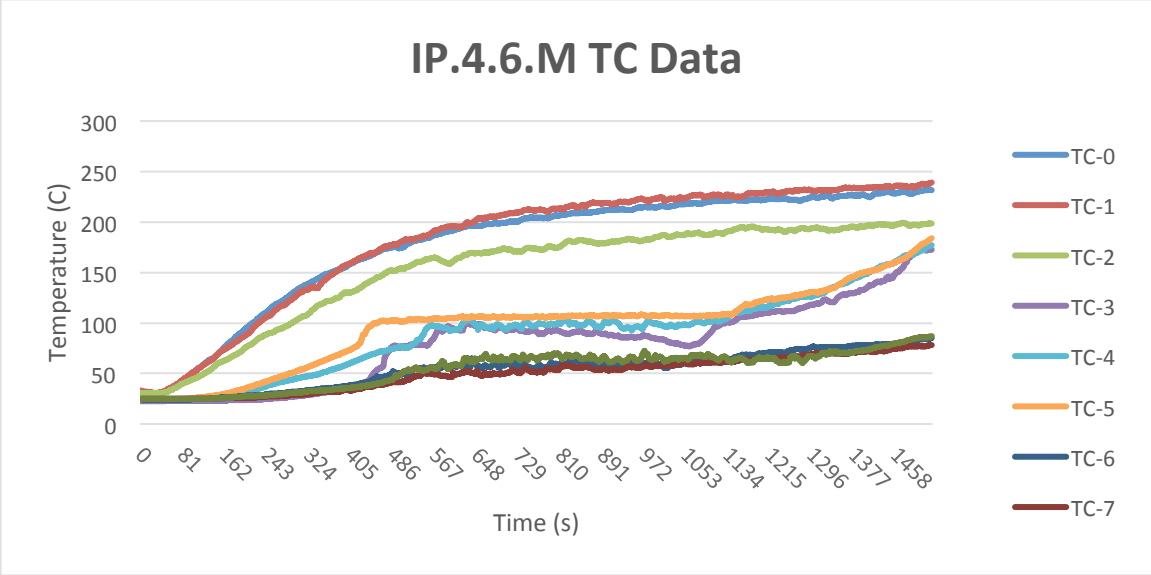
Test Id	Fuel	Diameter	Setting	Time (min:sec)	Ignition (Yes/No)	Time to Ignition (min:sec)
IP.3.8.H	Paper Towel	8”	High	5:20	Yes	5:20
Comment	Heavy smoke release was noted during test. Material underwent smoldering combustion and began to decrease mass prior to ignition.					



Test Id	Fuel	Diameter	Setting	Time (min:sec)	Ignition (Yes/No)	Time to Ignition (min:sec)
IP.4.6.L	Canola Oil	6”	Low	No test	No	
Comment	No test was conducted on low setting based on no ignition of material on medium setting.					

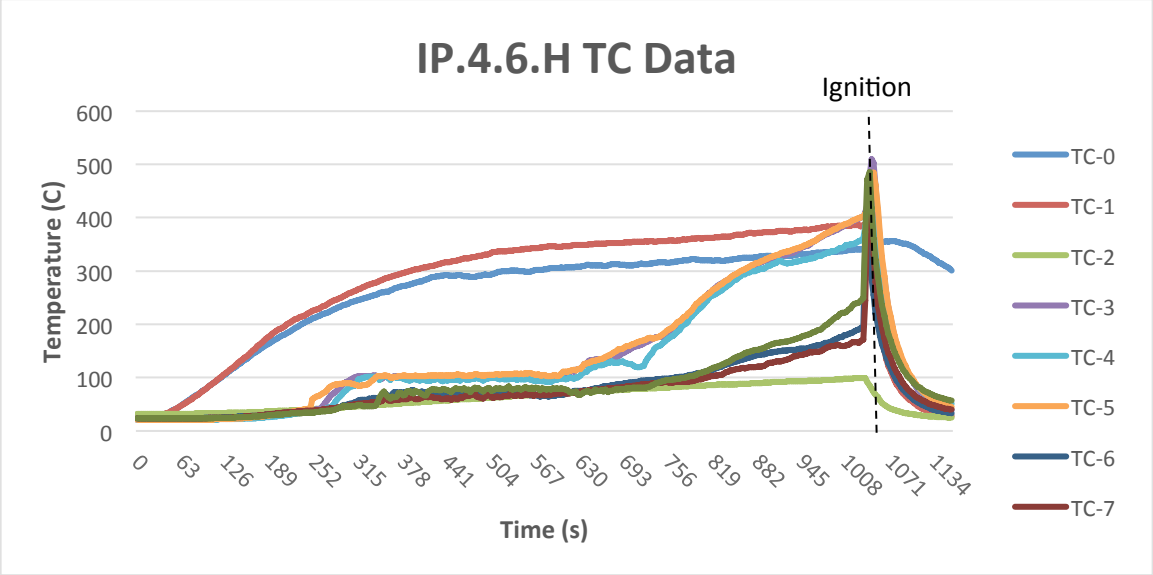
No Test Conducted

Test Id	Fuel	Diameter	Setting	Time (min:sec)	Ignition (Yes/No)	Time to Ignition (min:sec)
IP.4.6.M	Canola Oil	6”	Medium	25:00	No	
Comment	Material boiled and released vapor during test. A pungent odor was noted during test.					



Test Id	Fuel	Diameter	Setting	Time	Ignition	Time to Ignition

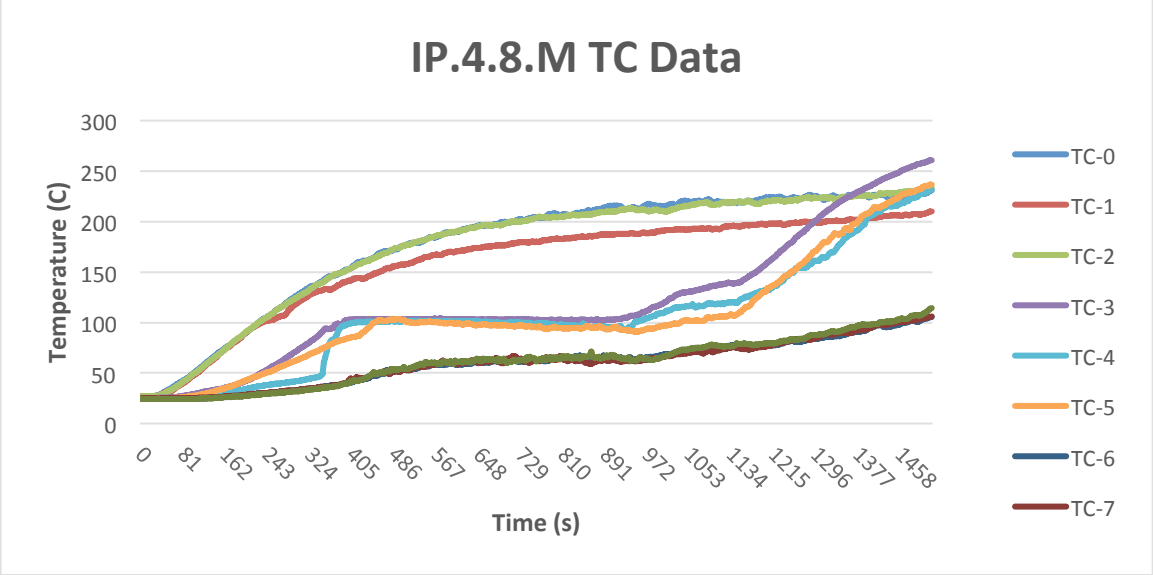
				(min:sec)	(Yes/No)	(min:sec)
IP.4.6.H	Canola Oil	6”	High	17:18	Yes	17:18
Comment	Material boiled and released vapors prior to ignition. Material began to blacken towards end prior to ignition.					



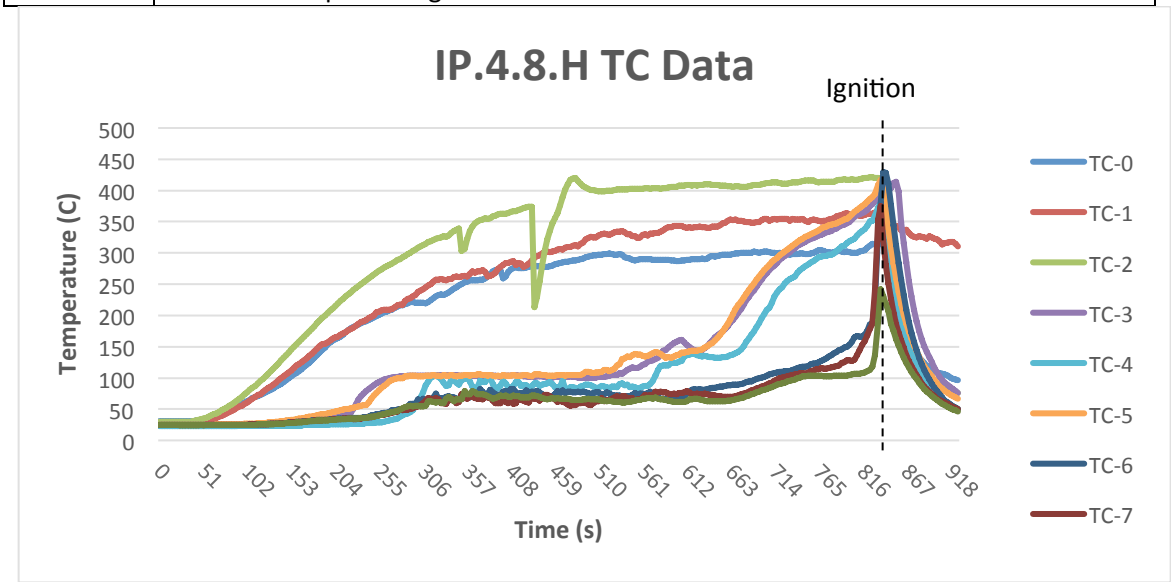
Test Id	Fuel	Diameter	Setting	Time (min:sec)	Ignition (Yes/No)	Time to Ignition (min:sec)
IP.4.8.L	Canola Oil	8”	Low	No test	No	
Comment	No test was conducted on low setting based on no ignition of material on medium setting.					

No Test Conducted

Test Id	Fuel	Diameter	Setting	Time (min:sec)	Ignition (Yes/No)	Time to Ignition (min:sec)
IP.4.8.M	Canola Oil	8”	Medium	25:00	No	
Comment	Material boiled and released vapor during test. A pungent odor was noted during test.					



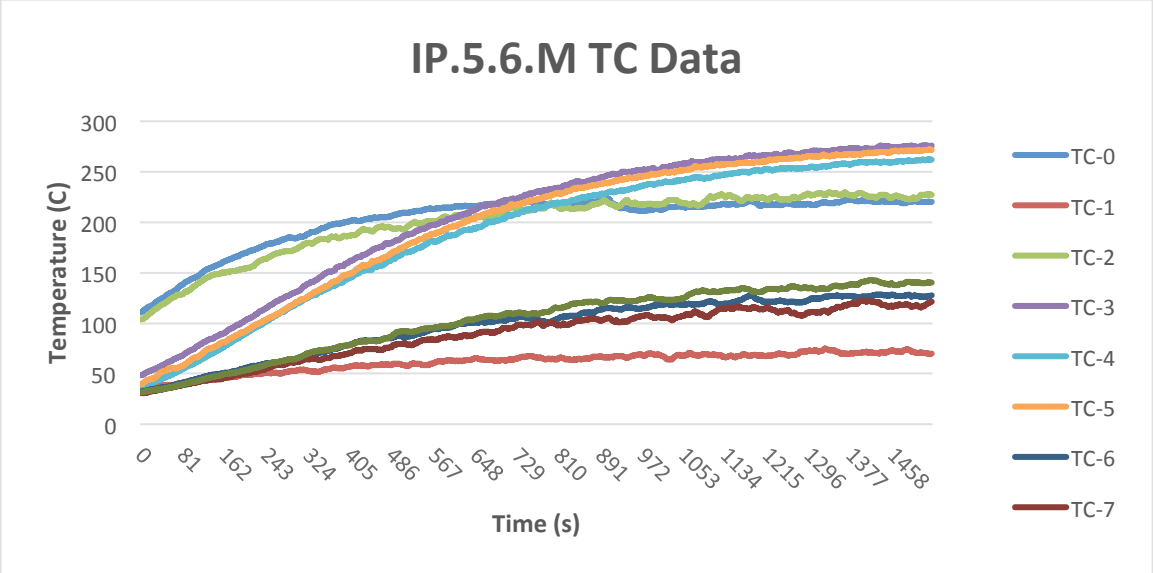
Test Id	Fuel	Diameter	Setting	Time (min:sec)	Ignition (Yes/No)	Time to Ignition (min:sec)
IP.4.8.H	Canola Oil	8”	High	13:31	Yes	13:31
Comment	Material boiled and released vapors prior to ignition. Material began to blacken towards end prior to ignition.					



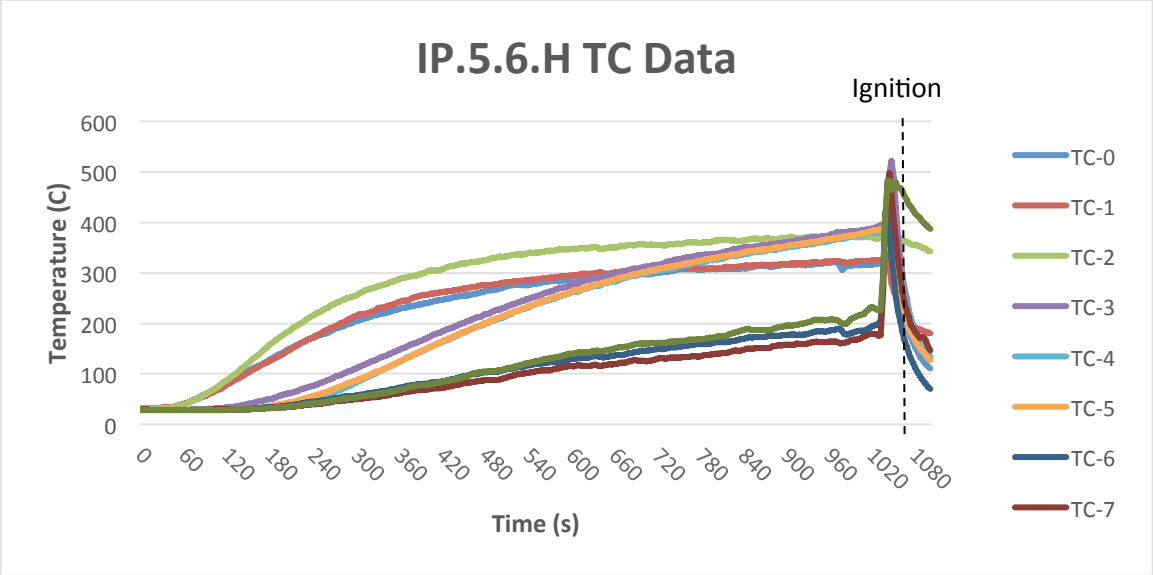
Test Id	Fuel	Diameter	Setting	Time (min:sec)	Ignition (Yes/No)	Time to Ignition (min:sec)
IP.5.6.L	Vegetable Oil	6”	Low	No test	No	
Comment	No test was conducted on low setting due to no ignition of material on medium setting.					

No Test Conducted

Test Id	Fuel	Diameter	Setting	Time (min:sec)	Ignition (Yes/No)	Time to Ignition (min:sec)
IP.5.6.M	Vegetable Oil	6”	Medium	25:00	No	
Comment	Material boiled and released vapors. A pungent odor was noted during testing.					



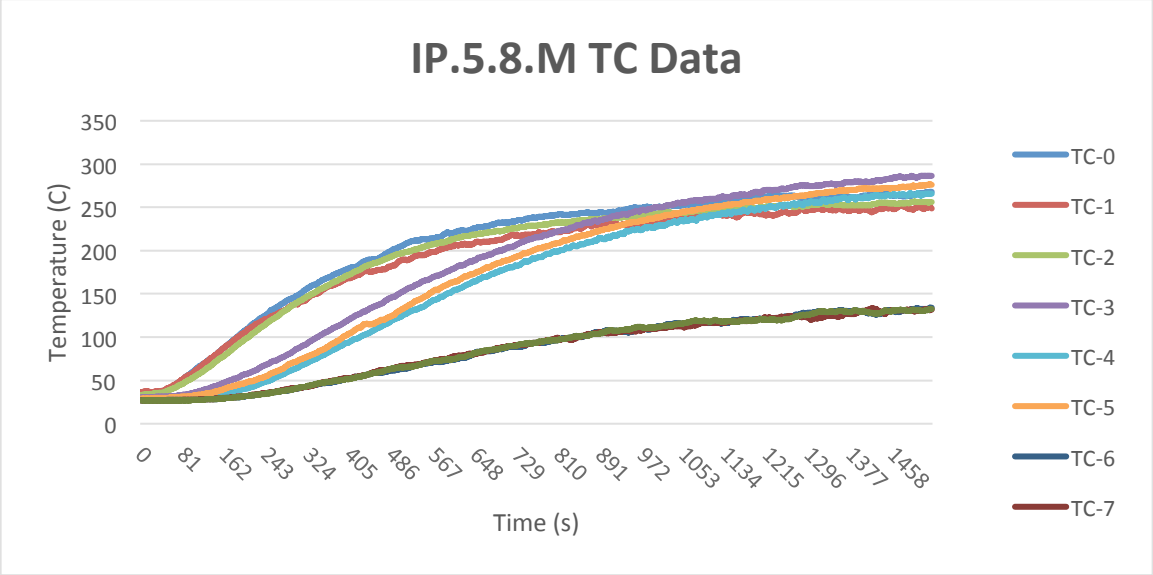
Test Id	Fuel	Diameter	Setting	Time (min:sec)	Ignition (Yes/No)	Time to Ignition (min:sec)
IP.5.6.H	Vegetable Oil	6”	High	17:16	Yes	17:16
Comment	Material boiled and released vapors prior to ignition. Discoloration of material was noted prior to ignition. Blackened residue was noted on pan after completion of test.					



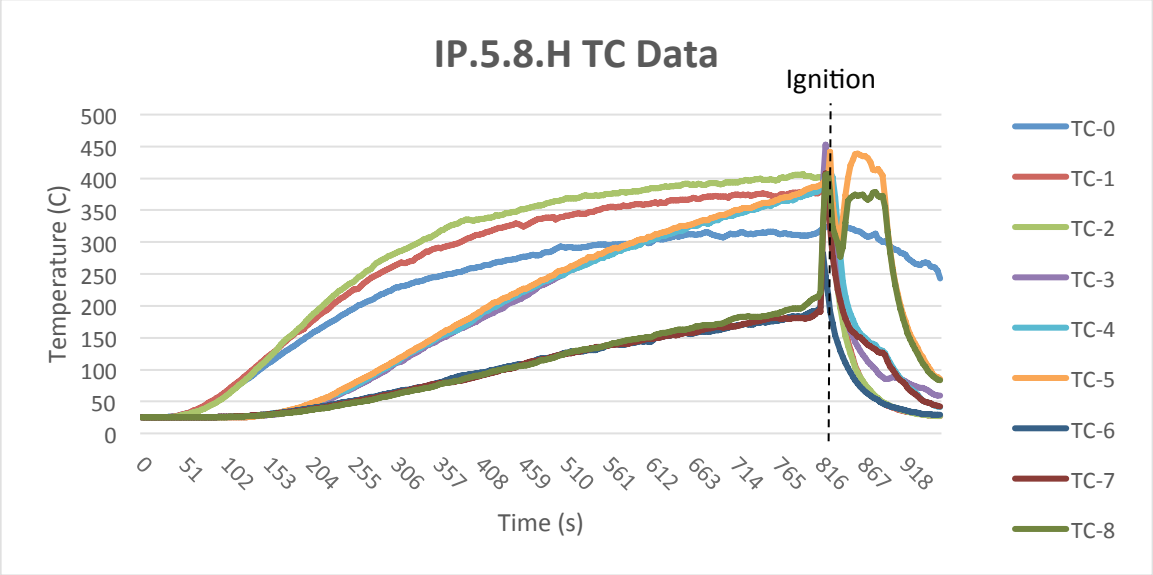
Test Id	Fuel	Diameter	Setting	Time (min:sec)	Ignition (Yes/No)	Time to Ignition (min:sec)
IP.5.8.L	Vegetable Oil	8”	Low	No test	No	
Comment	No test was conducted on low setting due to no ignition of material on medium setting.					

No Test Conducted

Test Id	Fuel	Diameter	Setting	Time (min:sec)	Ignition (Yes/No)	Time to Ignition (min:sec)
IP.5.8.M	Vegetable Oil	8”	Medium	25:00	No	
Comment	Material boiled and released vapors. A pungent odor was noted during testing.					



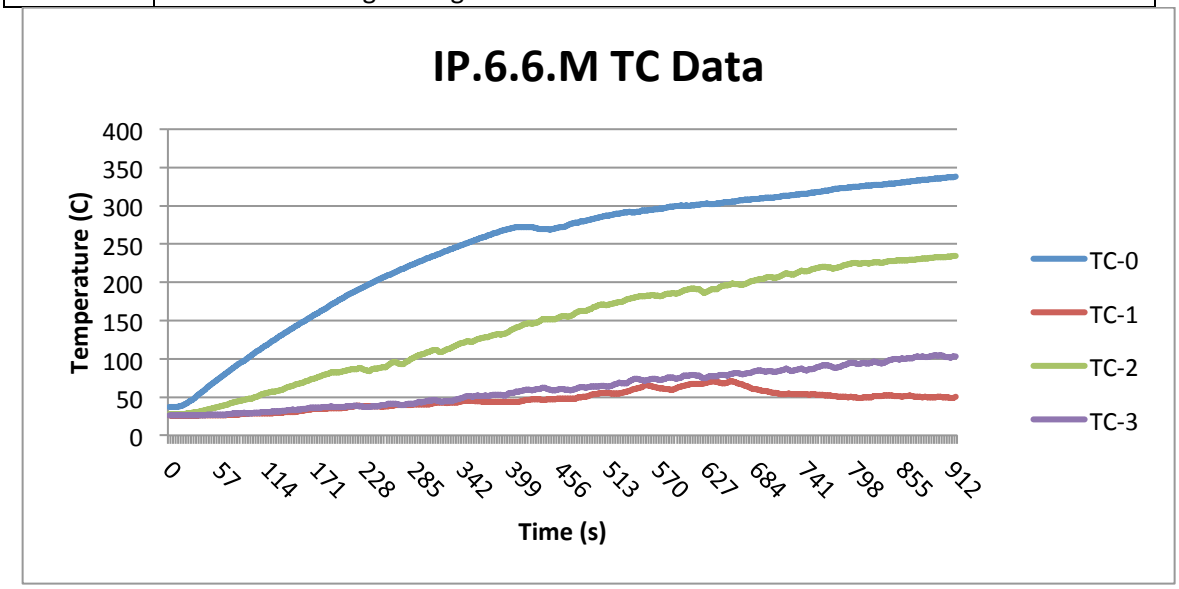
Test Id	Fuel	Diameter	Setting	Time (min:sec)	Ignition (Yes/No)	Time to Ignition (min:sec)
IP.5.8.H	Vegetable Oil	8”	High	13:13	Yes	13:13
Comment	Material boiled and released vapors prior to ignition. Discoloration of material was noted prior to ignition. Blackened residue was noted on pan after completion of test.					



