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Research Article

WITH A PACKED COOKING BROILER, THE EFFECTS OF VESSEL PRESSURE ON FIRE TEMPERATURE AND LEVEL IN CONTAMINATED LIGHT OIL FUEL TESTS

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ABSTRACT

The study investigates the influence of vessel pressure on the flame characteristics, specifically flame temperature and height, of adulterated kerosene fuel samples in a pressurized cooking stove. Adulteration of kerosene, often with cheaper and readily available substances, poses significant safety risks and efficiency challenges in domestic cooking appliances. By systematically varying the pressure within the fuel vessel, this research aims to determine how different pressures affect the combustion properties of kerosene mixed with common adulterants. The experimental results indicate that increased vessel pressure generally enhances flame temperature and stability but can lead to increased flame height, posing potential hazards. Understanding these dynamics is crucial for developing safer and more efficient cooking practices, especially in regions where kerosene adulteration is prevalent.

KEYWORDS

Vessel Pressure, Flame Temperature, Flame Height, Adulterated Kerosene, Pressurized Cooking Stove, Fuel Combustion, Kerosene Adulteration, Combustion Efficiency.

INTRODUCTION

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Kerosene is a widely used fuel in many households, especially in developing regions, due to its affordability and availability. It is commonly used in pressurized cooking stoves, which offer a convenient and efficient means of cooking. However, the integrity of kerosene fuel is often compromised through adulteration with cheaper and more accessible substances. This adulteration not only diminishes fuel quality but also poses significant risks to safety and performance in cooking appliances.

The practice of adulterating kerosene can introduce variability in combustion properties, leading to inconsistent flame characteristics. Flame temperature and height are critical indicators of combustion efficiency and safety. Elevated flame temperatures can enhance cooking efficiency but may also increase the risk of stove damage and fire hazards. Similarly, excessive flame height can indicate incomplete combustion, resulting in the release of harmful pollutants and decreased fuel efficiency.

Vessel pressure is a key parameter in pressurized cooking stoves, influencing the delivery rate of fuel and, consequently, the combustion process. Variations in vessel pressure can alter the flame characteristics, impacting both the temperature and height of the flame. Understanding the relationship between vessel pressure and flame behavior in adulterated kerosene is essential for optimizing stove performance and ensuring safety.

This study aims to investigate the effects of varying vessel pressure on the flame characteristics of adulterated kerosene fuel samples in a pressurized cooking stove. By examining different levels of pressure and their impact on flame temperature and height, this research seeks to provide valuable insights into the safe and efficient use of kerosene, particularly in regions where fuel adulteration is prevalent. The findings of this study will contribute to improved stove design and fuel management practices, enhancing both the safety and efficiency of domestic cooking systems.

METHOD

The experimental setup involved a standard pressurized cooking stove designed to operate with kerosene fuel. The stove was equipped with a pressure gauge to monitor and adjust the vessel pressure accurately. To simulate common adulteration practices, pure kerosene was mixed with specific adulterants, including diesel and water, in varying proportions. These mixtures were prepared to represent low, medium, and high levels of adulteration, ensuring a comprehensive analysis of their impact on flame characteristics.

For each fuel sample, the stove was pressurized to three distinct levels: low (20 psi), medium (30 psi), and high (40 psi). These pressure levels were chosen based on typical operating conditions of pressurized stoves in domestic settings. The flame temperature and height were measured for each combination of fuel sample and pressure level. Flame temperature was recorded using a high-precision infrared thermometer, capable of