Test Id	Fuel	Diameter	Setting	Time (min:sec)	Ignition (Yes/No)	Time to Ignition (min:sec)
IP.6.6.L	Nylon spatula	6”	Low	No Test	No	
Comment	No test was conducted on low setting based on no ignition results on medium test.					

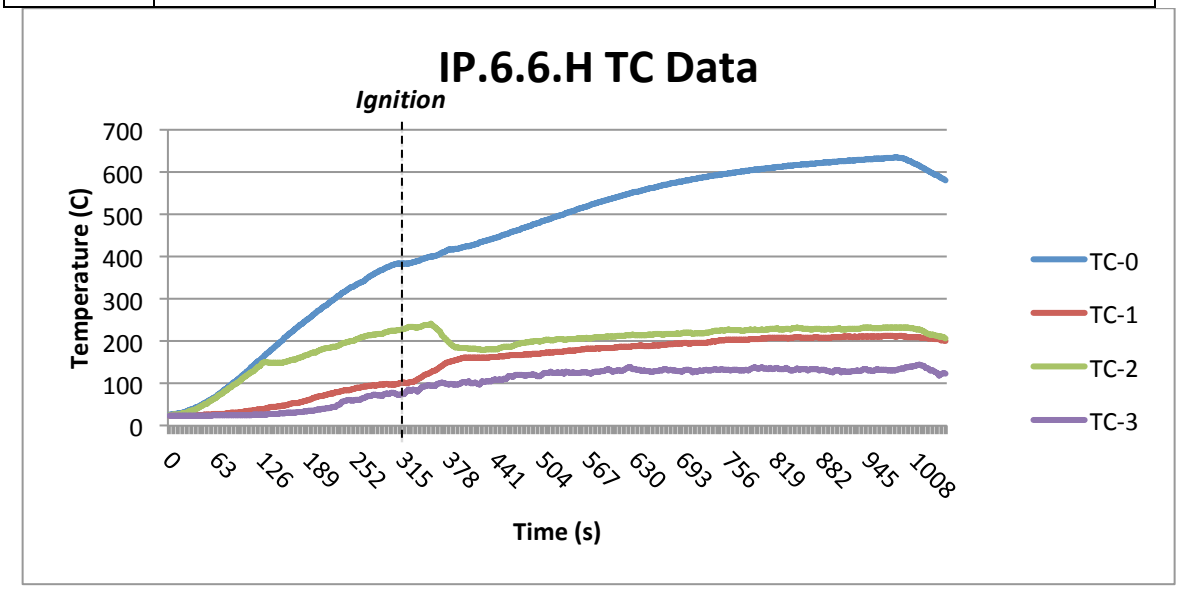
No Test Conducted

Test Id	Fuel	Diameter	Setting	Time (min:sec)	Ignition (Yes/No)	Time to Ignition (min:sec)
IP.6.6.M	Nylon spatula	6”	Medium	15:00	No	
Comment	Melting of material and mass loss was noted during testing. Heavy smoke release was noted during testing.					



Test Id	Fuel	Diameter	Setting	Time	Ignition	Time to Ignition

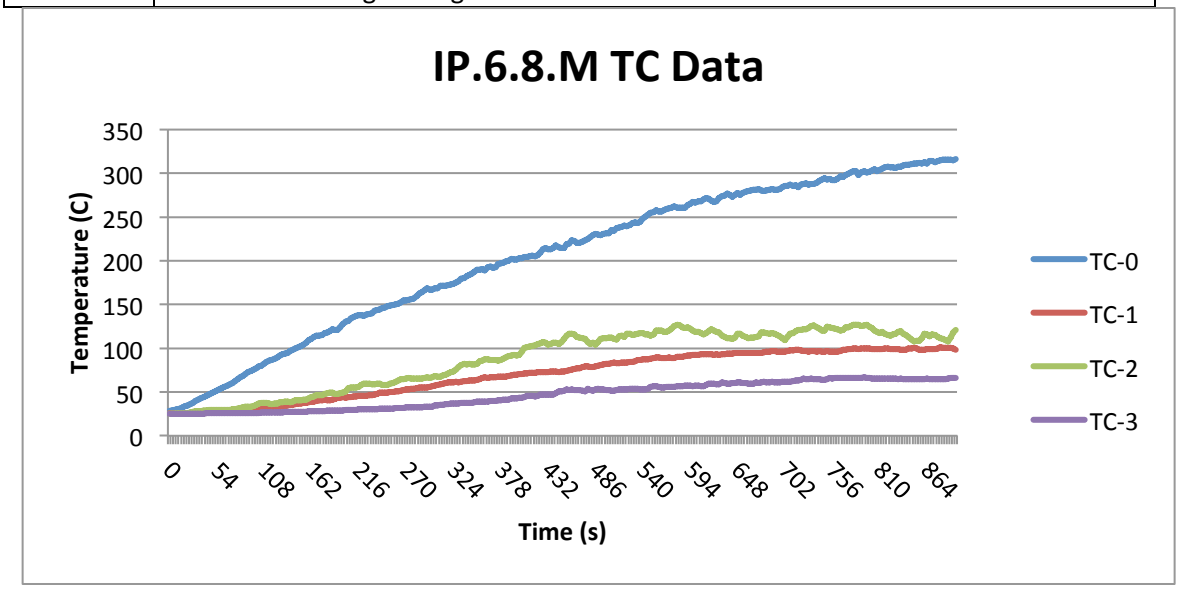
				(min:sec)	(Yes/No)	(min:sec)
IP.6.6.H	Nylon spatula	6”	High	4:45	Yes	4:45
Comment	Material melted and prior to ignition. Heavy smoke release was noted during test.					



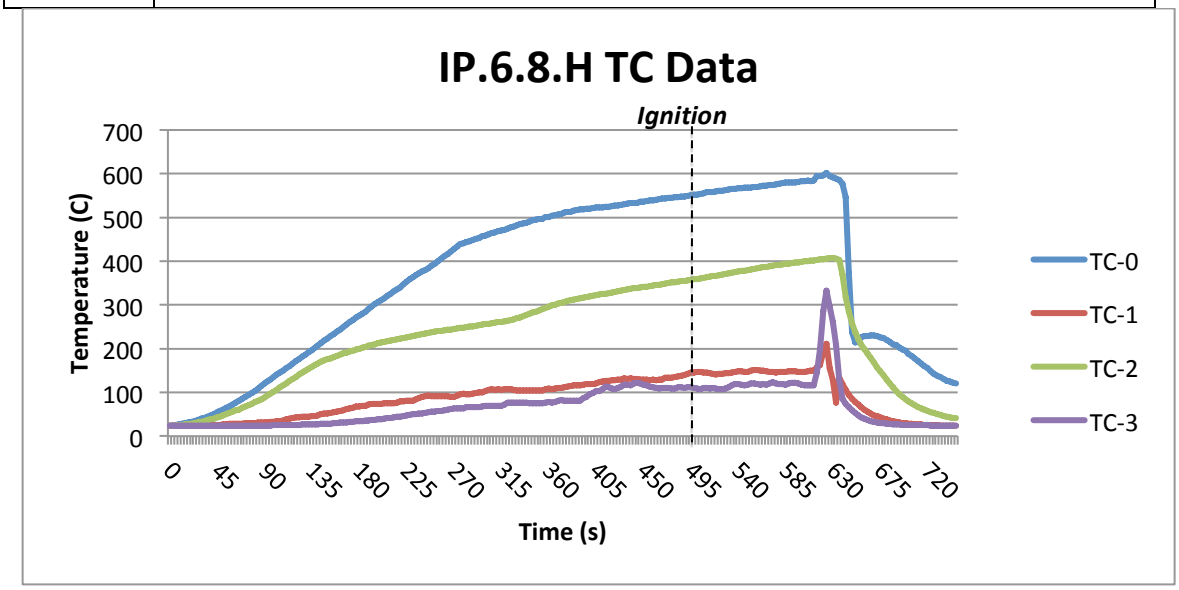
Test Id	Fuel	Diameter	Setting	Time (min:sec)	Ignition (Yes/No)	Time to Ignition (min:sec)
IP.6.8.L	Nylon spatula	8”	Low	No Test	No	
Comment	No test was conducted on low setting based on no ignition results on medium test.					

No Test Conducted

Test Id	Fuel	Diameter	Setting	Time (min:sec)	Ignition (Yes/No)	Time to Ignition (min:sec)
IP.6.8.M	Nylon spatula	8”	Medium	15:00	No	
Comment	Melting of material and mass loss was noted during testing. Heavy smoke release was noted during testing.					



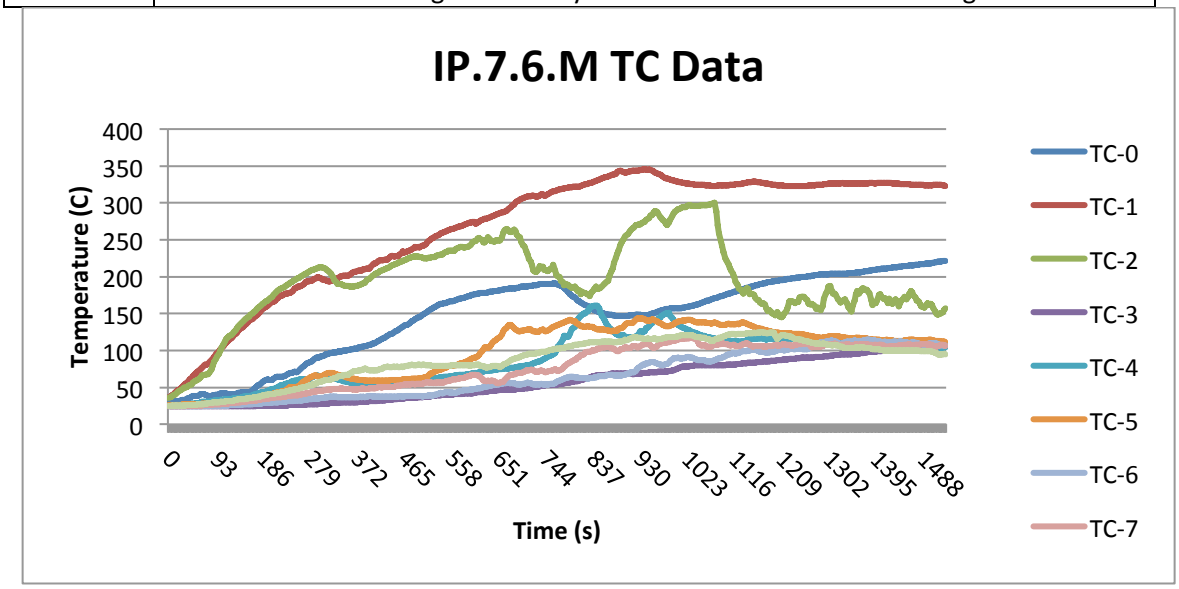
Test Id	Fuel	Diameter	Setting	Time (min:sec)	Ignition (Yes/No)	Time to Ignition (min:sec)
IP.6.8.H	Nylon spatula	8”	High	7:55	Yes	7:55
Comment	Material melted and prior to ignition. Heavy smoke release was noted during test.					



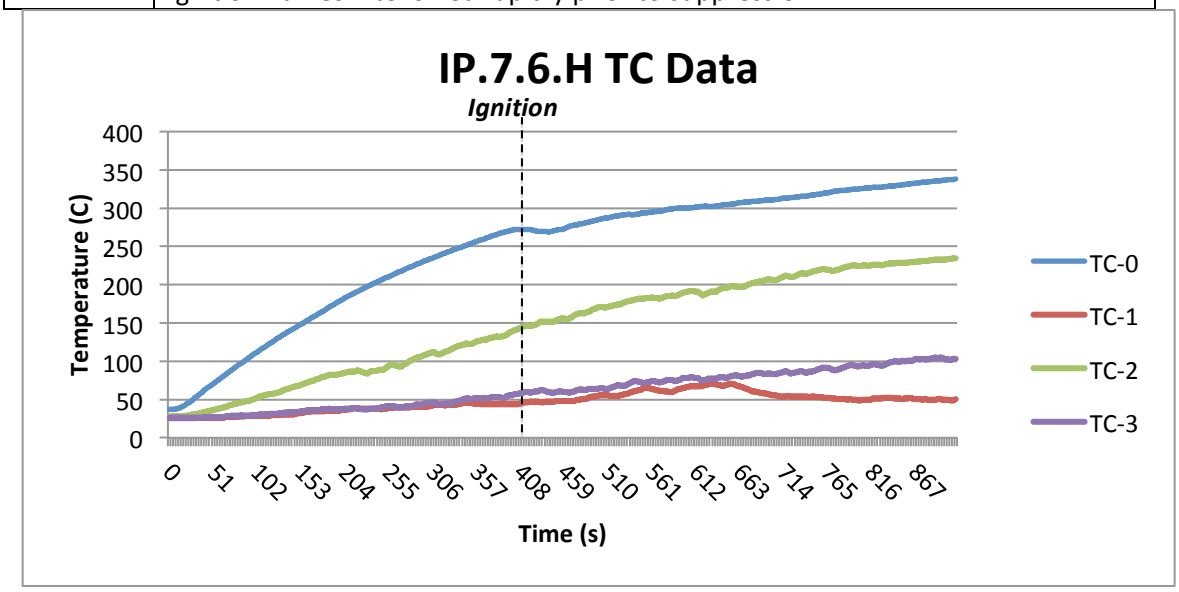
Test Id	Fuel	Diameter	Setting	Time (min:sec)	Ignition (Yes/No)	Time to Ignition (min:sec)
IP.7.6.L	Toaster	6”	Low	No test	No	
Comment	No test was conducted on low setting based on no ignition result for test conducted on medium setting.					

No Test Conducted

Test Id	Fuel	Diameter	Setting	Time (min:sec)	Ignition (Yes/No)	Time to Ignition (min:sec)
IP.7.6.M	Toaster	6”	Medium	25:00	No	
Comment	Material melted during test. Heavy smoke release was noted during test.					



Test Id	Fuel	Diameter	Setting	Time (min:sec)	Ignition (Yes/No)	Time to Ignition (min:sec)
IP.7.6.H	Toaster	6”	High	6:20	Yes	6:20
Comment	Material began to melt and release heavy smoke after a minute of testing. After ignition flames intensified rapidly prior to suppression.					



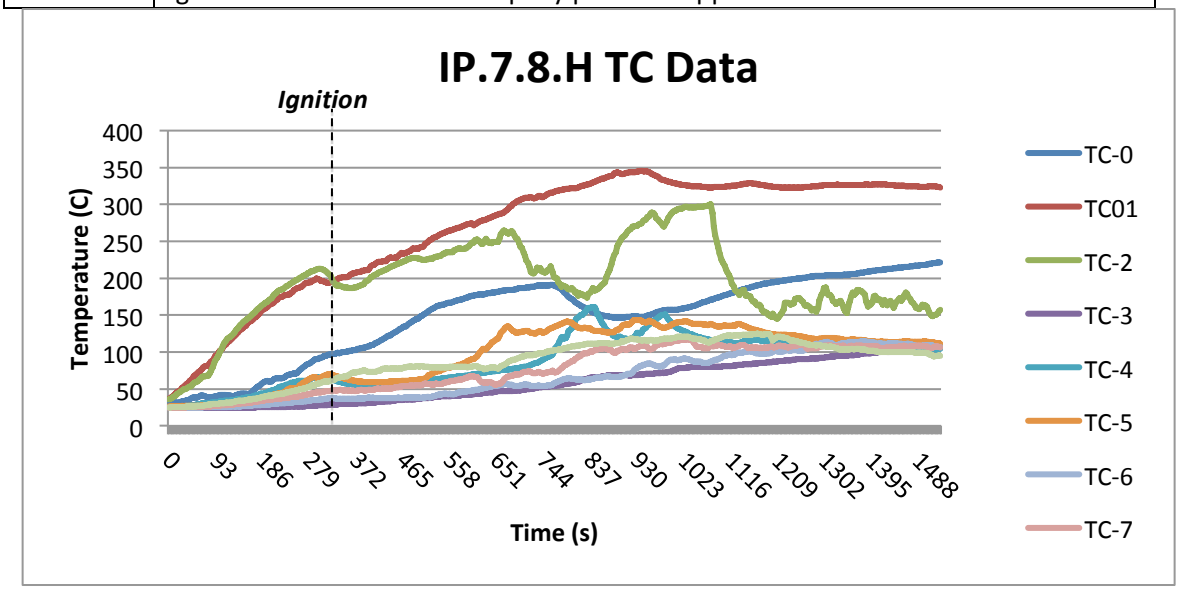
Test Id	Fuel	Diameter	Setting	Time (min:sec)	Ignition (Yes/No)	Time to Ignition (min:sec)
IP.7.8.L	Toaster	8”	Low	No test	No	
Comment	No test was conducted on low setting based on no ignition result for test conducted on medium setting.					

No Test Conducted

Test Id	Fuel	Diameter	Setting	Time (min:sec)	Ignition (Yes/No)	Time to Ignition (min:sec)
IP.7.8.M	Toaster	8”	Medium	25:00	No	
Comment	Material melted during test. Heavy smoke release was noted during test.					

No Graph

Test Id	Fuel	Diameter	Setting	Time (min:sec)	Ignition (Yes/No)	Time to Ignition (min:sec)
IP.7.8.H	Toaster	8”	High	5:20	Yes	5:20
Comment	Material began to melt and release heavy smoke after a minute of testing. After ignition flames intensified rapidly prior to suppression.					

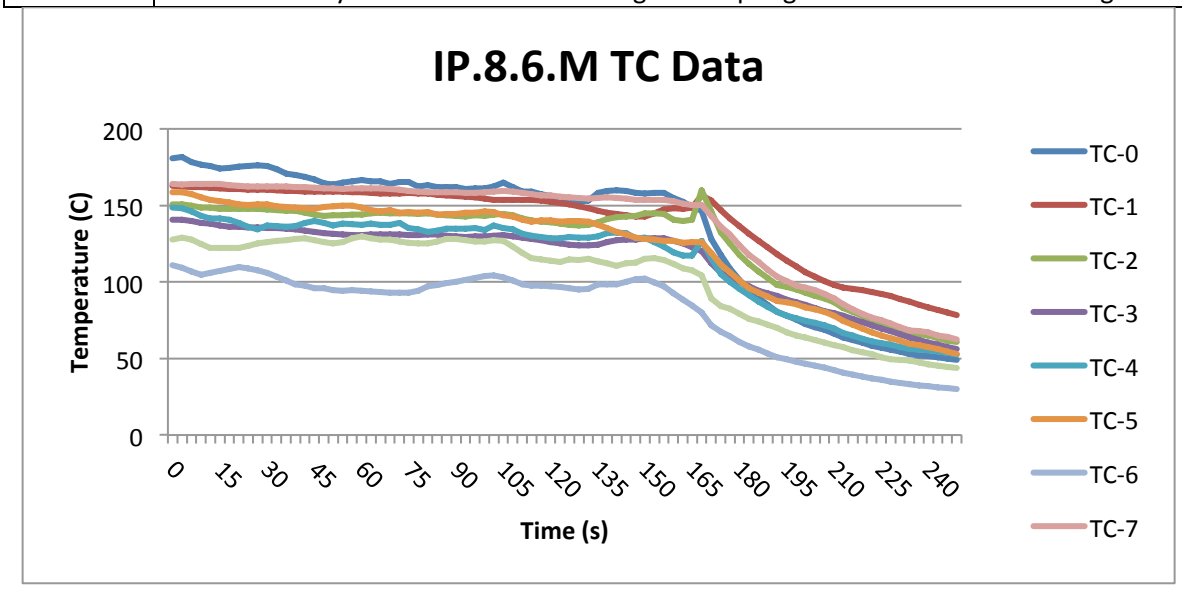


Test Id	Fuel	Diameter	Setting	Time	Ignition	Time to

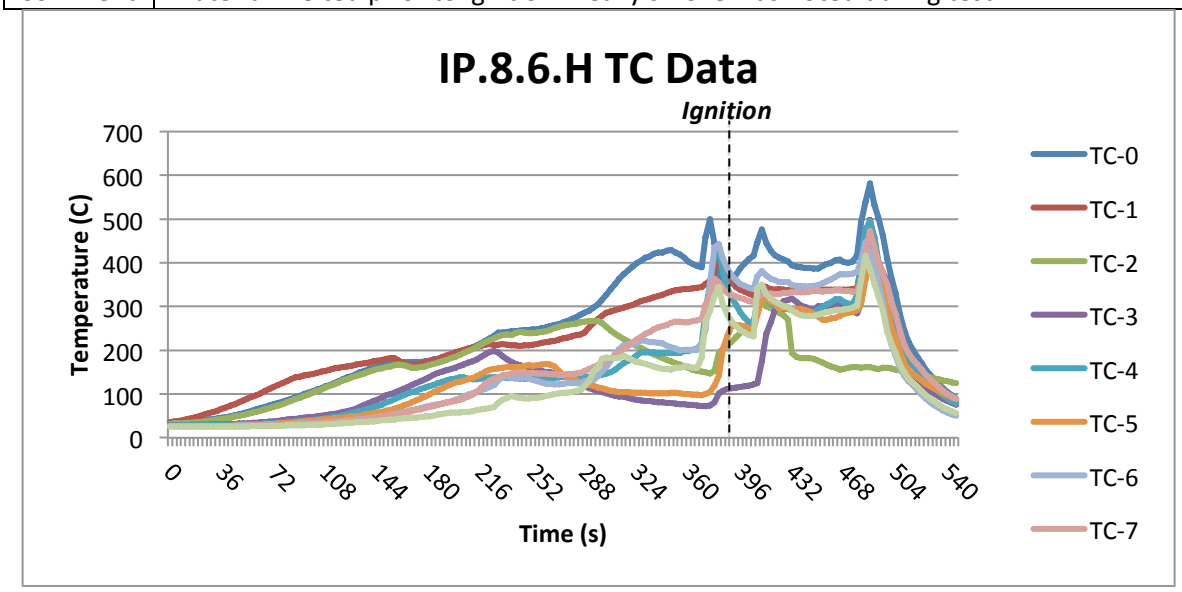
				(min:sec)	(Yes/No)	Ignition (min:sec)
IP.8.6.L	Food Storage Container	6”	Low	No test	No	
Comment	No test was conducted on low setting based on no ignition result from test conducted on medium setting.					

No Test Conducted

Test Id	Fuel	Diameter	Setting	Time (min:sec)	Ignition (Yes/No)	Time to Ignition (min:sec)
IP.8.6.M	Food Storage Container	6”	Medium	20:00	No	
Comment	Material melted and lost mass during test. Temperatures began to decline due to loss of mass. Heavy smoke was noted during test. A pungent odor was noted during test.					



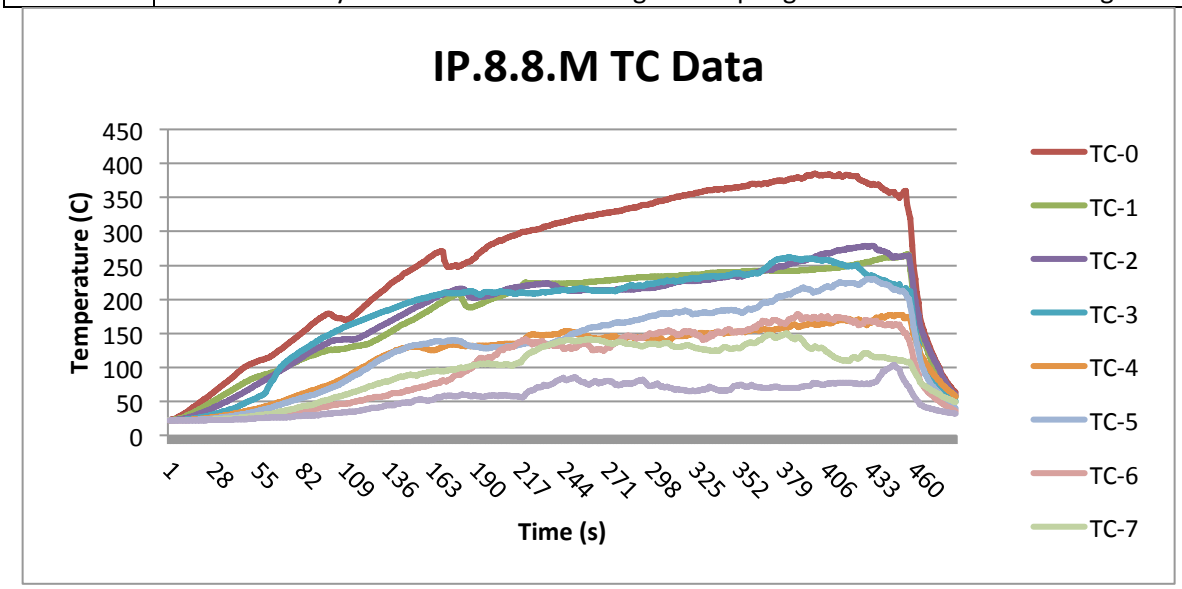
Test Id	Fuel	Diameter	Setting	Time (min:sec)	Ignition (Yes/No)	Time to Ignition (min:sec)
IP.8.6.H	Food Storage Container	6”	High	6:26	Yes	6:26
Comment	Material melted prior to ignition. Heavy smoke was noted during test.					



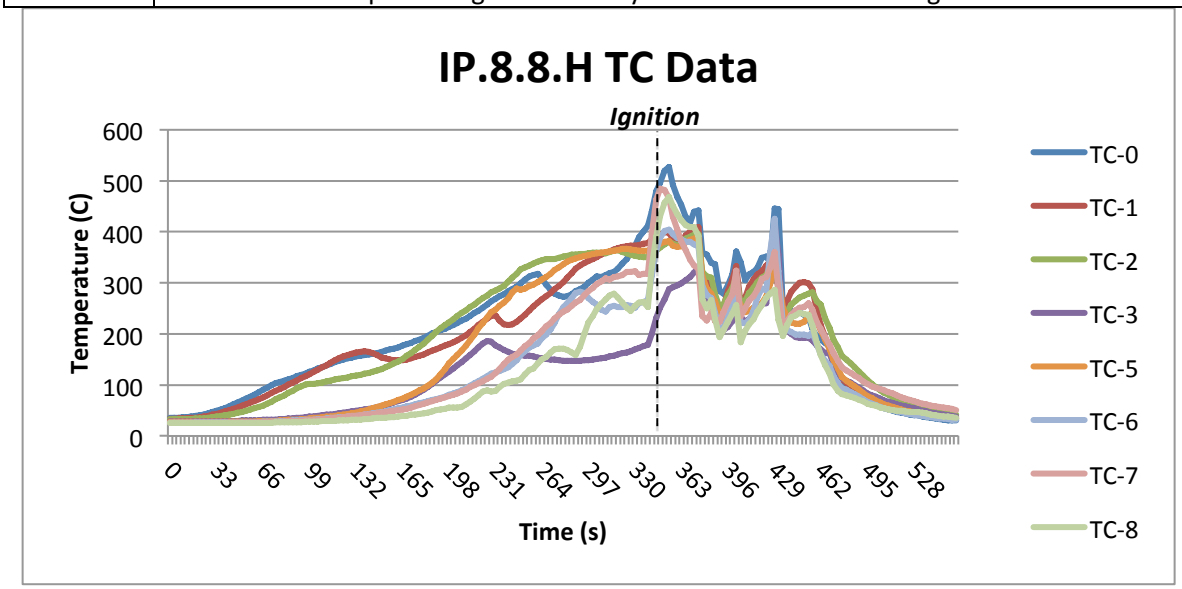
Test Id	Fuel	Diameter	Setting	Time (min:sec)	Ignition (Yes/No)	Time to Ignition (min:sec)
IP.8.8.L	Food Storage Container	8”	Low	No test	No	
Comment	No test was conducted on low setting based on no ignition result from test conducted on medium setting.					

No Test Conducted

Test Id	Fuel	Diameter	Setting	Time (min:sec)	Ignition (Yes/No)	Time to Ignition (min:sec)
IP.8.8.M	Food Storage Container	8”	Medium	6:30	No	
Comment	Material melted and lost mass during test. Temperatures began to decline due to loss of mass. Heavy smoke was noted during test. A pungent odor was noted during test.					



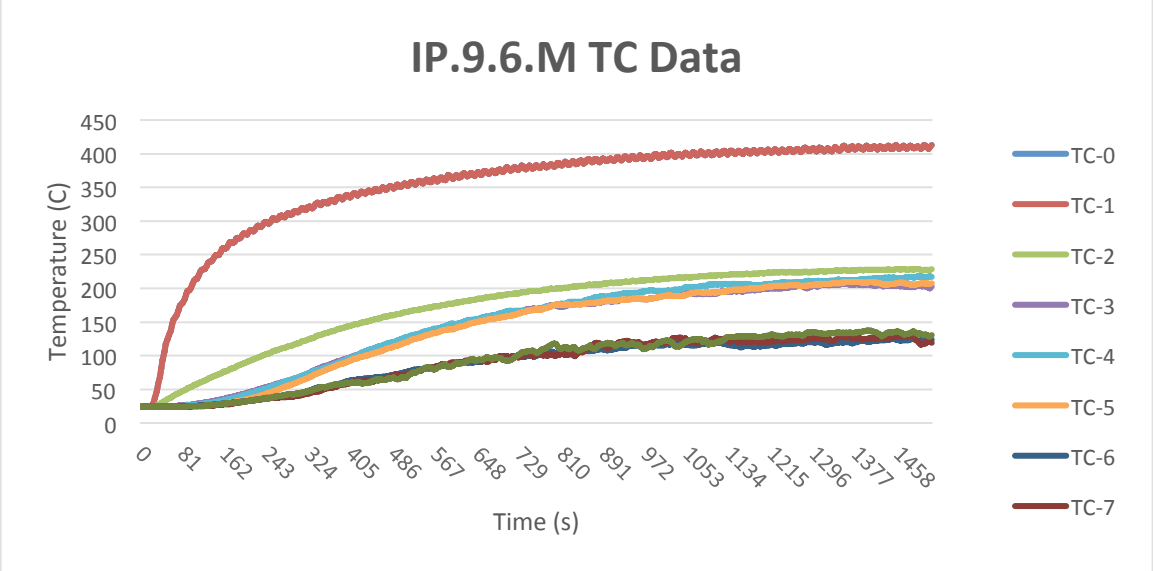
Test Id	Fuel	Diameter	Setting	Time (min:sec)	Ignition (Yes/No)	Time to Ignition (min:sec)
IP.8.8.H	Food Storage Container	8”	High	5:40	Yes	5:40
Comment	Material melted prior to ignition. Heavy smoke was noted during test.					



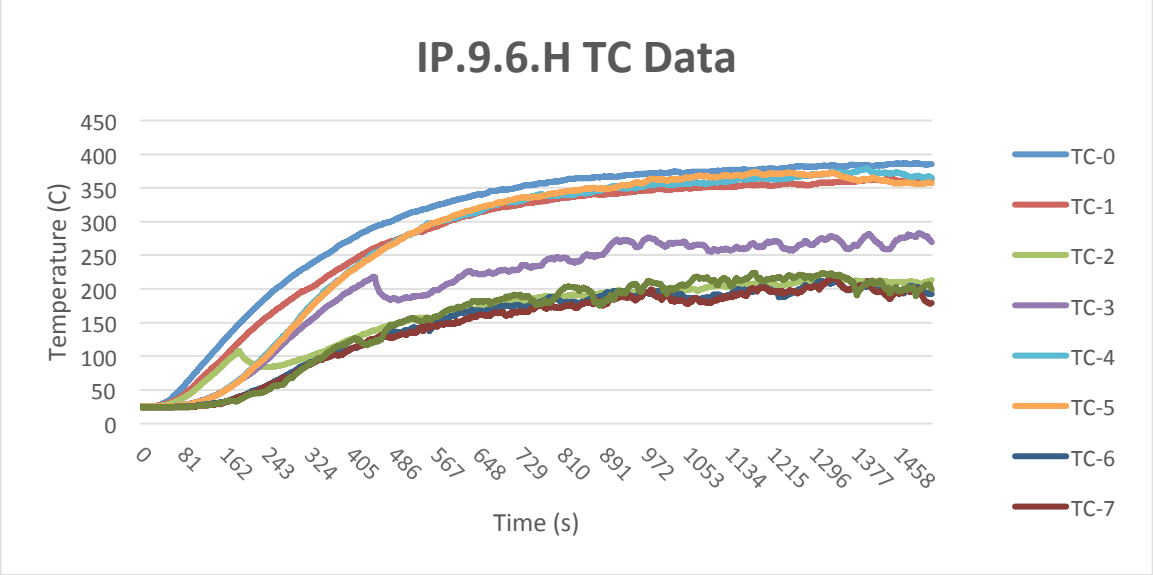
Test Id	Fuel	Diameter	Setting	Time (min:sec)	Ignition (Yes/No)	Time to Ignition (min:sec)
IP.9.6.L	Corn Oil	6”	Low	0:00	No	
Comment	No test conducted based on low based on no ignition from medium setting using 6 inch heating element.					

No Test Conducted

Test Id	Fuel	Diameter	Setting	Time (min:sec)	Ignition (Yes/No)	Time to Ignition (min:sec)
IP.9.6.M	Corn Oil	6”	Medium	25:00	No	
Comment	No signs of ignition.					



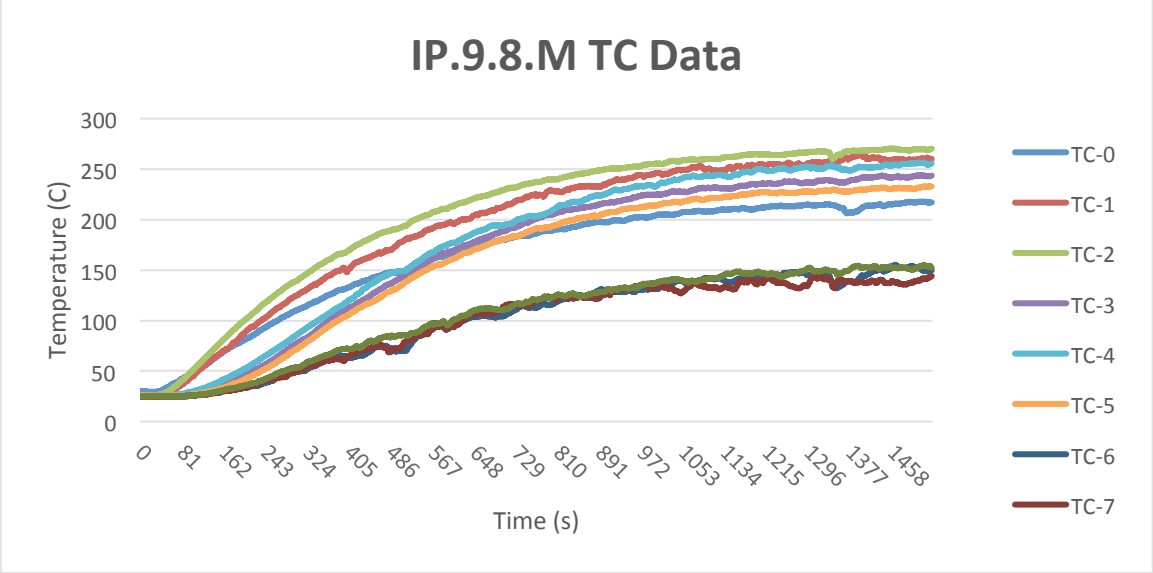
Test Id	Fuel	Diameter	Setting	Time (min:sec)	Ignition (Yes/No)	Time to Ignition (min:sec)
IP.9.6.H	Corn Oil	6”	High	25:00	No	
Comment	Heavy vapor release and smoke release. AIT was reached but no ignition occurred.					



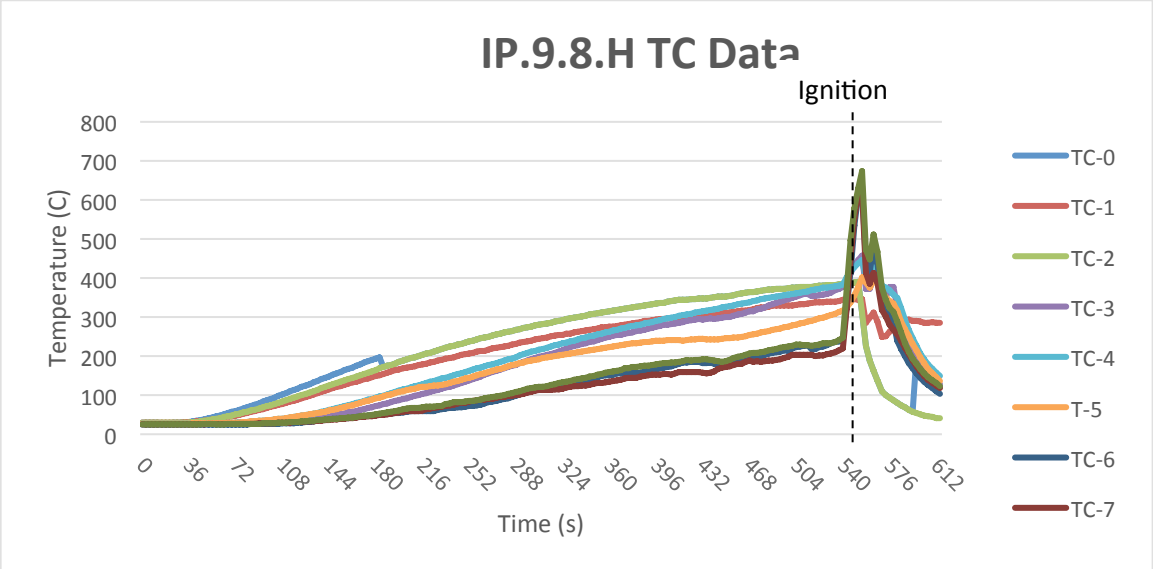
Test Id	Fuel	Diameter	Setting	Time (min:sec)	Ignition (Yes/No)	Time to Ignition (min:sec)
IP.9.8.L	Corn Oil	8”	Low	0:00	No	
Comment	No test conducted on low setting based on no ignition from both medium and high settings using 6 inch heating element.					

No Test Conducted

Test Id	Fuel	Diameter	Setting	Time (min:sec)	Ignition (Yes/No)	Time to Ignition (min:sec)
IP.9.8.M	Corn Oil	8”	Medium	25:00	No	
Comment	Potential signs of ignition.					

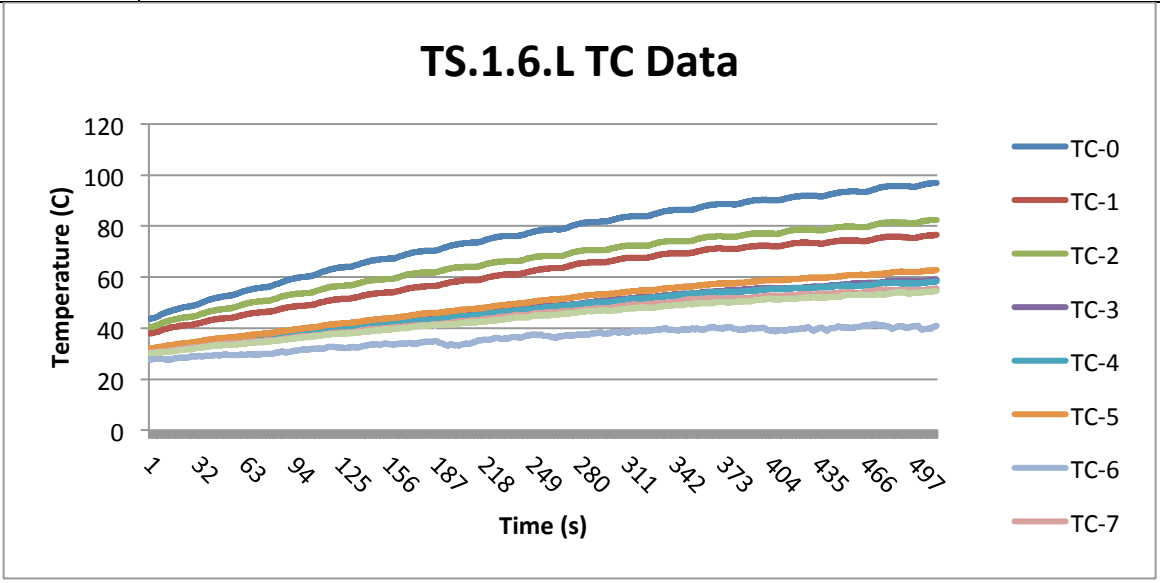


Test Id	Fuel	Diameter	Setting	Time (min:sec)	Ignition (Yes/No)	Time to Ignition (min:sec)
IP.9.8.H	Corn Oil	8”	High	8:45	No	8:45
Comment	Heavy vapor and smoke release was noted prior to ignition.					

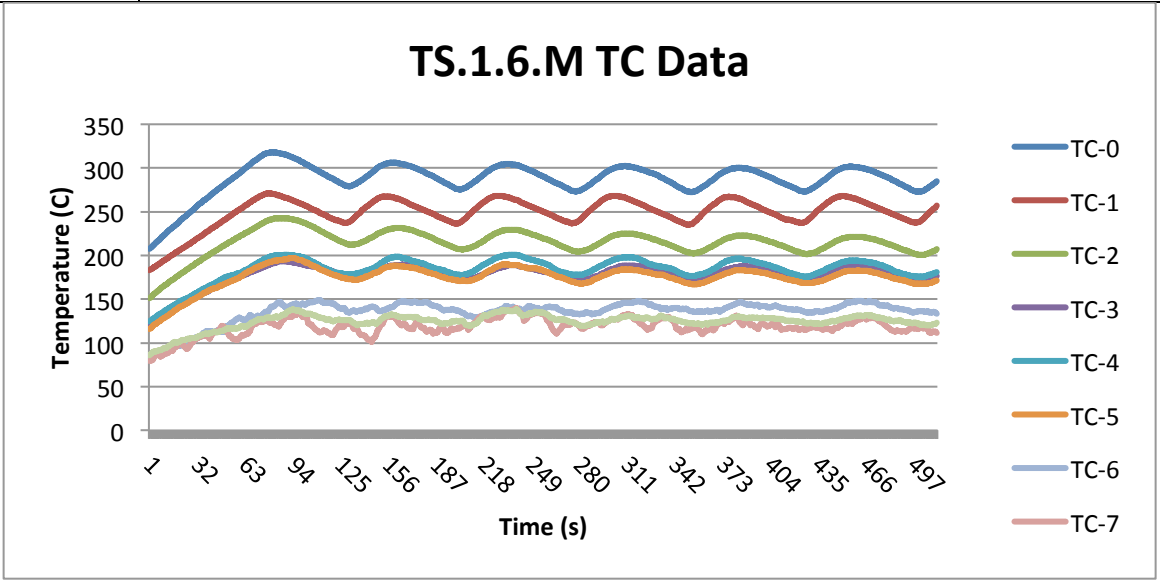


Appendix G- Electric Coil Cooktop Range with Temperature Sensor Plate

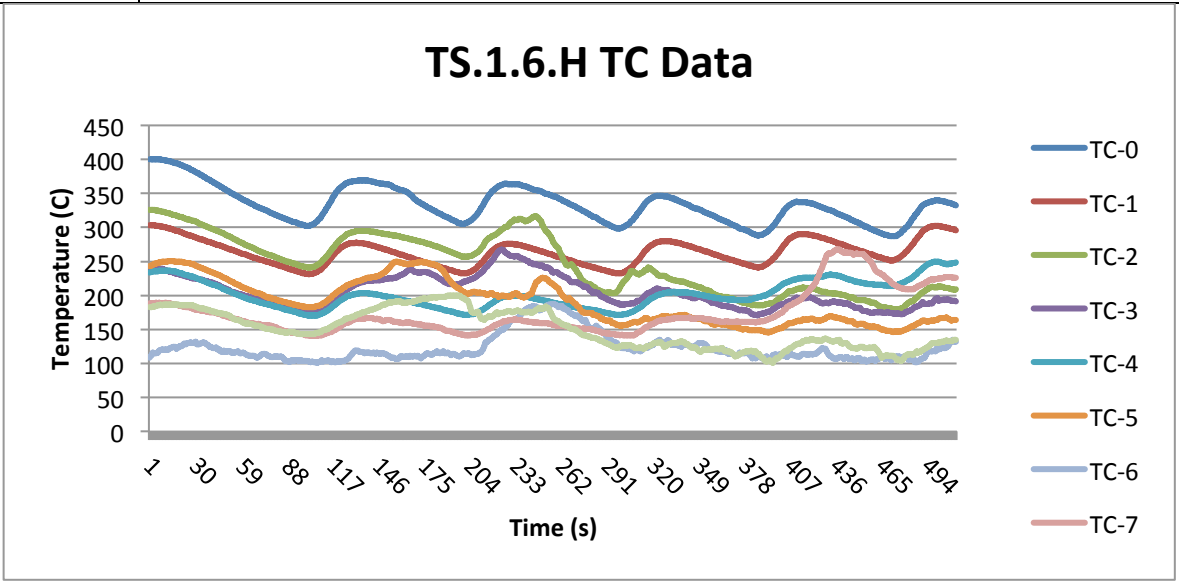
	Fuel	Diameter	Setting	Time (min:sec)	Ignition (Yes/No)	Time to Ignition (min:sec)
TS.1.6.L	Cardboard	6”	Low	30:00	No	
Comment	No signs of ignition. Material was only warm to the touch following the test.					