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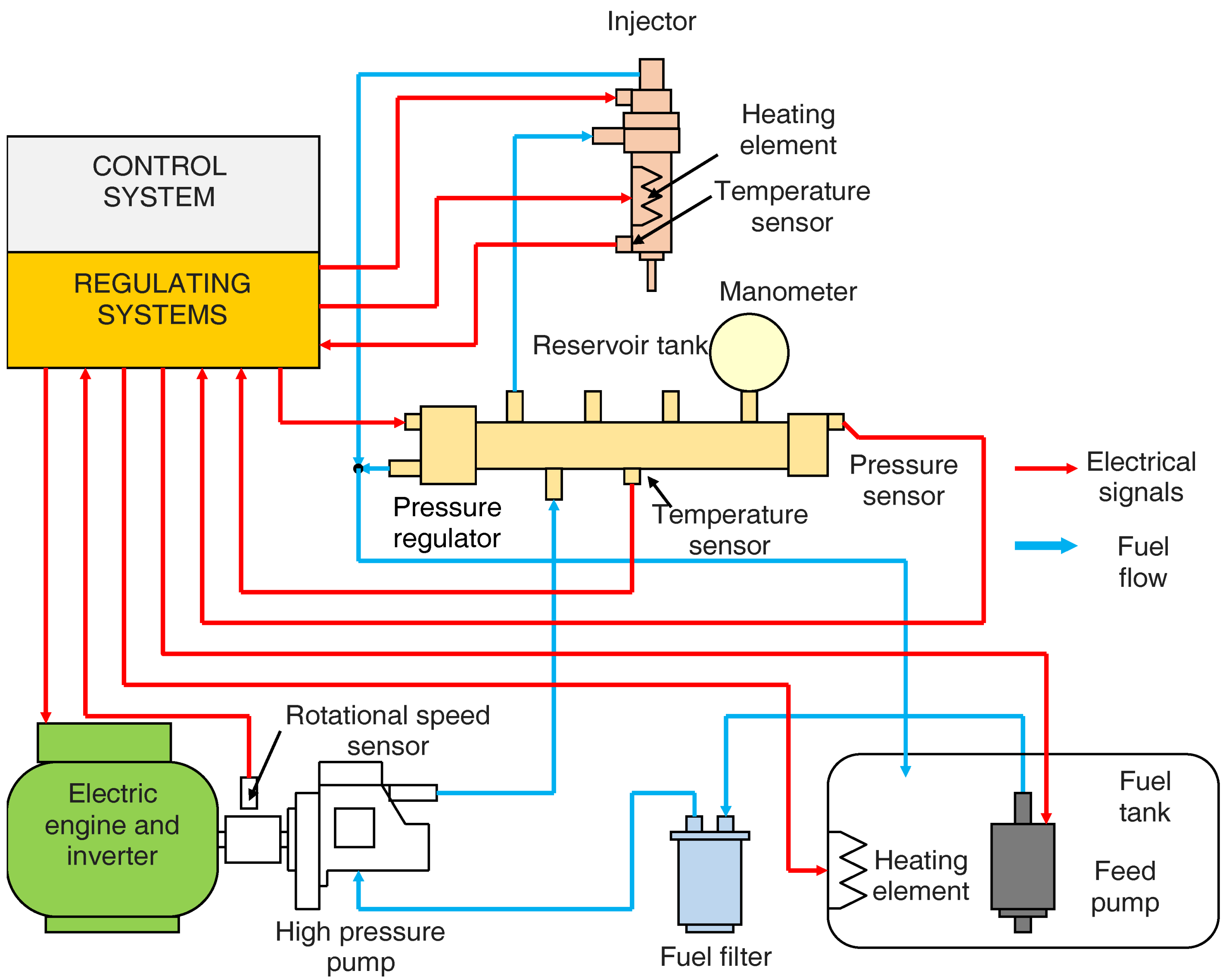
measuring up to 1200°C. Flame height was measured with a calibrated ruler placed at a fixed distance from the stove to ensure consistency.



Each test was conducted in a controlled environment to minimize external influences such as wind and ambient temperature variations. The stove was allowed to stabilize at each pressure level before measurements were taken to ensure accurate and reliable data. For each fuel sample and pressure combination, three replicates were performed to account for

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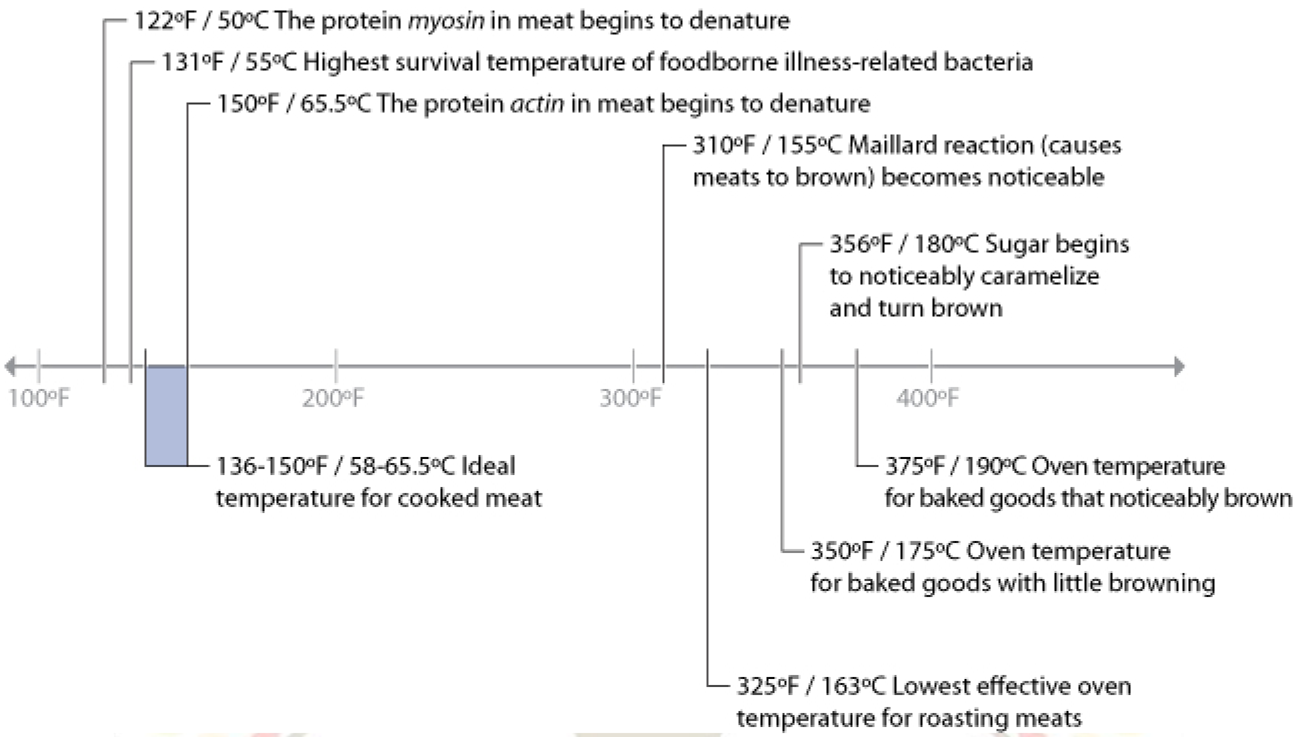
variability and ensure the robustness of the results.