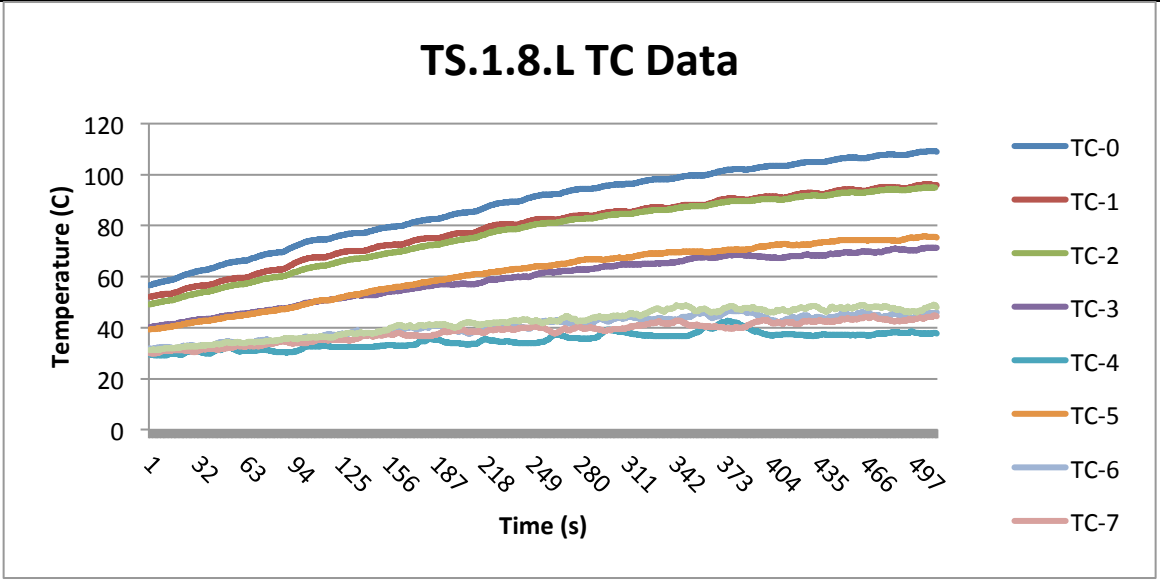
Test Id	Fuel	Diameter	Setting	Time (min:sec)	Ignition (Yes/No)	Time to Ignition (min:sec)
TS.1.6.M	Cardboard	6”	Medium	30:00	No	
Comment	Some mass loss due to smoldering combustion. A significant amount of smoke was reported during test.					



Test Id	Fuel	Diameter	Setting	Time (min:sec)	Ignition (Yes/No)	Time to Ignition (min:sec)
TS.1.6.H	Cardboard	6”	High	30:00	No	
Comment	Test stopped after 30 Minutes due to complete loss of mass from smoldering combustion. A significant amount of smoke was reported during test.					

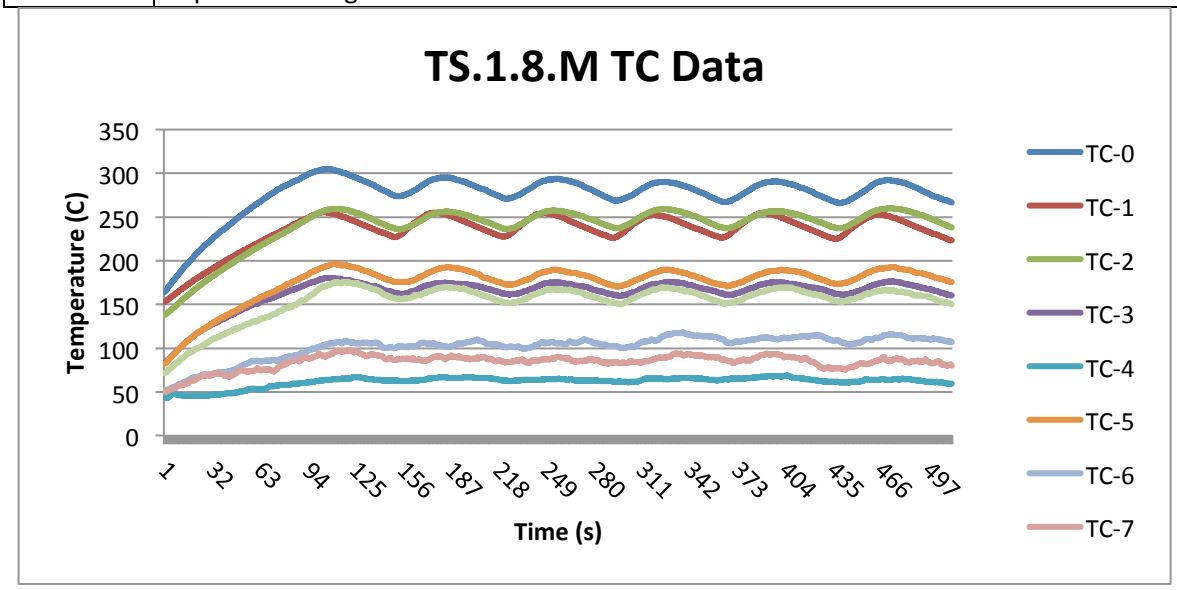


Test Id	Fuel	Diameter	Setting	Time (min:sec)	Ignition (Yes/No)	Time to Ignition (min:sec)
TS.1.8.L	Cardboard	8”	Low	30:00	No	
Comment	No signs of ignition. Material was only warm to the touch following the test.					

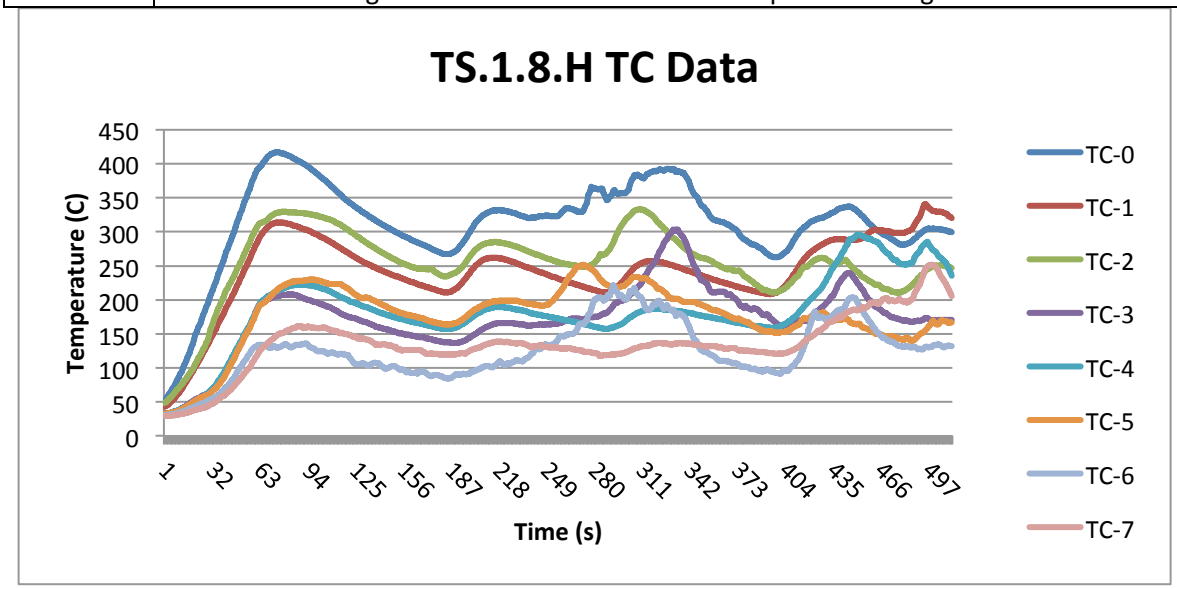


Test Id	Fuel	Diameter	Setting	Time	Ignition	Time to

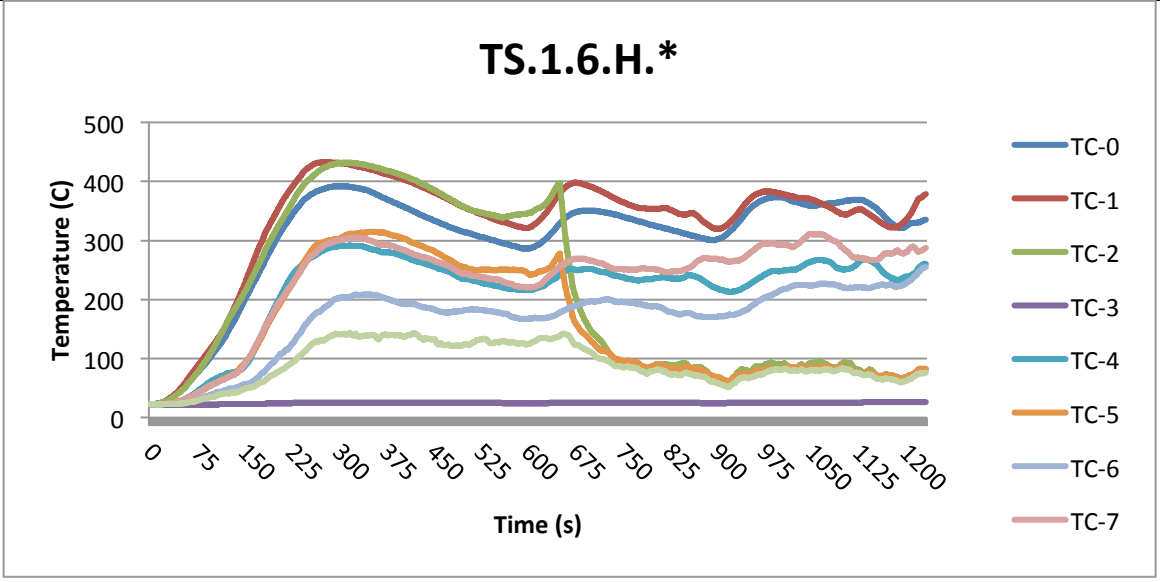
				(min:sec)	(Yes/No)	Ignition (min:sec)
TS.1.8.M	Cardboard	8”	Medium	30:00	No	
Comment	Some mass loss due to smoldering combustion. A significant amount of smoke was reported during test.					



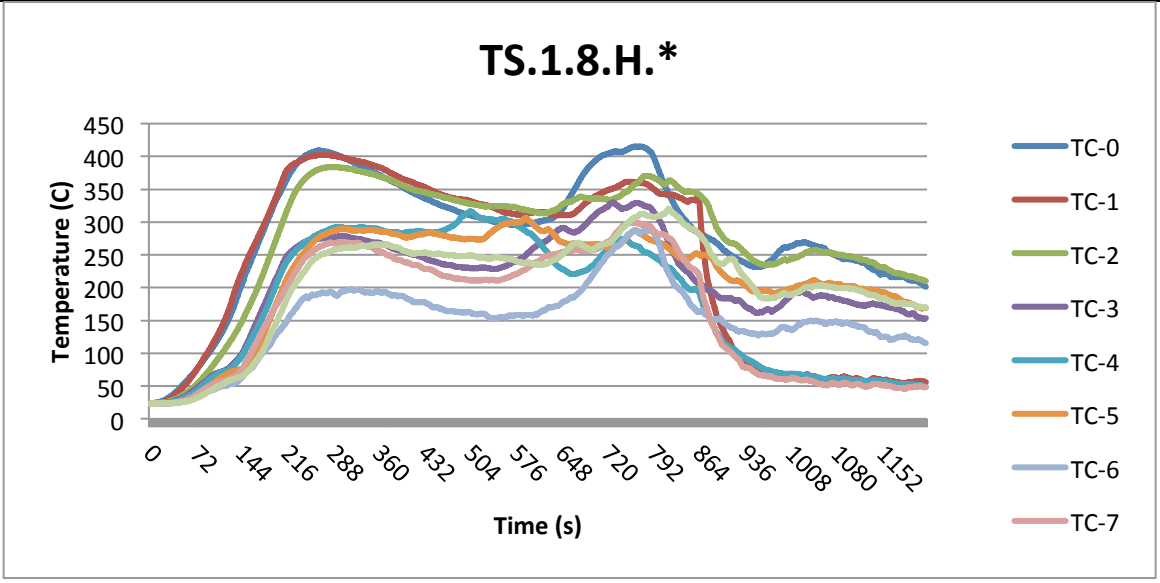
Test Id	Fuel	Diameter	Setting	Time (min:sec)	Ignition (Yes/No)	Time to Ignition (min:sec)
TS.1.8.H	Cardboard	8”	High	26:00	No	
Comment	Test stopped after 26 Minutes due to complete loss of mass from smoldering combustion. A significant amount of smoke was reported during test.					



Test Id	Fuel	Diameter	Setting	Time (min:sec)	Ignition (Yes/No)	Time to Ignition (min:sec)
TS.1.6.H.*	Cardboard	6”	High	20:00	No	
Comment	Test stopped after 20 Minutes due to majority of mass loss from smoldering combustion. A significant amount of smoke was reported during test.					



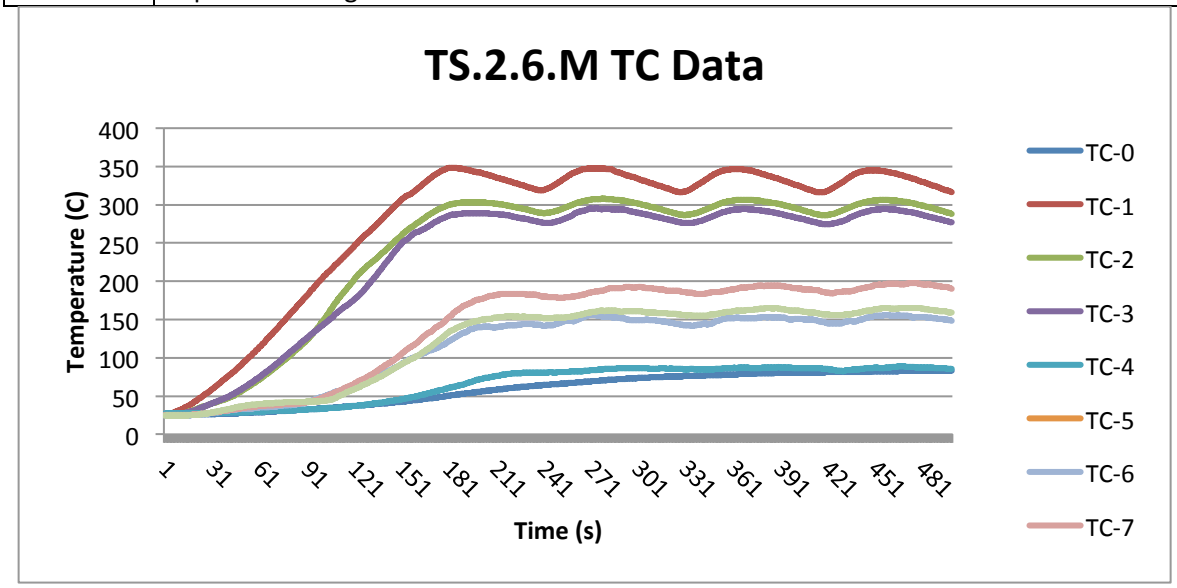
Test Id	Fuel	Diameter	Setting	Time (min:sec)	Ignition (Yes/No)	Time to Ignition (min:sec)
TS.1.8.H.*	Cardboard	8”	High	20:00	No	
Comment	Test stopped after 20 Minutes due to majority of mass loss from smoldering combustion. A significant amount of smoke was reported during test.					



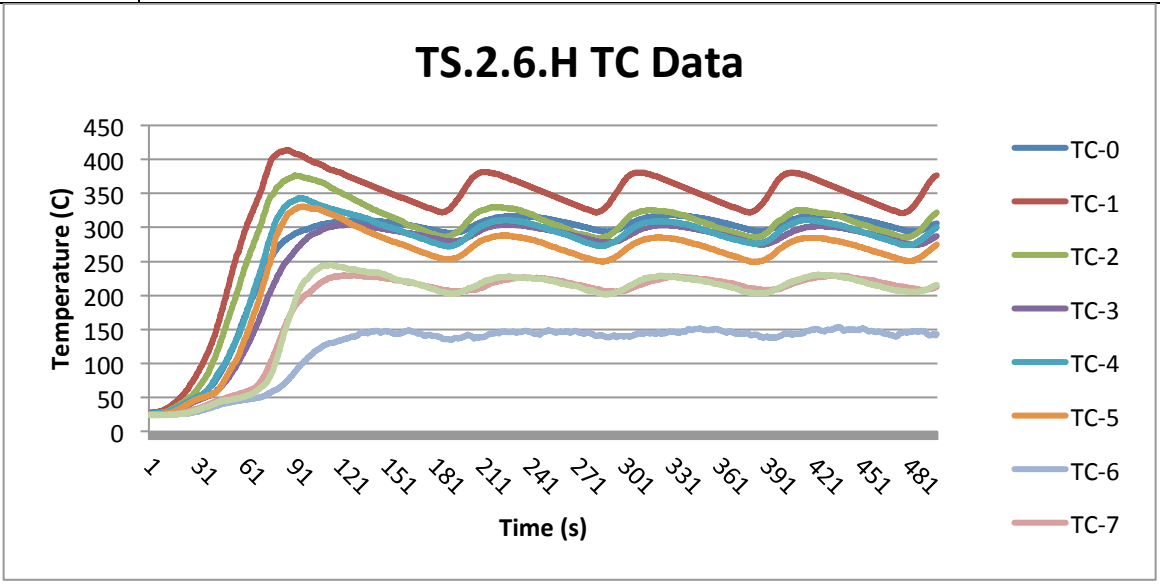
Test Id	Fuel	Diameter	Setting	Time (min:sec)	Ignition (Yes/No)	Time to Ignition (min:sec)
TS.2.6.L	Cotton	6”	Low	00:00	No	
Comment	No test was conducted based on no ignition from both medium and high setting test.					

No Test Conducted

Test Id	Fuel	Diameter	Setting	Time (min:sec)	Ignition (Yes/No)	Time to Ignition (min:sec)
TS.2.6.M	Cotton	6”	Medium	25:00	No	
Comment	Some mass loss due to smoldering combustion. A significant amount of smoke was reported during test.					



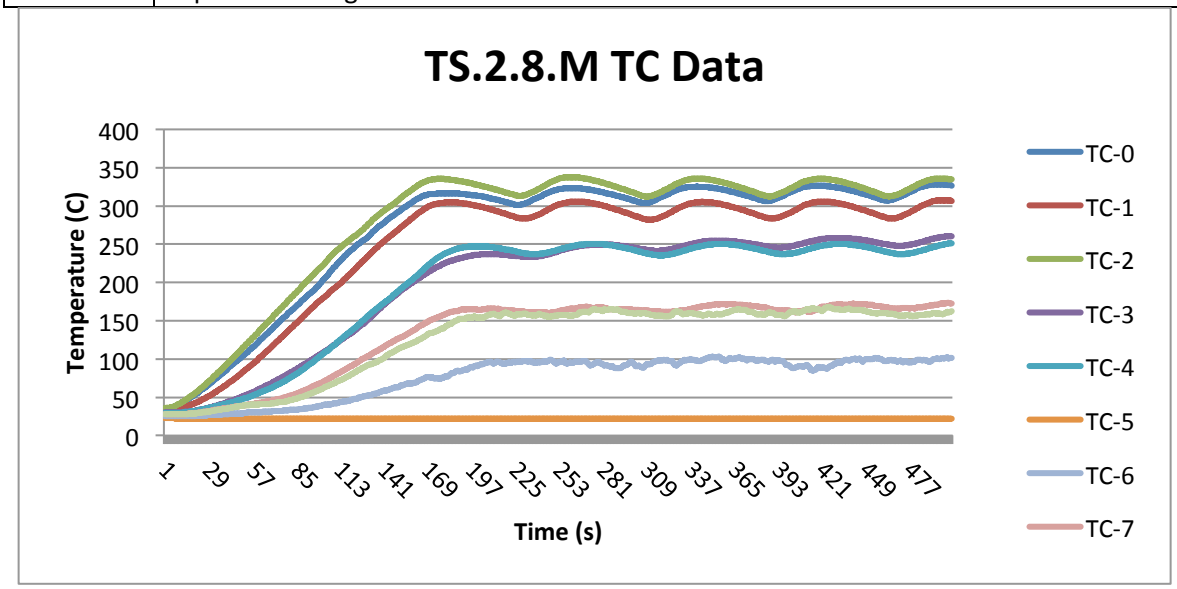
Test Id	Fuel	Diameter	Setting	Time (min:sec)	Ignition (Yes/No)	Time to Ignition (min:sec)
TS.2.6.H	Cotton	6”	High	25:00	No	
Comment	Significant amount of mass loss from smoldering combustion. A significant amount of smoke was reported during test.					



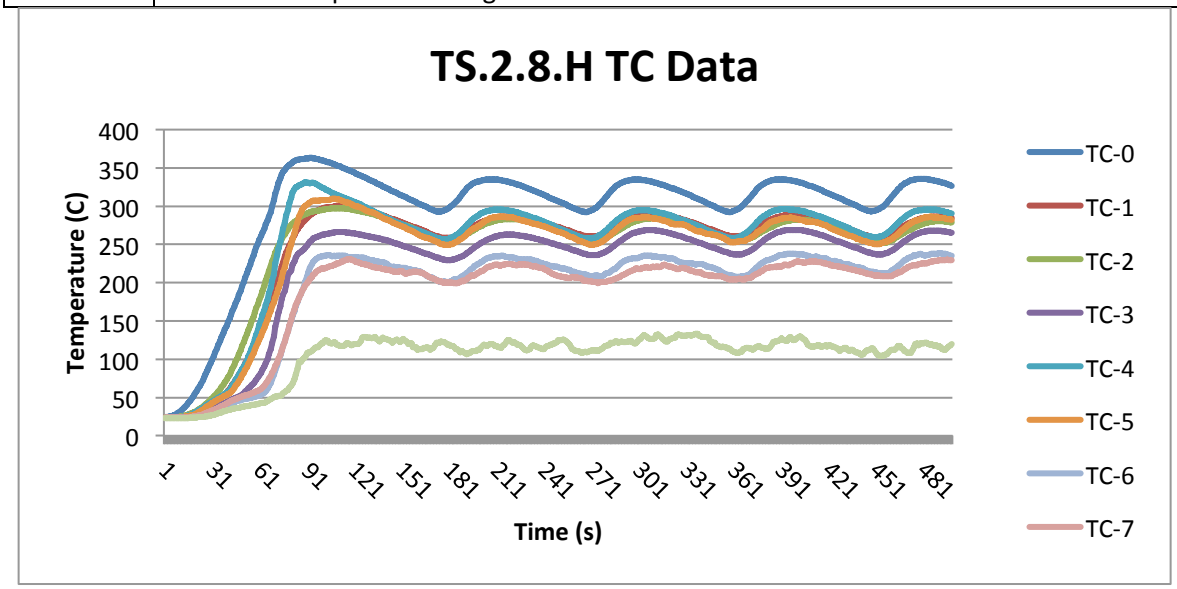
Test Id	Fuel	Diameter	Setting	Time (min:sec)	Ignition (Yes/No)	Time to Ignition (min:sec)
TS.2.8.L	Cotton	8”	Low		No	
Comment	No test was conducted based on no ignition from both medium and high setting test.					

No Test Conducted

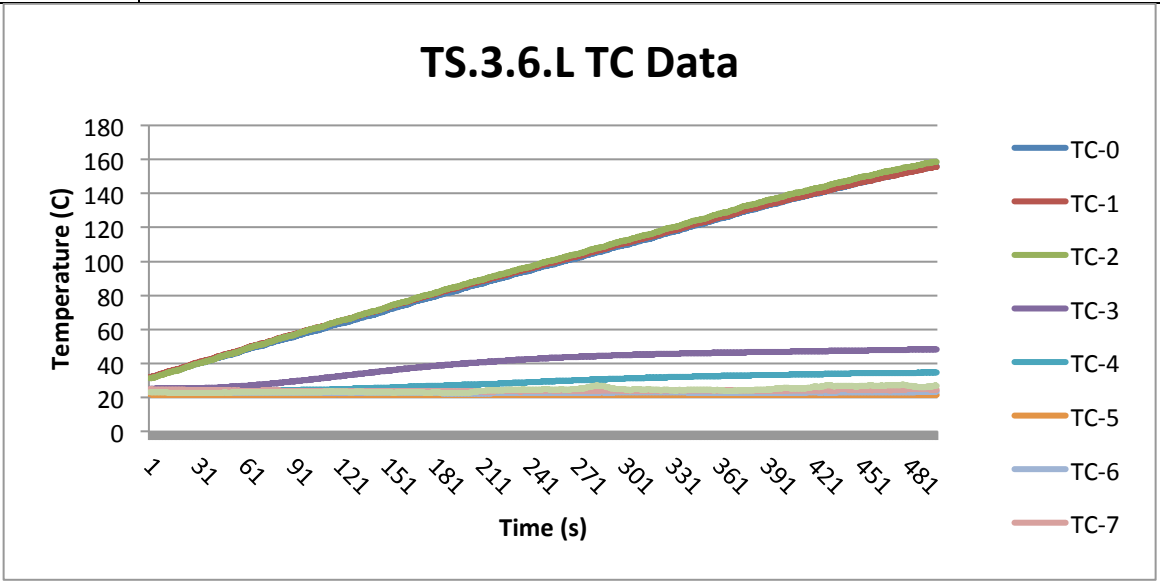
Test Id	Fuel	Diameter	Setting	Time (min:sec)	Ignition (Yes/No)	Time to Ignition (min:sec)
TS.2.8.M	Cotton	8”	Medium		No	
Comment	Some mass loss due to smoldering combustion. A significant amount of smoke was reported during test.					



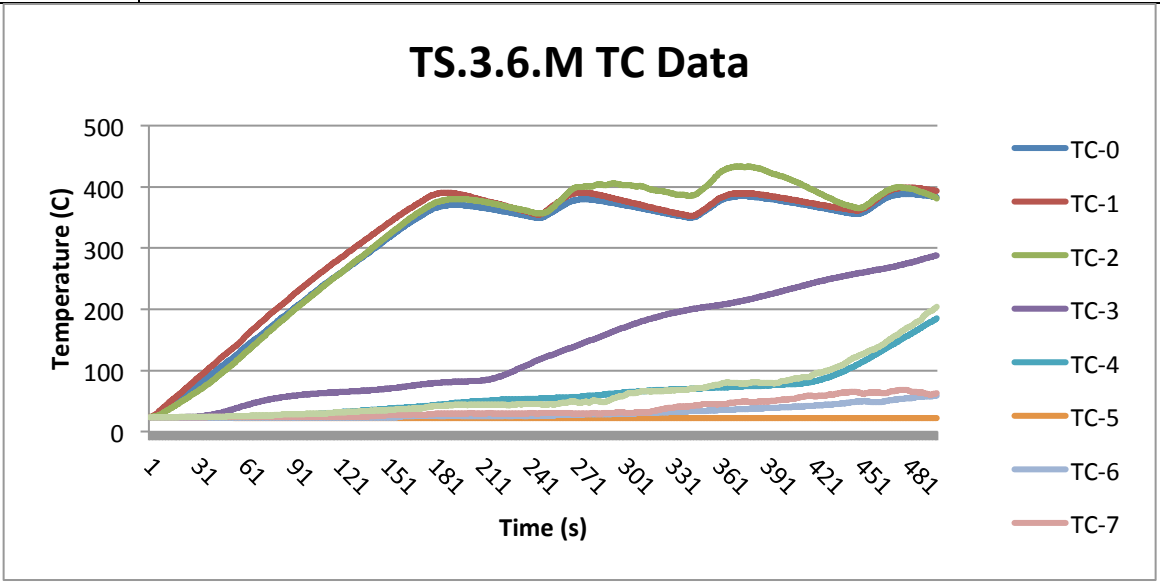
Test Id	Fuel	Diameter	Setting	Time (min:sec)	Ignition (Yes/No)	Time to Ignition (min:sec)
TS.2.8.H	Cotton	8”	High	25:00	No	
Comment	Significant amount of mass loss from smoldering combustion. A significant amount of smoke was reported during test.					



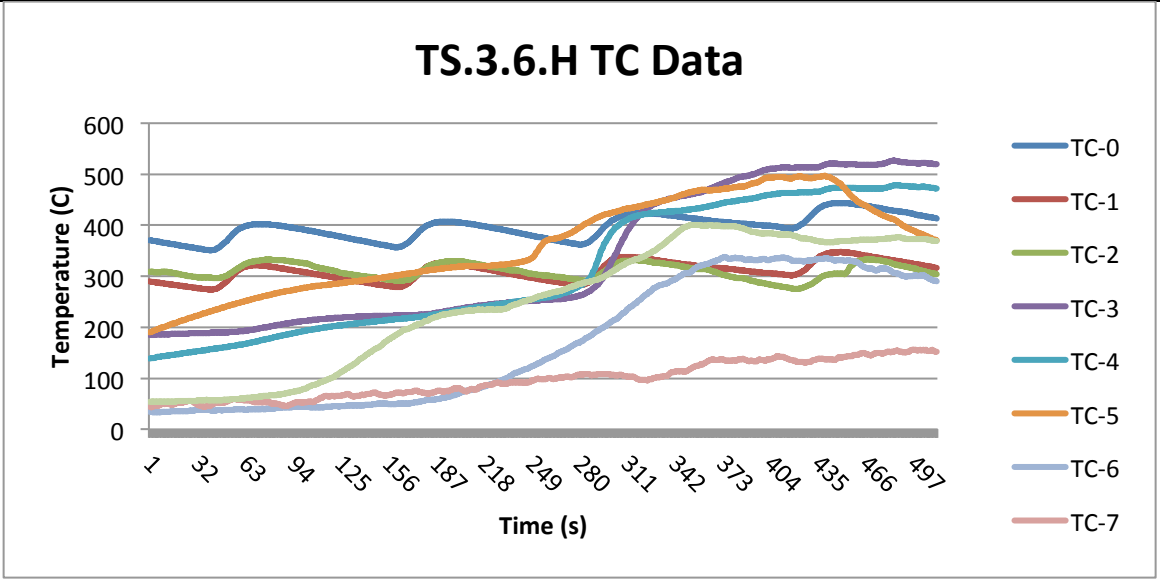
Test Id	Fuel	Diameter	Setting	Time (min:sec)	Ignition (Yes/No)	Time to Ignition (min:sec)
TS.3.6.L	Paper Towel	6”	Low	25:00	No	
Comment	No signs of ignition. Material was only warm to the touch following the test.					



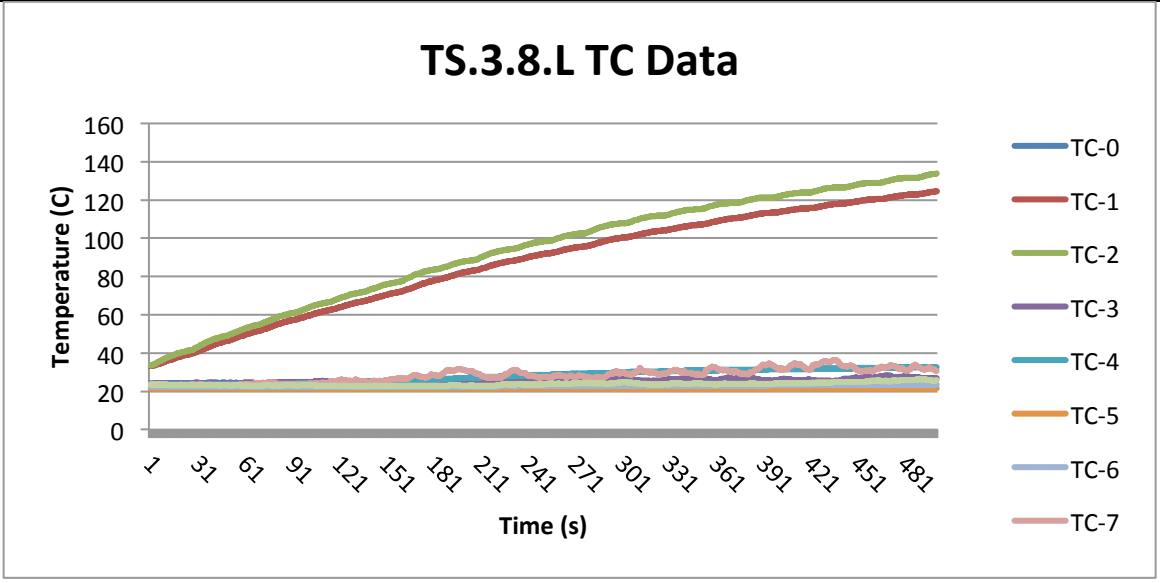
Test Id	Fuel	Diameter	Setting	Time (min:sec)	Ignition (Yes/No)	Time to Ignition (min:sec)
TS.3.6.M	Paper Towel	6”	Medium	25:00	No	
Comment	Some mass loss due to smoldering combustion. A significant amount of smoke was reported during test.					



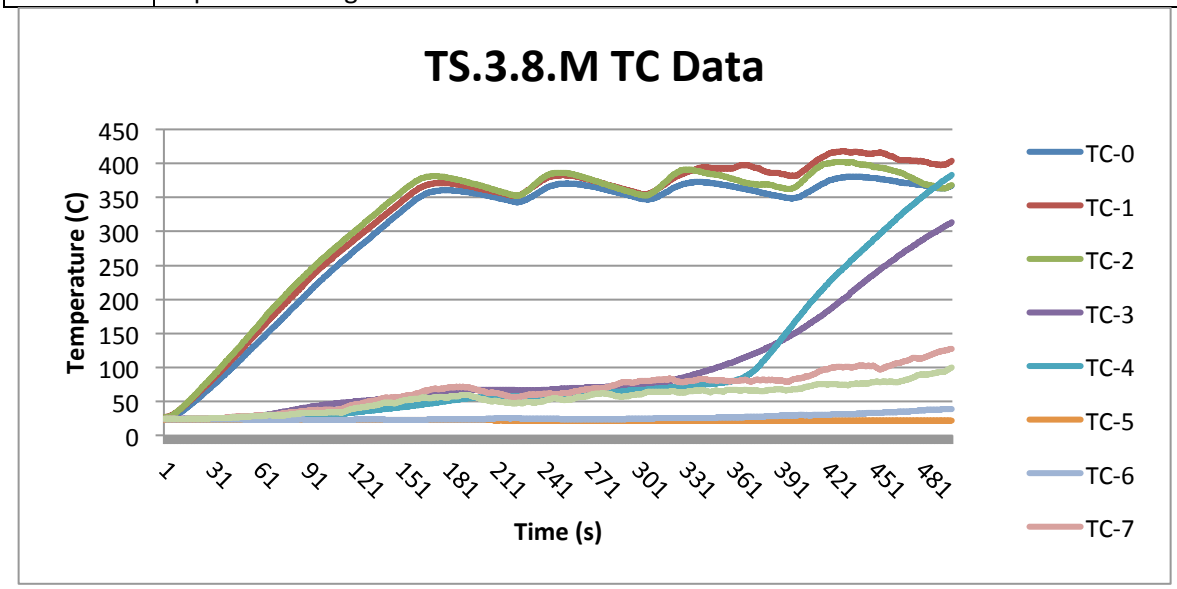
Test Id	Fuel	Diameter	Setting	Time (min:sec)	Ignition (Yes/No)	Time to Ignition (min:sec)
TS.3.6.H	Paper Towel	6”	High	40:00	No	
Comment	Significant amount of mass loss from smoldering combustion. A significant amount of smoke was reported during test. Material ignited when removing from heating element after completion of test.					



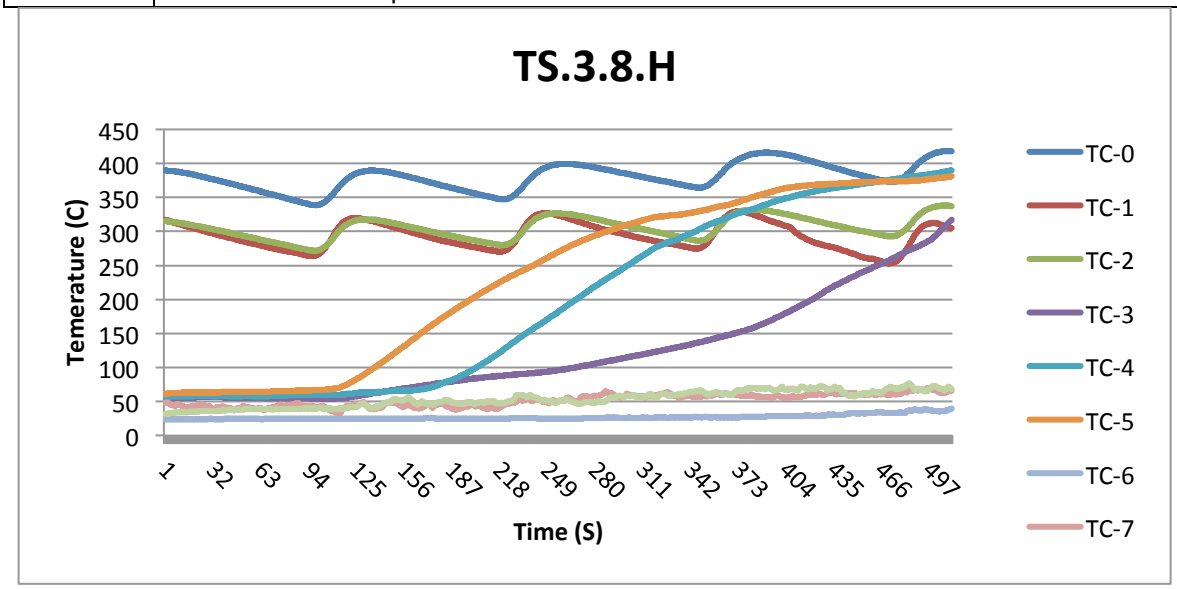
Test Id	Fuel	Diameter	Setting	Time (min:sec)	Ignition (Yes/No)	Time to Ignition (min:sec)
TS.3.8.L	Paper Towel	8”	Low	25:00	No	
Comment	No signs of ignition. Material was only warm to the touch following the test.					



Test Id	Fuel	Diameter	Setting	Time (min:sec)	Ignition (Yes/No)	Time to Ignition (min:sec)
TS.3.8.M	Paper Towel	8”	Medium	25:00	No	
Comment	Some mass loss due to smoldering combustion. A significant amount of smoke was reported during test.					



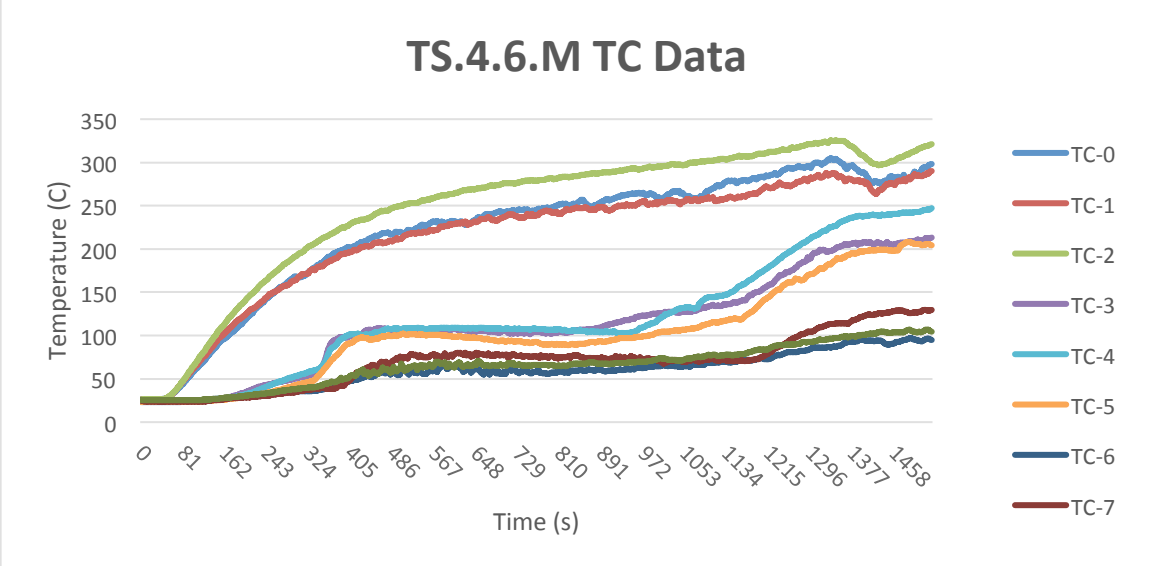
Test Id	Fuel	Diameter	Setting	Time (min:sec)	Ignition (Yes/No)	Time to Ignition (min:sec)
TS.3.8.H	Paper Towel	8”	High	40:00	No	
Comment	Significant amount of mass loss from smoldering combustion. A significant amount of smoke was reported during test. Material ignited when removing from heating element after completion of test.					



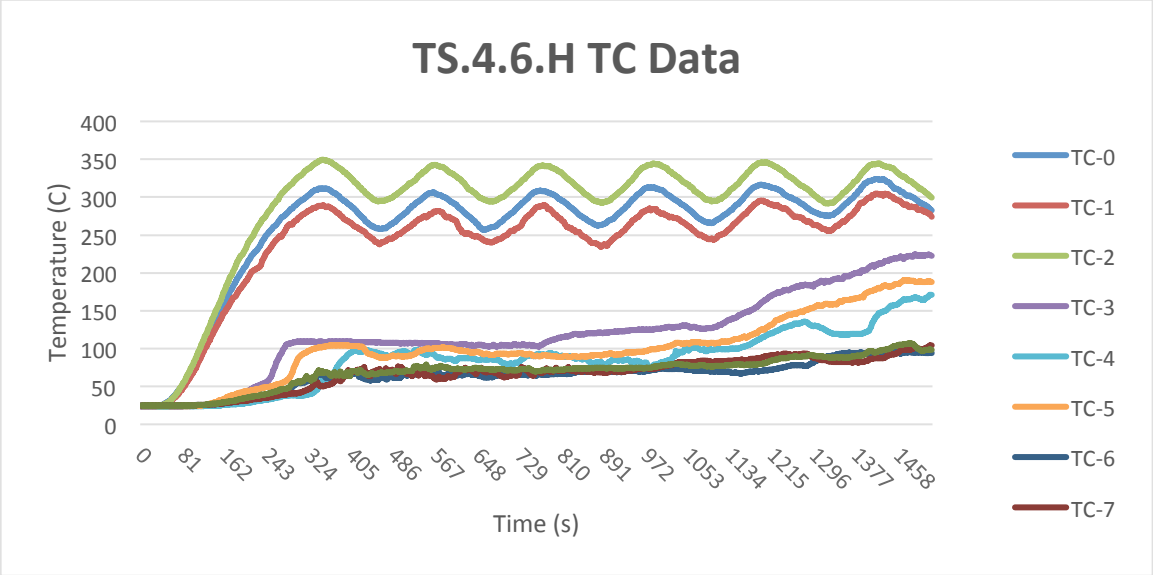
Test Id	Fuel	Diameter	Setting	Time (min:sec)	Ignition (Yes/No)	Time to Ignition (min:sec)
TS.4.6.L	Canola Oil	6”	Low	00:00	No	
Comment	No test was conducted based on no ignition from both medium and high setting test.					

No Test Conducted

Test Id	Fuel	Diameter	Setting	Time (min:sec)	Ignition (Yes/No)	Time to Ignition (min:sec)
TS.4.6.M	Canola Oil	6”	Medium	25:00	No	
Comment	No signs of ignition.					