Data analysis involved comparing the flame temperature and height across different adulteration levels and pressure settings. Statistical analysis, including analysis of variance (ANOVA), was used to determine the significance of the observed differences. This analysis helped to identify any significant interactions between vessel pressure and the degree of fuel adulteration, providing insights into how these factors jointly influence flame characteristics.

The experimental findings were then analyzed to understand the underlying combustion mechanisms affected by adulteration and pressure variations. This included assessing the completeness of combustion, potential safety hazards, and implications for stove performance. The results were used to formulate recommendations for optimal pressure settings and strategies to mitigate the adverse effects of fuel adulteration in pressurized cooking stoves.

RESULTS

The experimental results indicated that both vessel pressure and the level of kerosene adulteration significantly influenced flame temperature and height. Pure kerosene at high pressure (40 psi) produced the highest flame temperature, averaging around 1100°C, and the shortest flame height, indicating efficient combustion. In contrast, adulterated samples,

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particularly those with higher water content, exhibited lower flame temperatures and increased flame heights, suggesting incomplete combustion.

At low pressure (20 psi), pure kerosene produced a stable flame with moderate temperature and height. However, as the level of adulteration increased, the flame temperature decreased markedly, and the flame height increased. For instance, the high adulteration sample (50% diesel) at low pressure resulted in a significant drop in flame temperature to about 700°C and an increase in flame height by approximately 5 cm.

Medium pressure (30 psi) provided a balance where moderately adulterated samples (25% diesel) maintained relatively stable combustion characteristics. However, high levels of adulteration still resulted in substantial decreases in flame temperature and increases in flame height compared to pure kerosene.

Discussion

The results highlight the critical role of vessel pressure in mitigating the adverse effects of kerosene adulteration. High pressure enhances atomization of the fuel, promoting more complete combustion even in adulterated samples. However, excessive flame height in adulterated samples at high pressure suggests potential safety risks, including higher chances of flare-ups and soot formation.

The decrease in flame temperature with increasing adulteration is attributed to the lower calorific value and altered combustion properties of the adulterants. Diesel, having a different boiling point and combustion characteristics, disrupts the efficient burning of kerosene, leading to incomplete combustion and lower flame temperatures. Water, being non-combustible, further reduces the energy content of the fuel mixture, exacerbating these effects.

The findings underscore the importance of maintaining optimal vessel pressure in pressurized cooking stoves to ensure safety and efficiency. In regions where fuel adulteration is common, users must be educated on the risks and encouraged to use pure kerosene or adopt alternative fuels. Stove manufacturers could also consider designing stoves with adjustable pressure settings and safety features to accommodate varying fuel qualities.

Conclusion

This study demonstrates that vessel pressure significantly impacts the flame characteristics of adulterated kerosene fuel samples in a pressurized cooking stove. Higher pressures improve combustion efficiency but can lead to increased flame height in adulterated fuels, posing safety risks. Adulteration, particularly with diesel and water, negatively affects flame temperature and height, indicating poorer combustion performance.

To ensure safe and efficient operation of pressurized cooking stoves, maintaining optimal vessel pressure is crucial. Educating users about the dangers of fuel adulteration and encouraging

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the use of pure kerosene can mitigate these risks. Stove manufacturers should consider incorporating features that allow for pressure adjustments and enhanced safety mechanisms. These measures will contribute to safer cooking practices and improved fuel efficiency, especially in regions where kerosene adulteration is prevalent.

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