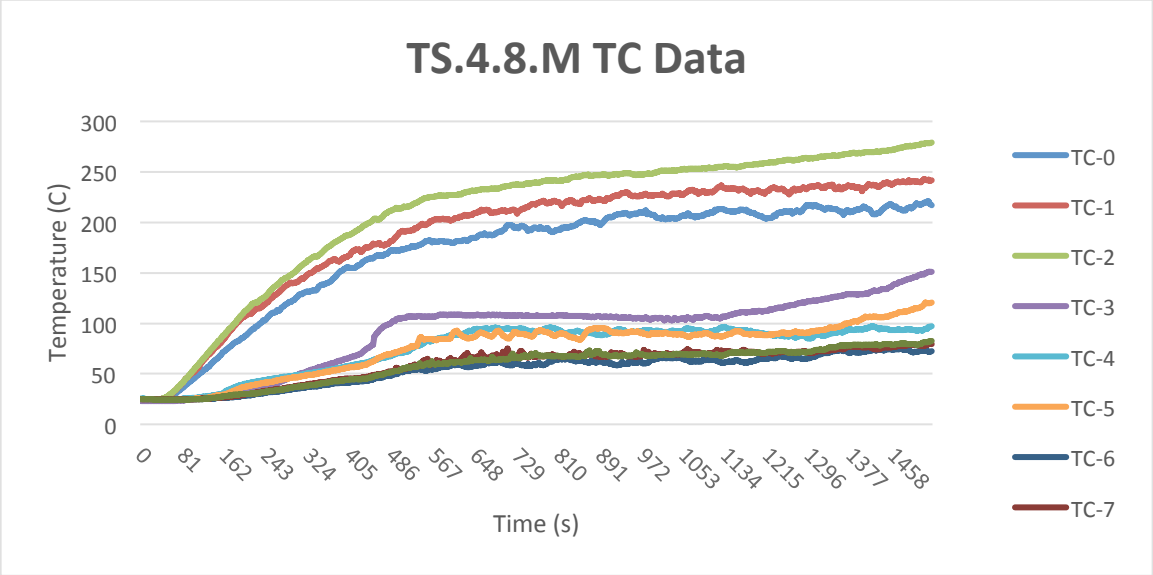
Test Id	Fuel	Diameter	Setting	Time (min:sec)	Ignition (Yes/No)	Time to Ignition (min:sec)
TS.4.6.H	Canola Oil	6”	High	20:00	No	
Comment	No signs of ignition.					



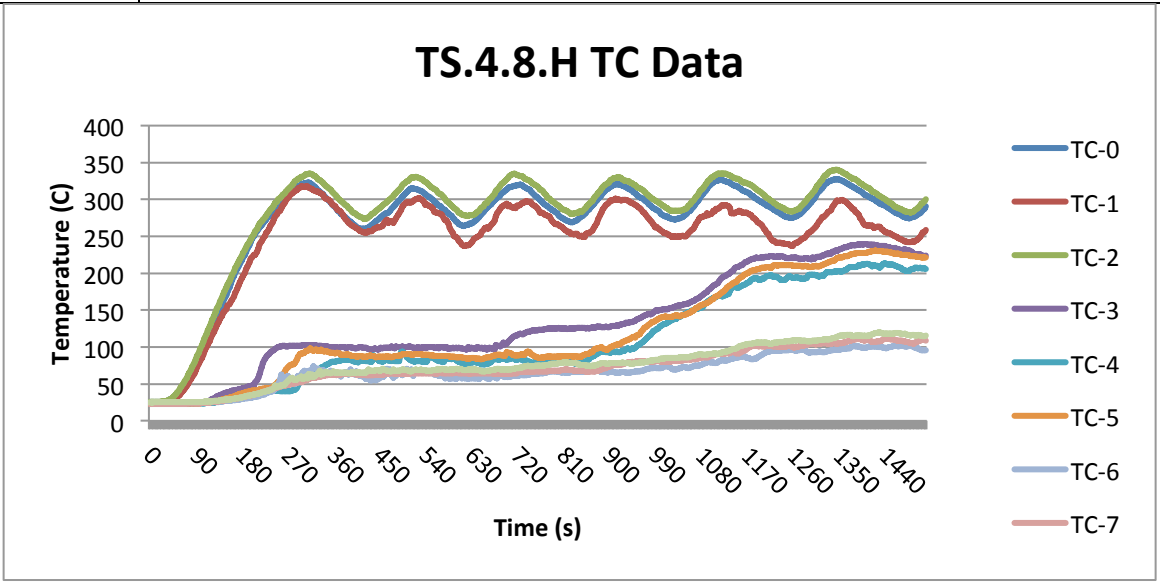
Test Id	Fuel	Diameter	Setting	Time (min:sec)	Ignition (Yes/No)	Time to Ignition (min:sec)
TS.4.8.L	Canola Oil	8”	Low	00:00	No	
Comment	No test was conducted based on no ignition from both medium and high setting test.					

No Test Conducted

Test Id	Fuel	Diameter	Setting	Time (min:sec)	Ignition (Yes/No)	Time to Ignition (min:sec)
TS.4.8.M	Canola Oil	8”	Medium	25:00	No	
Comment	No signs of ignition.					



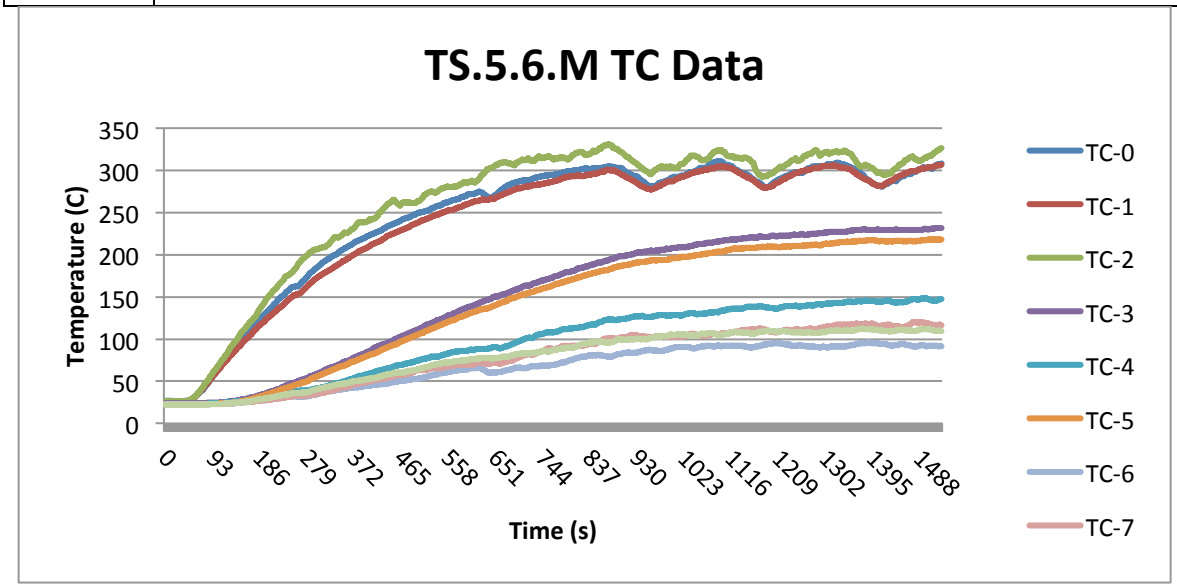
Test Id	Fuel	Diameter	Setting	Time (min:sec)	Ignition (Yes/No)	Time to Ignition (min:sec)
TS.4.8.H	Canola Oil	8”	High	25:00	No	
Comment	No signs of ignition.					



Test Id	Fuel	Diameter	Setting	Time (min:sec)	Ignition (Yes/No)	Time to Ignition (min:sec)
TS.5.6.L	Vegetable Oil	6”	Low	00:00	No	
Comment	No test was conducted based on no ignition from both medium and high setting test.					

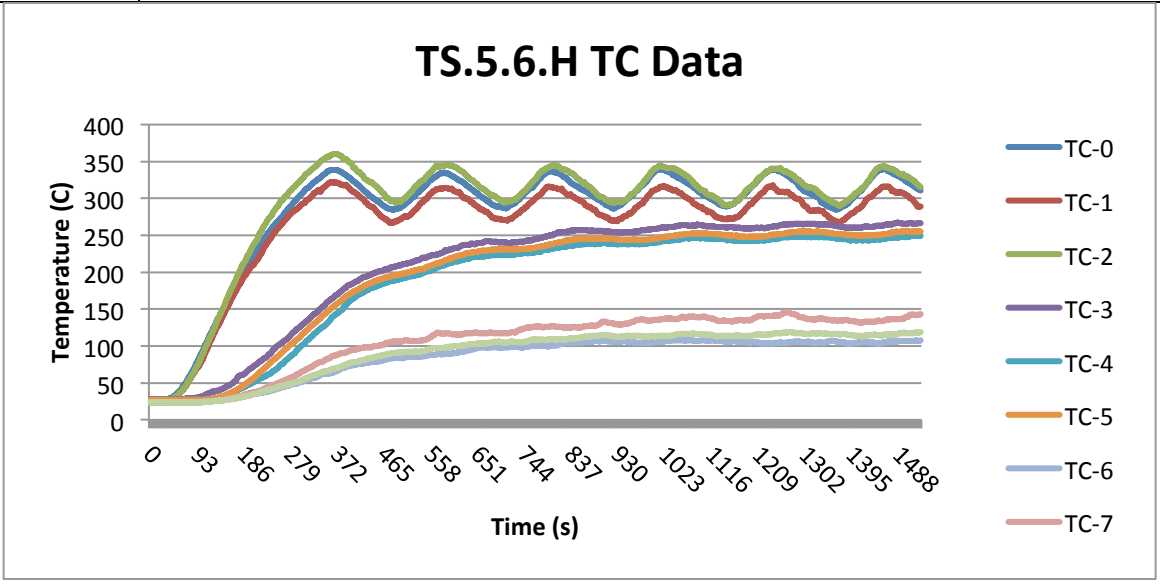
No Test Conducted

Test Id	Fuel	Diameter	Setting	Time (min:sec)	Ignition (Yes/No)	Time to Ignition (min:sec)
TS.5.6.M	Vegetable Oil	6”	Medium	25:00	No	
Comment	No signs of ignition.					



Test Id	Fuel	Diameter	Setting	Time	Ignition	Time to

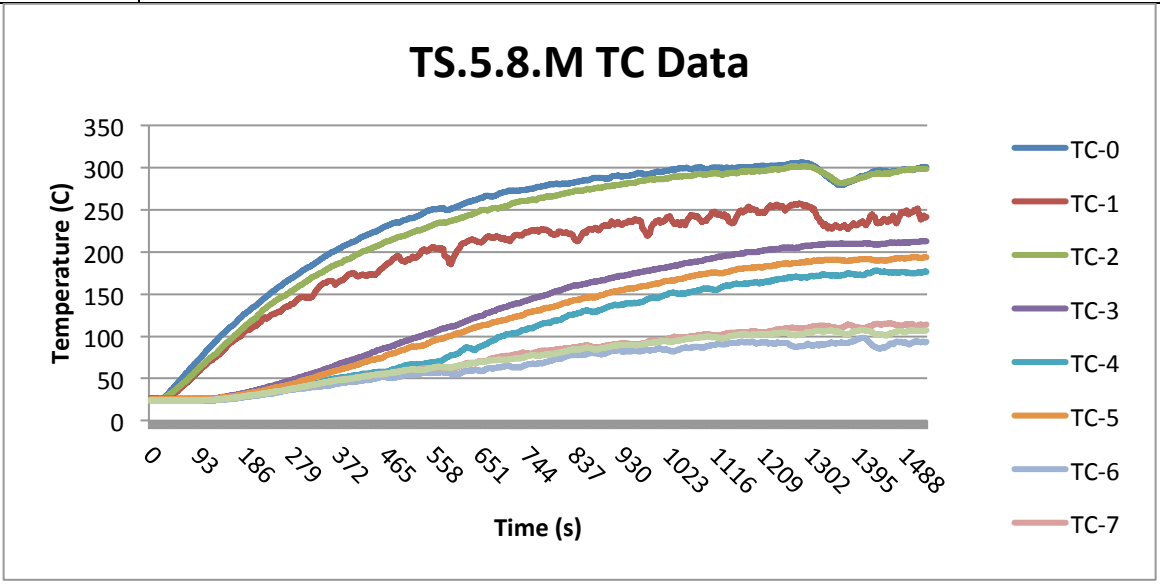
				(min:sec)	(Yes/No)	Ignition (min:sec)
TS.5.6.H	Vegetable Oil	6”	High	25:00	No	
Comment	No signs of ignition.					



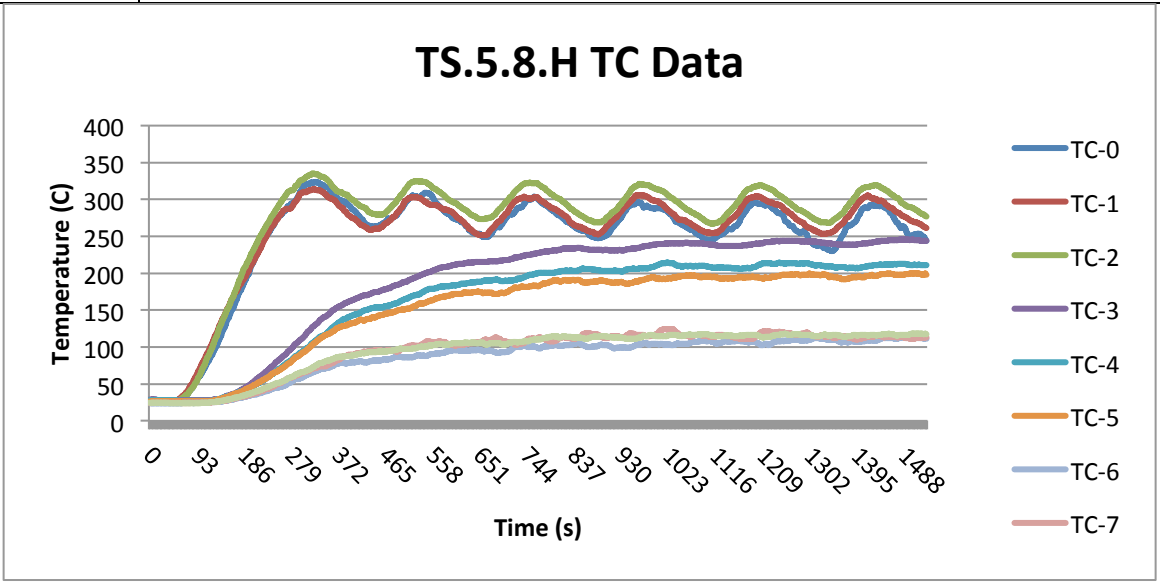
Test Id	Fuel	Diameter	Setting	Time (min:sec)	Ignition (Yes/No)	Time to Ignition (min:sec)
TS.5.8.L	Vegetable Oil	8”	Low	00:00	No	
Comment	No test was conducted based on no ignition from both medium and high setting test.					

No Test Conducted

Test Id	Fuel	Diameter	Setting	Time (min:sec)	Ignition (Yes/No)	Time to Ignition (min:sec)
TS.5.8.M	Vegetable Oil	8”	Medium	25:00	No	
Comment	No signs of ignition.					



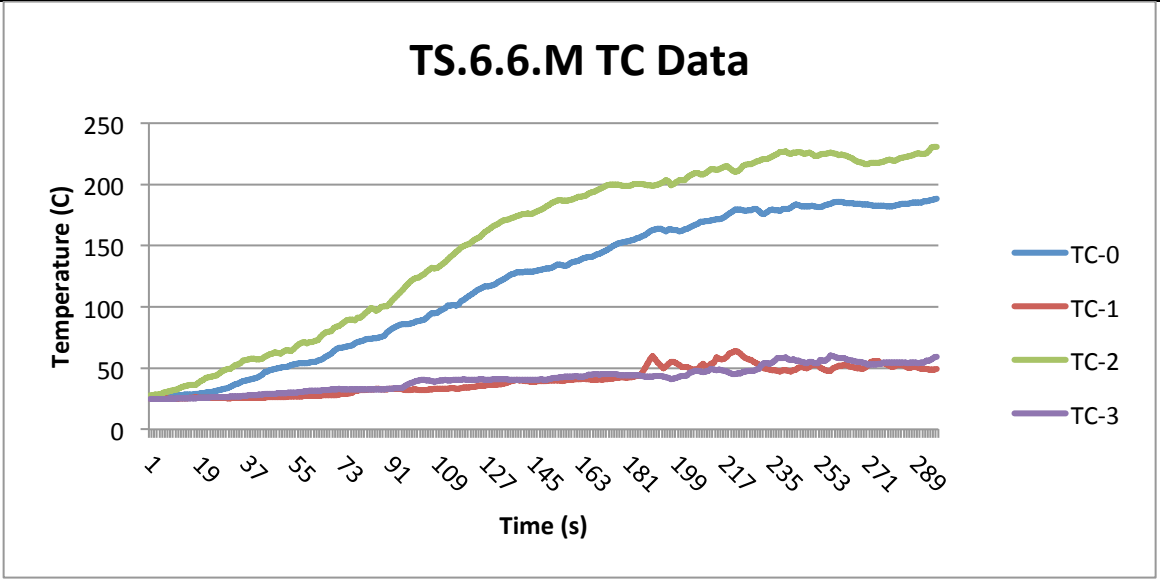
Test Id	Fuel	Diameter	Setting	Time (min:sec)	Ignition (Yes/No)	Time to Ignition (min:sec)
TS.5.8.H	Vegetable Oil	8”	High	25:00	No	
Comment	No signs of ignition.					



Test Id	Fuel	Diameter	Setting	Time (min:sec)	Ignition (Yes/No)	Time to Ignition (min:sec)
TS.6.6.L	Nylon Spatula	6”	Low	00:00	No	
Comment	No test was conducted based on no ignition from both medium and high setting test.					

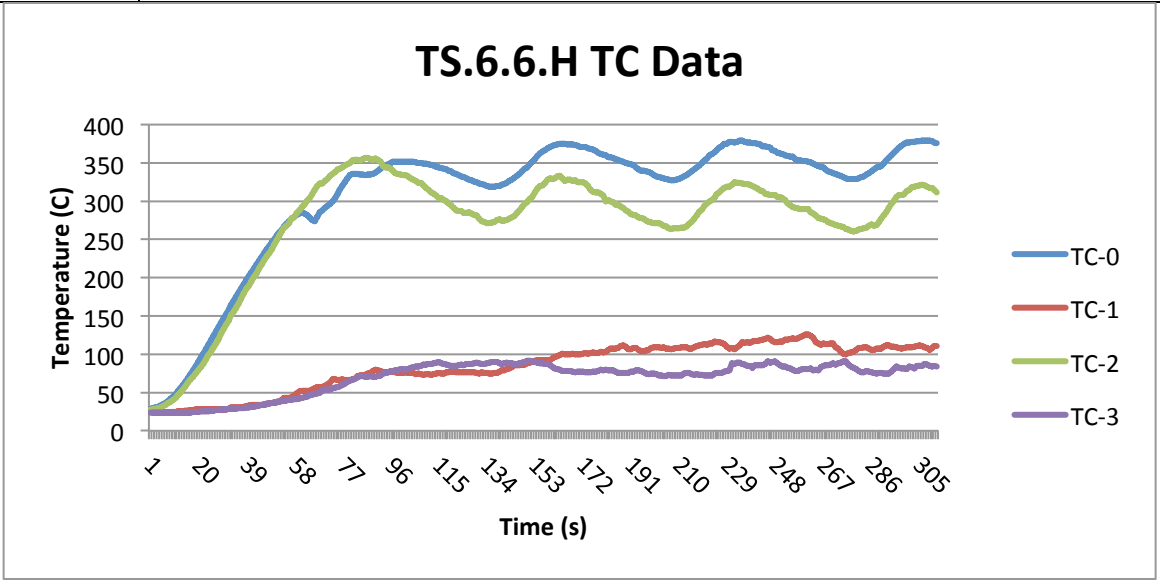
No Test Conducted

Test Id	Fuel	Diameter	Setting	Time (min:sec)	Ignition (Yes/No)	Time to Ignition (min:sec)
TS.6.6.M	Nylon Spatula	6”	Medium	15:00	No	
Comment	Material melted where it made contact with heating element. A significant amount of smoke was reported during test. No significant signs of ignition.					



Test Id	Fuel	Diameter	Setting	Time	Ignition	Time to

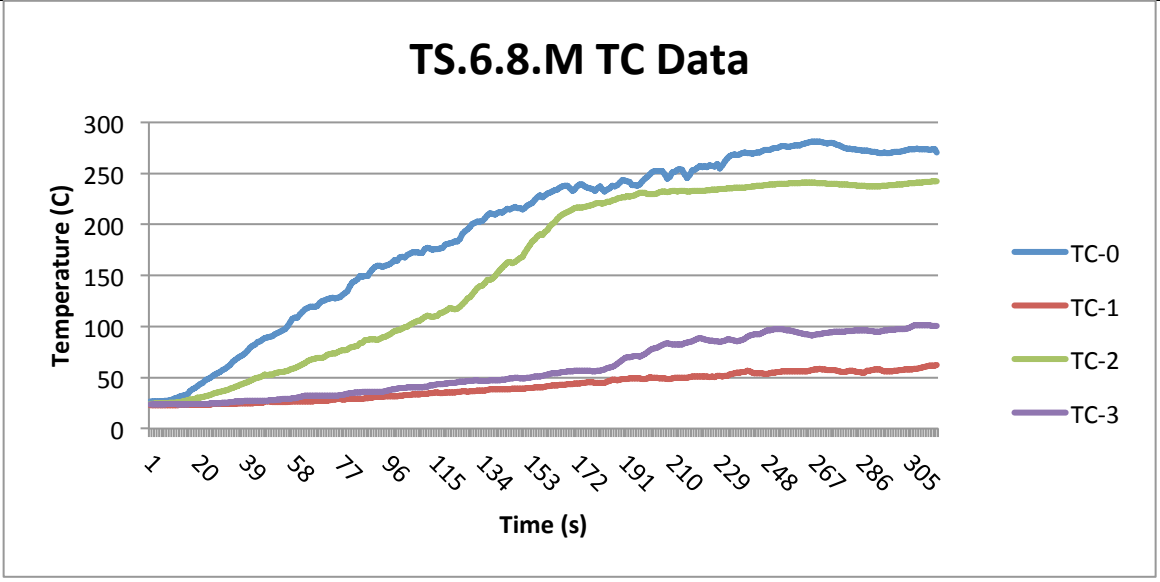
				(min:sec)	(Yes/No)	Ignition (min:sec)
TS.6.6.H	Nylon Spatula	6”	High	15:00	No	
Comment	Complete melting of material. A significant amount of smoke was reported during test.					



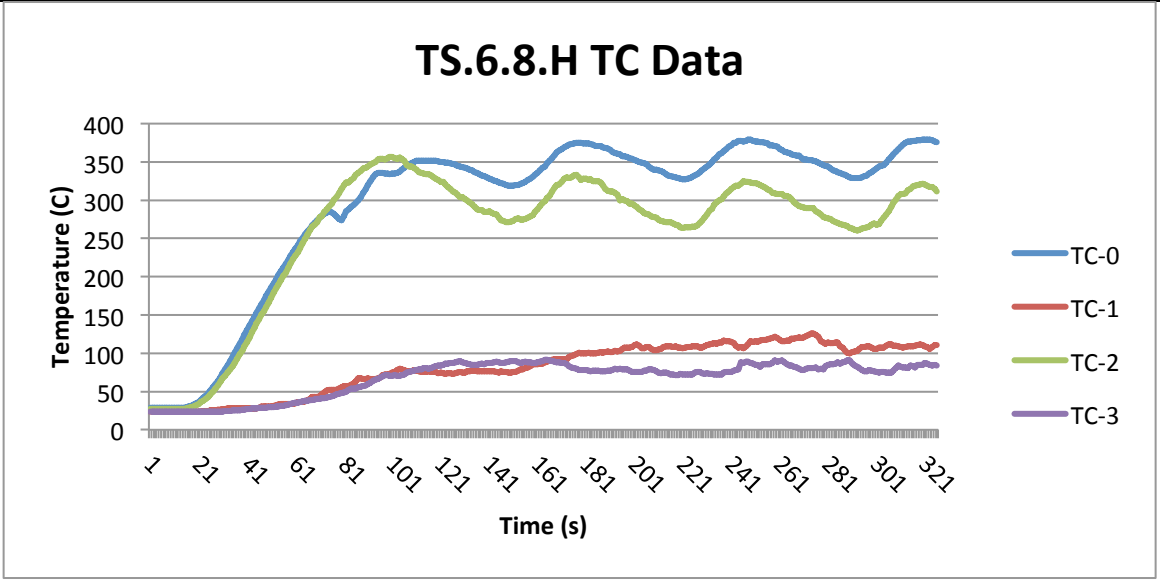
Test Id	Fuel	Diameter	Setting	Time (min:sec)	Ignition (Yes/No)	Time to Ignition (min:sec)
TS.6.8.L	Nylon Spatula	8”	Low	00:00	No	
Comment	No test was conducted based on no ignition from both medium and high setting test.					

No Test Conducted

Test Id	Fuel	Diameter	Setting	Time (min:sec)	Ignition (Yes/No)	Time to Ignition (min:sec)
TS.6.8.M	Nylon Spatula	8”	Medium	15:00	No	
Comment	Material melted where it made contact with heating element. A significant amount of smoke was reported during test. No significant signs of ignition.					



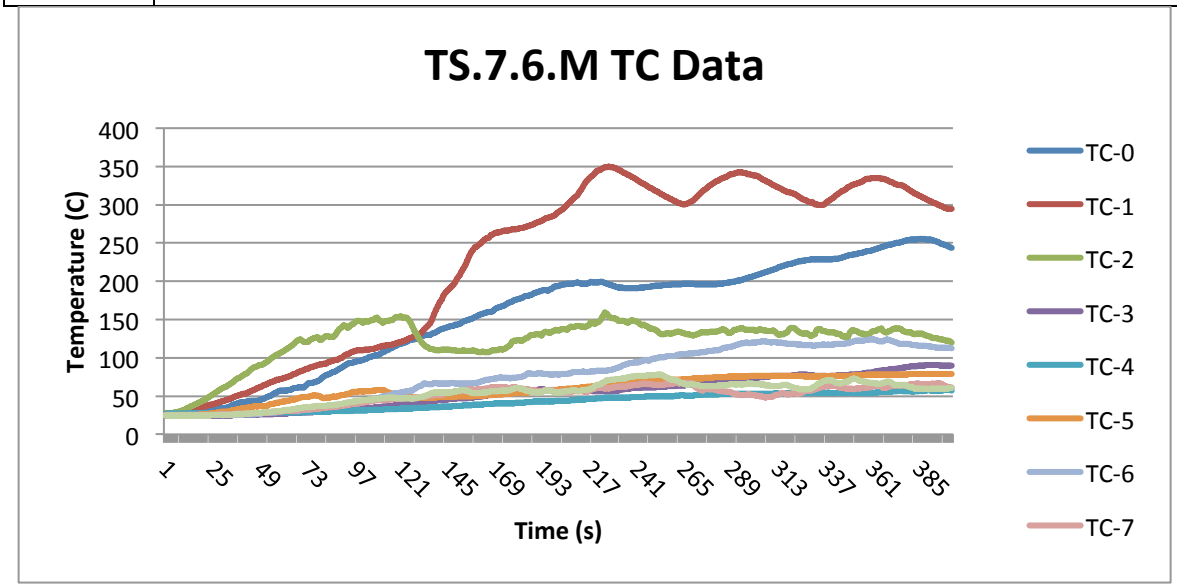
Test Id	Fuel	Diameter	Setting	Time (min:sec)	Ignition (Yes/No)	Time to Ignition (min:sec)
TS.6.8.H	Nylon Spatula	8”	High	15:00	No	
Comment	Complete melting of material. A significant amount of smoke was reported during test.					



Test Id	Fuel	Diameter	Setting	Time (min:sec)	Ignition (Yes/No)	Time to Ignition (min:sec)
TS.7.6.L	Toaster	6”	Low	00:00	No	
Comment	No test was conducted based on no ignition from both medium and high setting test.					

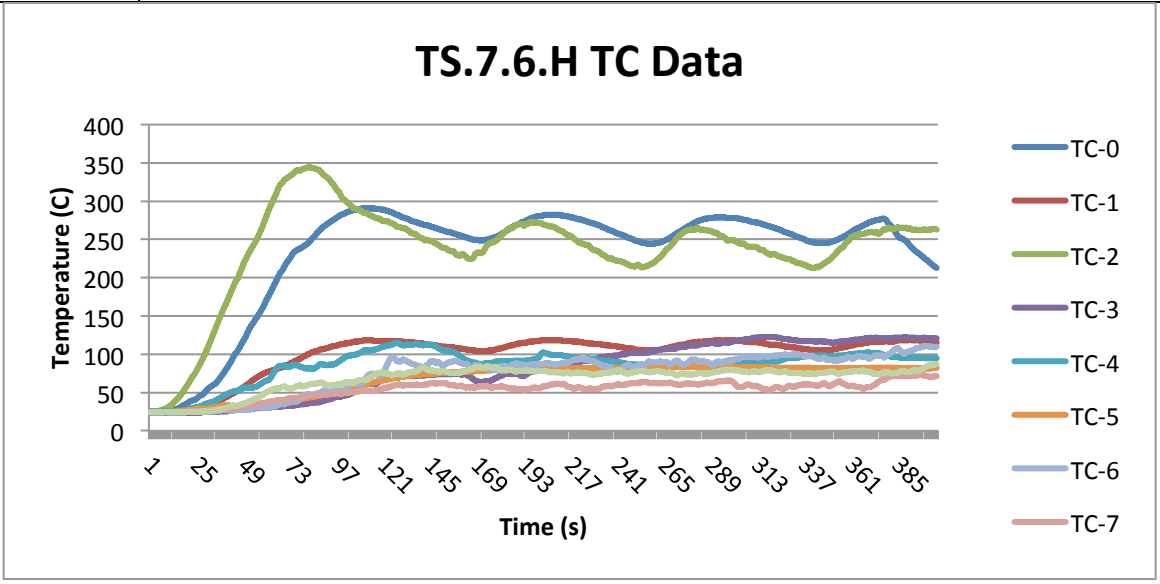
No Test Conducted

Test Id	Fuel	Diameter	Setting	Time (min:sec)	Ignition (Yes/No)	Time to Ignition (min:sec)
TS.7.6.M	Toaster	6”	Medium	20:00	No	
Comment	Melting of exterior housing only. A significant amount of smoke was reported during test.					



Test Id	Fuel	Diameter	Setting	Time	Ignition	Time to

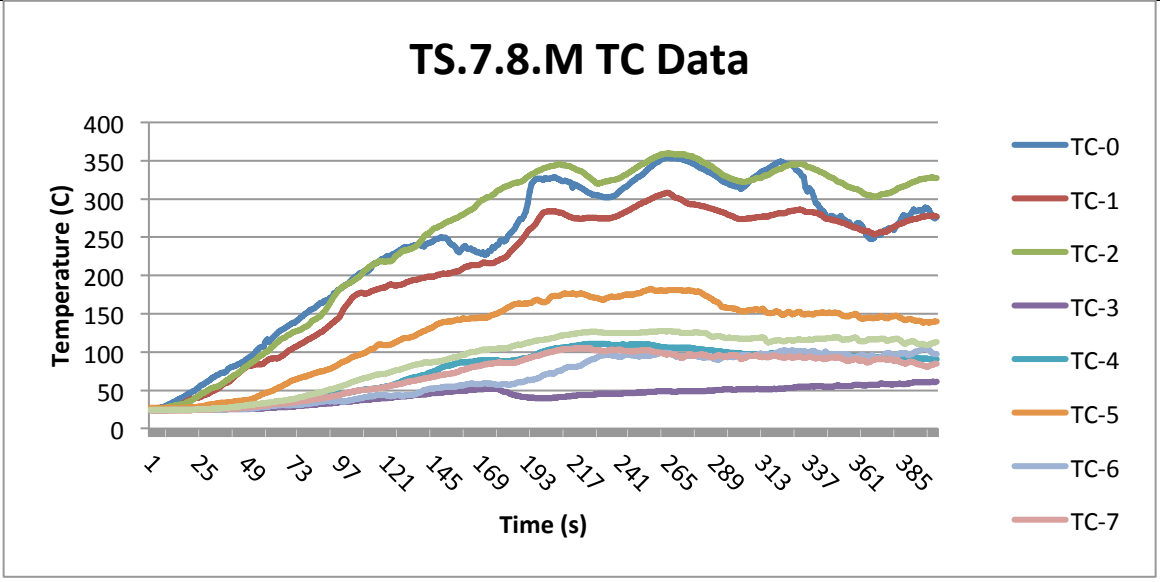
				(min:sec)	(Yes/No)	Ignition (min:sec)
TS.7.6.H	Toaster	6”	High	20:00	No	
Comment	A considerable amount of melting of exterior housing only. A significant amount of smoke was reported during test.					



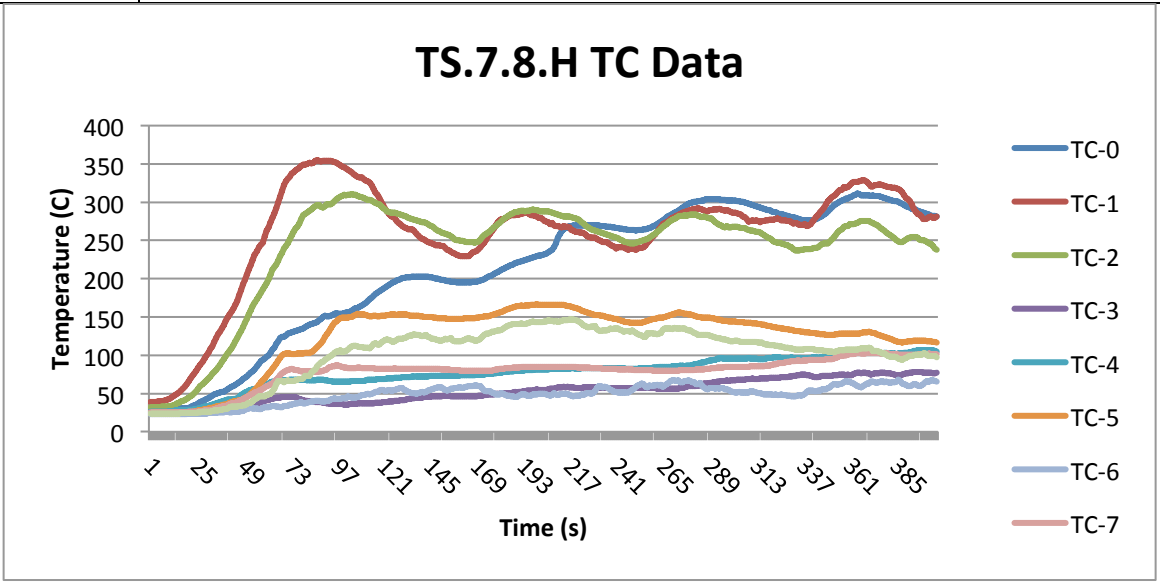
Test Id	Fuel	Diameter	Setting	Time (min:sec)	Ignition (Yes/No)	Time to Ignition (min:sec)
TS.7.8.L	Toaster	8”	Low	00:00	No	
Comment	No test was conducted based on no ignition from both medium and high setting test.					

No Test Conducted

Test Id	Fuel	Diameter	Setting	Time (min:sec)	Ignition (Yes/No)	Time to Ignition (min:sec)
TS.7.8.M	Toaster	8”	Medium	20:00	No	
Comment	Melting of exterior housing only. A significant amount of smoke was reported during test.					



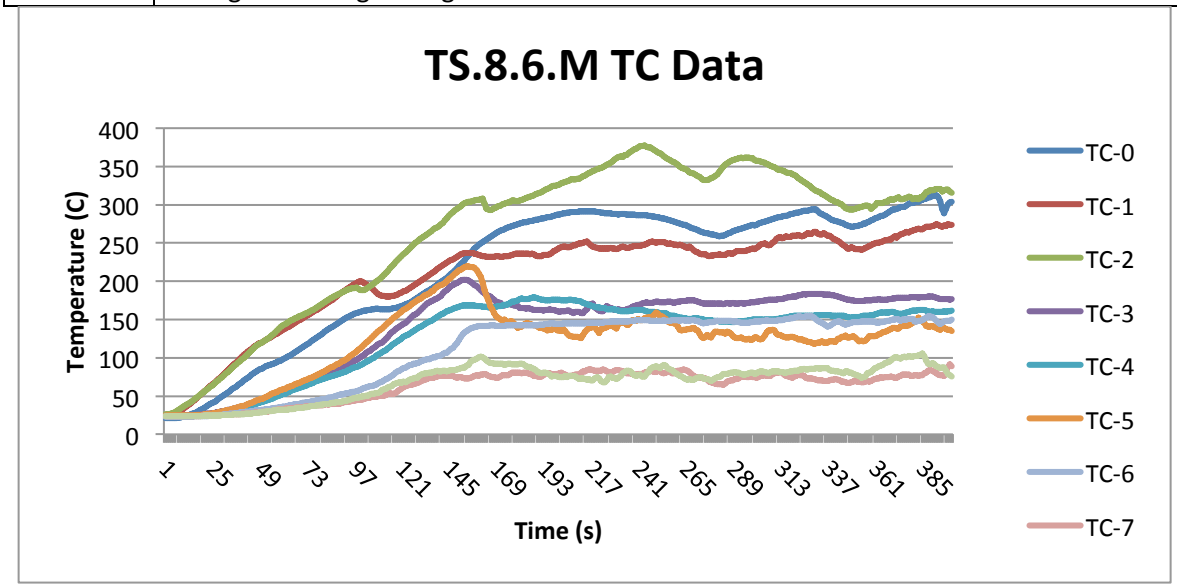
Test Id	Fuel	Diameter	Setting	Time (min:sec)	Ignition (Yes/No)	Time to Ignition (min:sec)
TS.7.8.H	Toaster	8”	High	20:00	No	
Comment	A considerable amount of melting of exterior housing only. A significant amount of smoke was reported during test.					



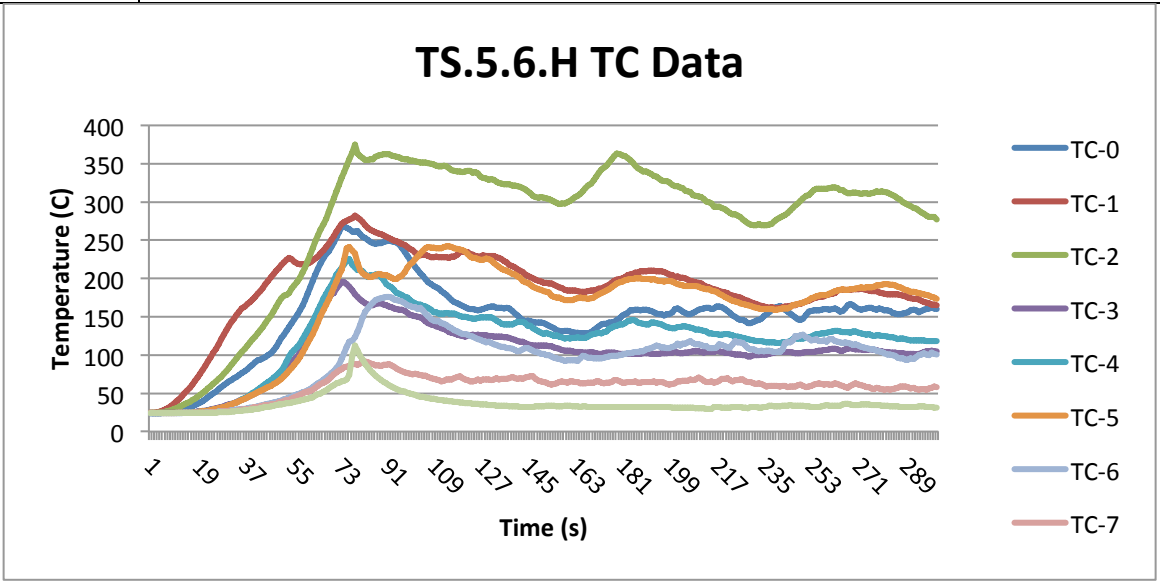
Test Id	Fuel	Diameter	Setting	Time (min:sec)	Ignition (Yes/No)	Time to Ignition (min:sec)
TS.8.6.L	Food Storage Container	6”	Low	00:00	No	
Comment	No test was conducted based on no ignition from both medium and high setting test.					

No Test Conducted

Test Id	Fuel	Diameter	Setting	Time (min:sec)	Ignition (Yes/No)	Time to Ignition (min:sec)
TS.8.6.M	Food Storage Container	6”	Medium	20:00	No	
Comment	Fuel melted and off gassed. A significant amount of smoke was reported during test. No significant signs of ignition.					



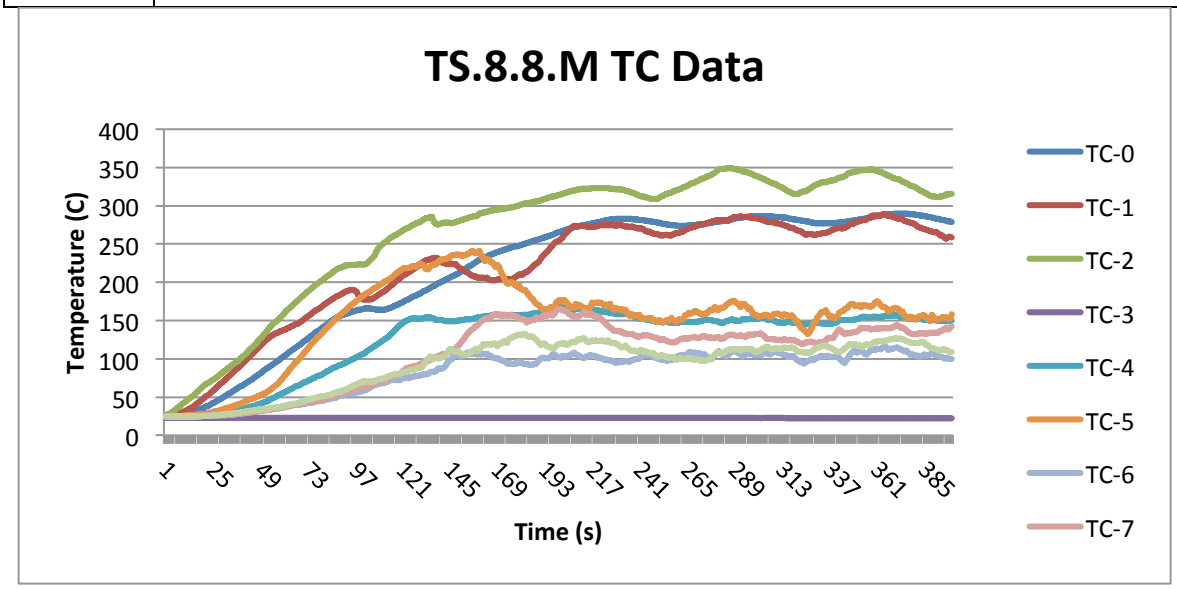
Test Id	Fuel	Diameter	Setting	Time (min:sec)	Ignition (Yes/No)	Time to Ignition (min:sec)
TS.8.6.H	Food Storage Container	6”	High	20:00	No	
Comment	Fuel melted and off gassed. A significant amount of smoke was reported during test. No significant signs of ignition.					



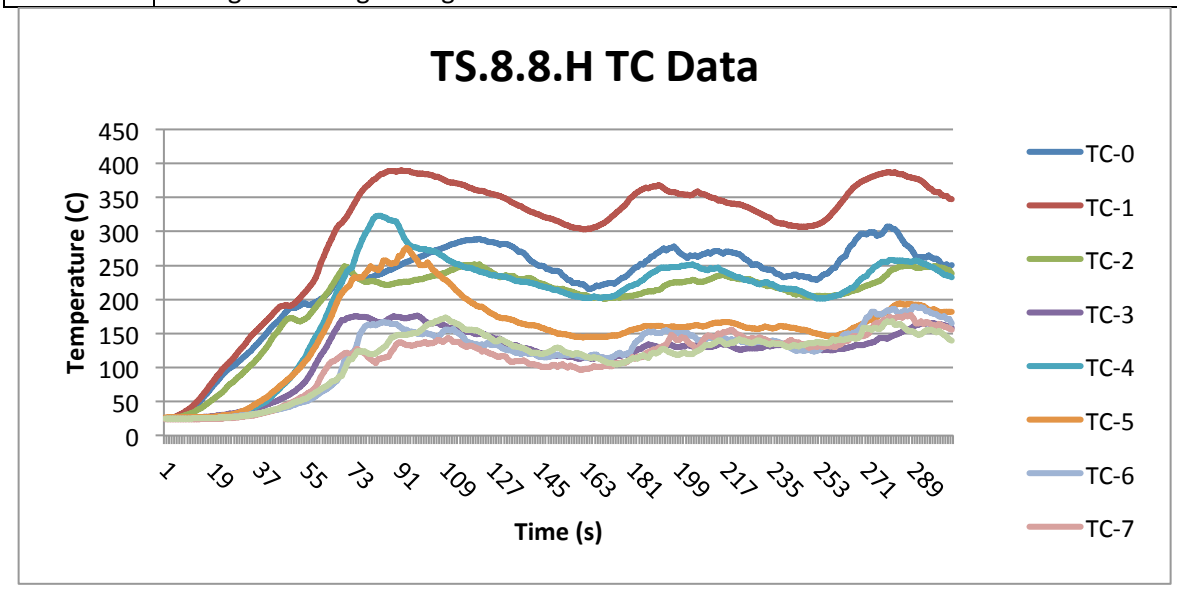
Test Id	Fuel	Diameter	Setting	Time (min:sec)	Ignition (Yes/No)	Time to Ignition (min:sec)
TS.8.8.L	Food Storage Container	8”	Low	00:00	No	
Comment	No test was conducted based on no ignition from both medium and high setting test.					

No Test Conducted

Test Id	Fuel	Diameter	Setting	Time (min:sec)	Ignition (Yes/No)	Time to Ignition (min:sec)
TS.8.8.M	Food Storage Container	8”	Medium	20:00	No	
Comment	Fuel melted and off gassed. A significant amount of smoke was reported during test. No significant signs of ignition.					



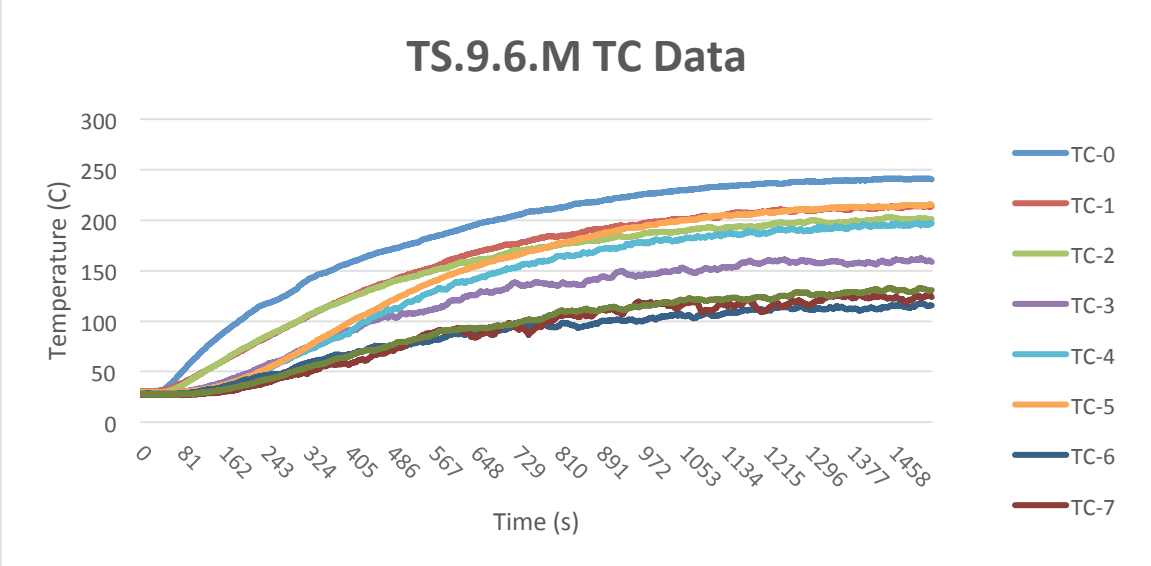
Test Id	Fuel	Diameter	Setting	Time (min:sec)	Ignition (Yes/No)	Time to Ignition (min:sec)
TS.8.8.H	Food Storage Container	8”	High	20:00	No	
Comment	Fuel melted and off gassed. A significant amount of smoke was reported during test. No significant signs of ignition.					



Test Id	Fuel	Diameter	Setting	Time (min:sec)	Ignition (Yes/No)	Time to Ignition (min:sec)
TS.9.6.L	Corn Oil	6”	Low		No	
Comment	No test was conducted based on no ignition on both medium and high test.					

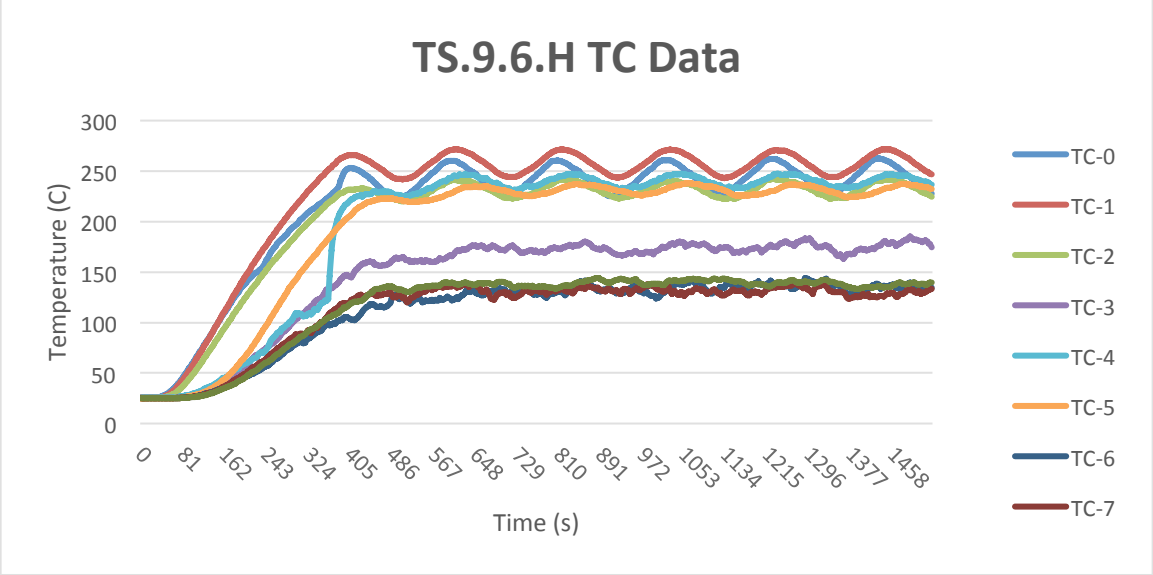
No Test Conducted

Test Id	Fuel	Diameter	Setting	Time (min:sec)	Ignition (Yes/No)	Time to Ignition (min:sec)
TS.9.6.M	Corn Oil	6”	Medium	25:00	No	
Comment	No signs of ignition. Due to quantity of oil only TC 3 was submersed in oil. No heavy release of smoke or vapors.					



Test Id	Fuel	Diameter	Setting	Time	Ignition	Time to

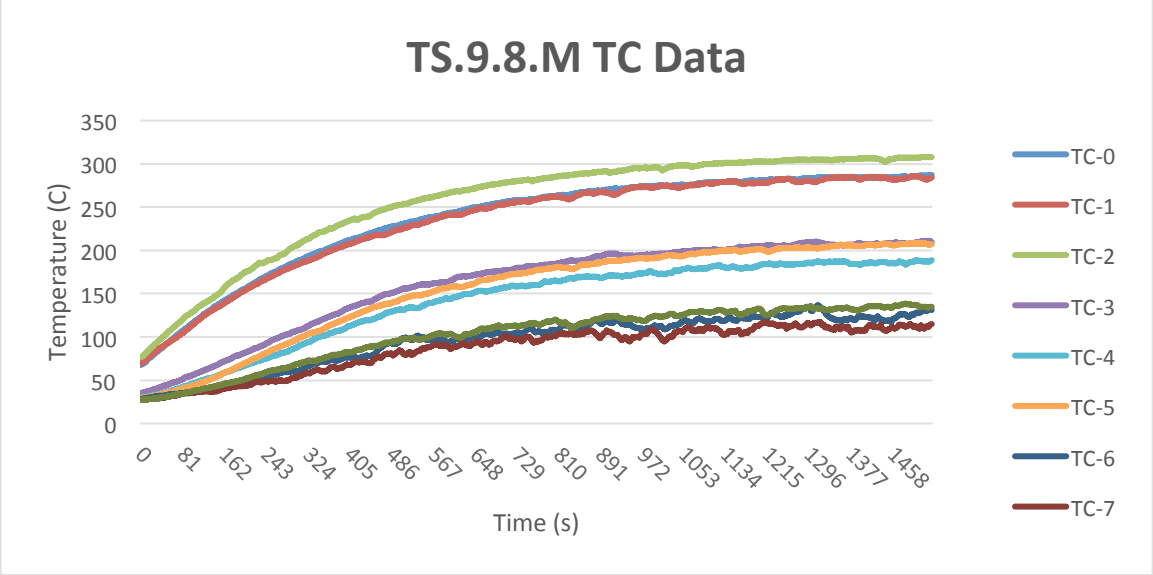
				(min:sec)	(Yes/No)	Ignition (min:sec)
TS.9.6.H	Corn Oil	6”	High	25:00	No	
Comment	No signs of ignition. Fuel did not boil or release smoke.					



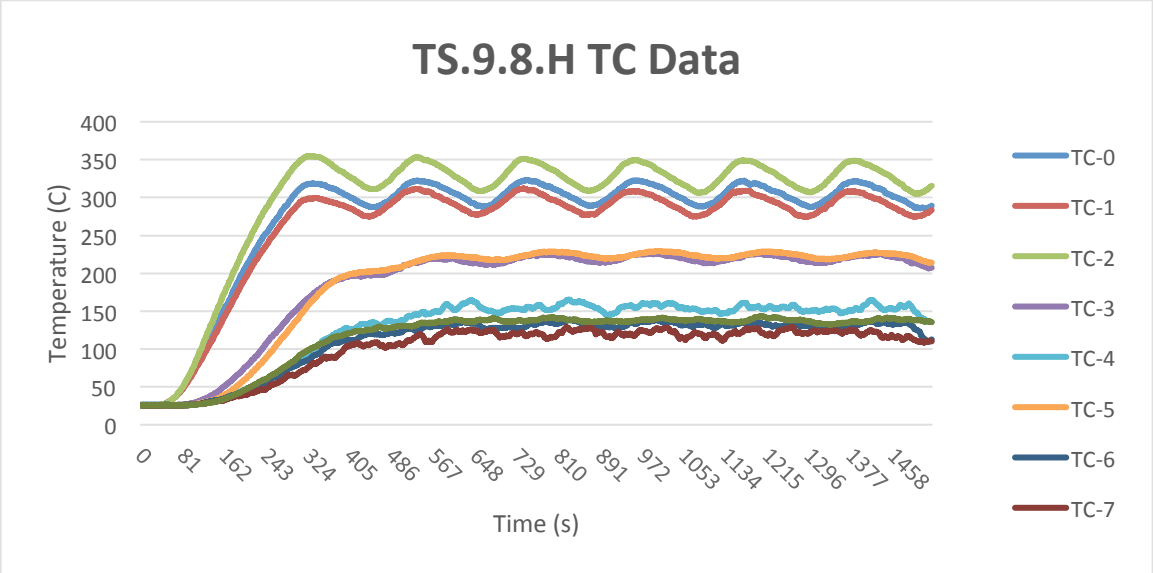
Test Id	Fuel	Diameter	Setting	Time (min:sec)	Ignition (Yes/No)	Time to Ignition (min:sec)
TS.9.8.L	Corn Oil	6”	Low	00:00	No	
Comment	No test was conducted based on no ignition on both medium and high test.					

No Test Conducted

Test Id	Fuel	Diameter	Setting	Time (min:sec)	Ignition (Yes/No)	Time to Ignition (min:sec)
TS.9.8.M	Corn Oil	6”	Medium	25:00	No	
Comment	No signs of ignition. Fuel did not boil or release smoke.					

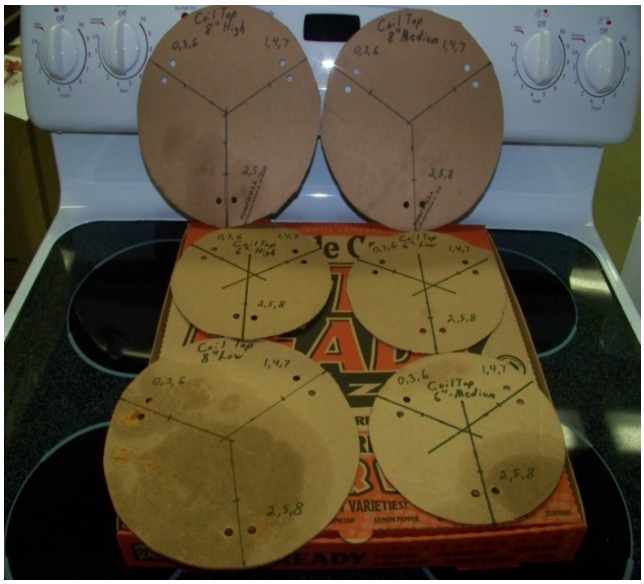


Test Id	Fuel	Diameter	Setting	Time (min:sec)	Ignition (Yes/No)	Time to Ignition (min:sec)
TS.9.8.H	Corn Oil	6”	High	25:00	No	
Comment	No signs of ignition. Fuel did not boil or release smoke.					



Appendix H – Photographs of Fuels

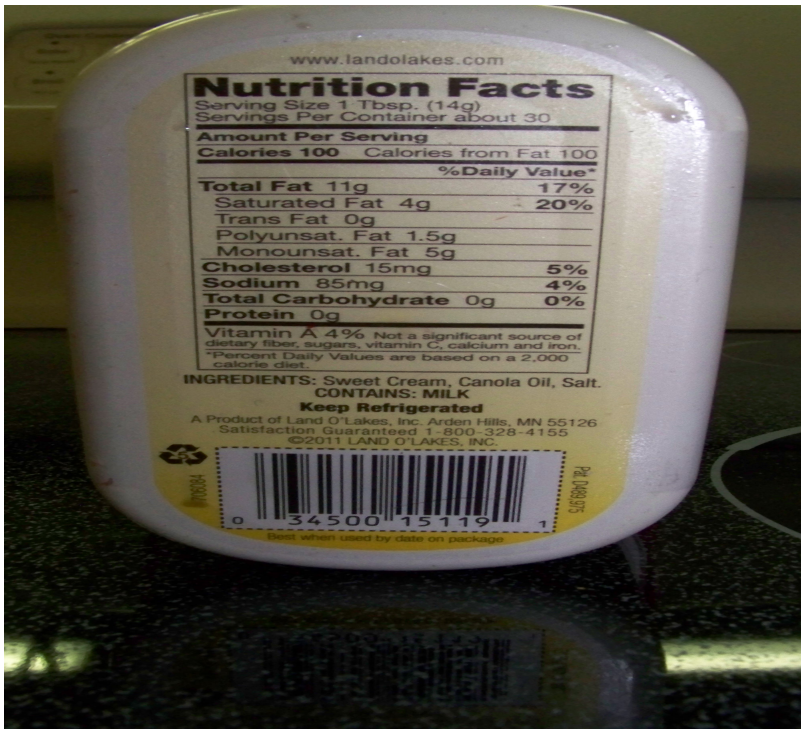
1. Cardboard (pizza box)



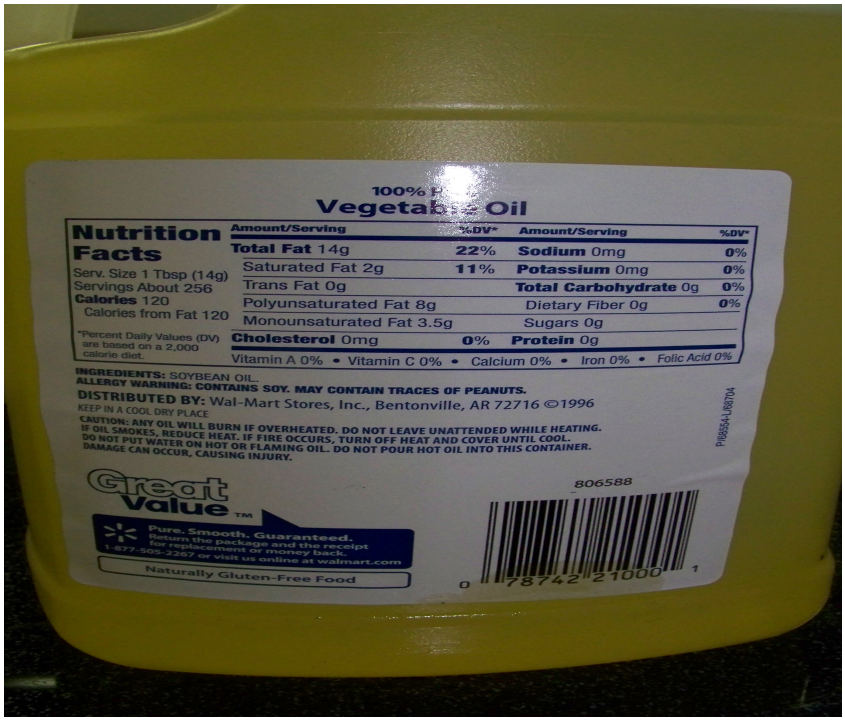
2. Dish Towel (Cotton)

3. Paper Towel (Paper)

4. Canola Oil (butter)

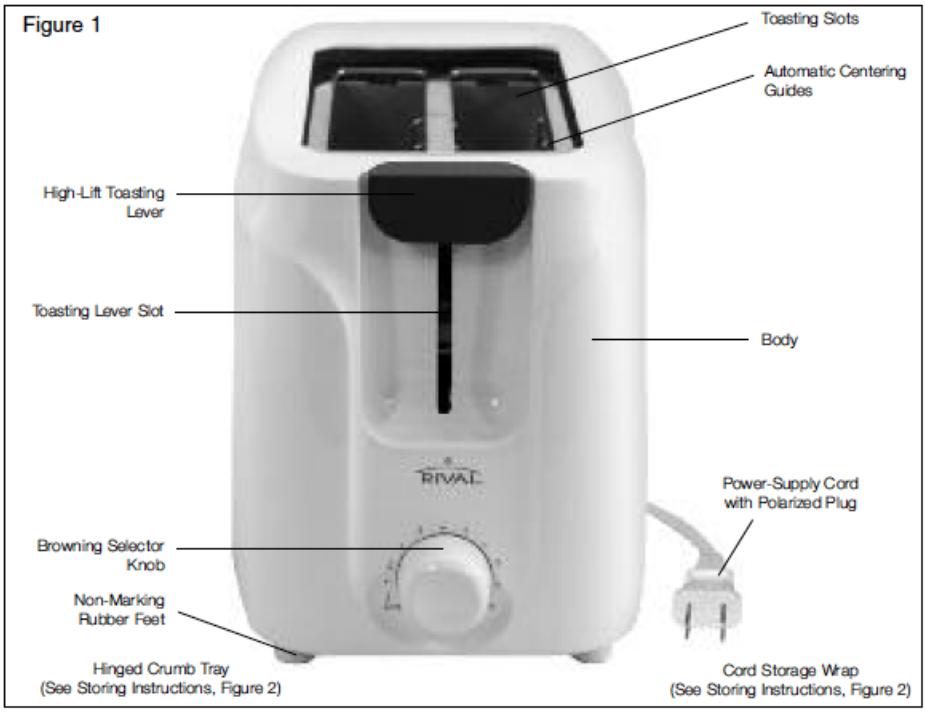


5. Vegetable Oil



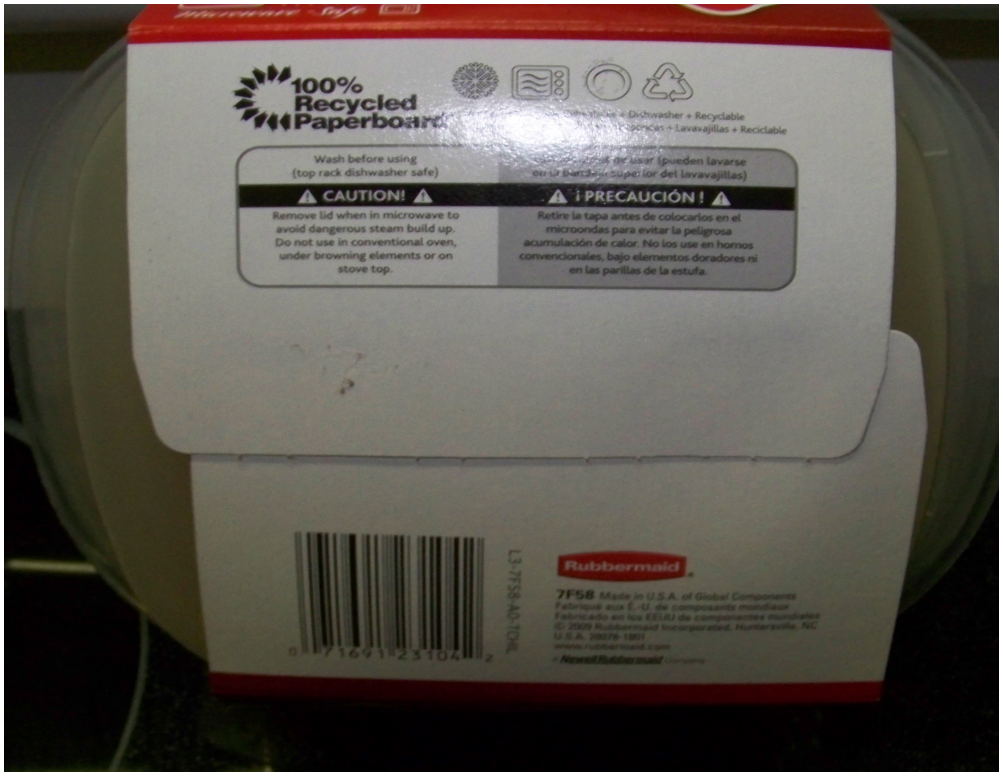
6. Kitchen Utensil (Nylon Short Turner Spatula)

7. Toaster – Appliance (Polypropylene)



Source: Rival manual
http://www.rivalproducts.com/manuals/MANUALS/16041_43_96048060.PDF

8. Food Storage Container (Polyethylene)



10. Corn Oil


Great Value
100% Pure
Corn Oil
48 FL OZ (1.5 QT) 1.4L
0g Trans Fat per Serving
No Artificial Flavors or Colors


Nutrition Facts
Total Fat 14g 22%
Saturated Fat 2g 9%
Trans Fat 0g
Polyunsaturated Fat 8g
Monounsaturated Fat 4g
Cholesterol 0mg 0%
Sodium 0mg 0%
Potassium 0mg 0%
Total Carbohydrate 0g 0%
Dietary Fiber 0g 0%
Sugars 0g
Protein 0g
Vitamin A 0% • Vitamin C 0% • Calcium 0% • Iron 0% • Folic Acid 0%
INGREDIENTS: CORN OIL
ALLERGY WARNING: MAY CONTAIN TRACES OF PEANUTS AND SOY.
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