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Using Spent Used Cooking Oil As An Aromatic Lamp

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ABSTRACT

The Carnot cycle consists of four processes: two isothermal and two adiabatic, which increase efficiency by regulating temperature. In contrast, the Rankine cycle overcomes Carnot's weaknesses by using steam heating and condensation. In addition, making candles from used cooking oil is an environmentally friendly innovation that processes waste into useful products. This process involves heating the oil to remove odors, mixing it with paraffin, and adding aromas. Making lamps from cans also utilizes used materials, demonstrating creativity in waste management. The 1:3 ratio (paraffin:oil), which is more oil-dominant, results in the fastest and most efficient burn, with the highest amount of candle mass burned after 40 minutes. This is suitable for applications that require rapid burning, such as in the creation of a moving nightlight that utilizes the Carnot cycle to convert heat into mechanical energy for movement. In contrast, the 3:1 ratio (paraffin:oil) produces a harder and more durable candle, with less mass burned, making it more suitable for long-term use and stable movement. The 1:2 and 2:1 ratios provide a balance between burn duration and light intensity, allowing them to be chosen based on specific needs.

Keywords: Carnot Cycle, Waste Oil Candles, Tin Can Lamps.

1. INTRODUCTION

Cycles in heat engines are part of the science of thermodynamics that are interesting to study. Where in actual conditions, heat engine cycles are very difficult to analyze because they have many influences from complex conditions, such as friction and time to reach equilibrium[1].

The Carnot cycle is an ideal thermodynamic cycle first described by Sadi Carnot in 1824. There are two types of cycles that are generally applied to steam power plants, namely the Rankine Cycle and the Carnot Cycle. In the Carnot Cycle there are 4 (four) processes, namely two isothermal processes and two adiabatic processes. In conditions 1-2, the fluid is heated reversibly isothermally in the boiler. Conditions 2-3 are expanded adiabatically in the turbine. Then in conditions 3-4 the working fluid is condensed reversibly and isothermally in the condenser. Furthermore, in condition 4 the fluid is compressed isentropically by the compressor and then returns to condition 1. During isothermal expansion, the system is connected to a high-temperature reservoir T_H and absorbs energy Q_H. Thus, the system remains in thermal equilibrium. From the first law of thermodynamics, the amount of heat required to expand the system is Assume that the system undergoes an isothermal expansion from LA to LB. During the expansion, the wave function of the two-particle system is a superposition of the ground state and the first excited state. In the expansion there is an adiabatic process in the turbine. During adiabatic expansion, there is no change in energy in the system and the system experiences a change in temperature. In this state, the wave function and the energy of the system remain in the first excited state. under conditions 3-4 the fluid is condensed reversibly and isothermally. During isothermal compression, the state function of the system is a superposition of the ground state and the first excited state. In addition, the system remains in thermal equilibrium [2].

The Carnot cycle is thermodynamically reversible. A Carnot engine receives heat energy at a high temperature, converts some of it into work, and then releases the rest as heat at a lower temperature. The Carnot refrigeration cycle is the opposite of the Carnot cycle, where the refrigeration cycle channels energy from a low temperature to a higher temperature, so the refrigeration cycle requires external work to produce work [3]. The main advantage of the Carnot cycle is its maximum efficiency, which is determined by the temperature ratio between the hot and cold reservoirs. The efficiency of a Carnot engine can be expressed by the formula $\eta = 1 - Tc/Th$ where Tc is the temperature of the cold reservoir and Th is the temperature of the hot reservoir. The greater the temperature difference between the two reservoirs, the higher the efficiency that can be achieved [4]. The Carnot cycle serves as a reference for other heat engines, because no real engine can achieve efficiency as high as the Carnot engine. This is due to the fact that all processes in the Carnot cycle are reversible, whereas real engines undergo irreversible processes that reduce efficiency.

In today's modern era, of course, you are familiar with lamps. Even so, there are also lamps that do not require electrical energy in order to produce light, for example kerosene lamps and there are also solar lamps which utilize solar energy as their energy source. In addition to some types of lamps, we can also make simpler lamps without using electrical energy and produce aromas as aromatherapy. Lamps are artificial lighting systems made by humans for lighting needs. Several types of lamps according to their materials and technology are; incandescent lamps, fluorescent lamps, HID lamps (Halogen, Mercury, Sodium), ultraviolet lamps, infrared lamps, and so on. Lamps according to how they are placed are hanging lamps, wall lamps, table lamps, standing lamps, downlights, spotlights and so on. Lamps also function to support the atmosphere of a room, for example, night lights[5].

Aromatherapy is an alternative that can be used to reduce stress and anxiety levels in some patient conditions. Aromatherapy comes from the word "aroma" which means fragrance or smell and "therapy" means treatment. Aromatherapy is one of the complementary treatments that uses essential oils as the main therapeutic agent. Essential oils are obtained from the extraction of flowers, leaves, stems, fruits, roots, and also from resin. Essential oils as aromatherapy are used through inhalation and or topical routes. When inhaled, essential oils work in the brain and nervous system through stimulation of the olfactory nerves. This response will stimulate the production of brain nerve transmitters (neurotransmitters) related to the recovery of psychological conditions such as emotions, feelings, thoughts and desires[6]. An aromatherapy lamp is a device that combines lighting functionality with aromatherapy, using essential oils to create a calming

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atmosphere. These lamps typically have a container to hold essential oils that are heated, allowing the resulting aroma to diffuse throughout the room, providing relaxation and mood enhancement.

Using an aromatherapy lamp serves not only as decoration, but is also believed to improve physical and mental health, help reduce stress, enhance sleep quality, and create a more comfortable environment. Additionally, these lamps are often used in various places like spas, hotels, and homes to create a pleasant and calming atmosphere. Socialization of aromatherapy candle making utilizes waste cooking oil which can be processed into scented candles with various calming aromas. Due to the difficulty of processing or recycling used cooking oil into something beneficial, it has the potential to have a high selling price. One option for obtaining a very good economic value is to process used cooking oil into aromatherapy candles. Candles are made for several purposes, one of which is to be used as a source of light. Candlelight can be used as an emergency tool in case of power outages. Candles can also be used to enhance the appearance of a room by decorating it. The implementation of this appeal was successfully executed thanks to the full support of the parties, especially the Head of Tanah Seribu City, by collaborating and bringing in approximately 15 local residents to the expansion location for implementation[7].

Used Cooking Oil is the name given to cooking oil that has been used too many times. cooking oil that has been repeatedly used, too often consuming consuming used cooking oil can cause the potential for cancer to increase[8]. The management and utilization of used cooking oil waste has been widely used as biodiesel fuel[9]. Used cooking oil is an oil that is considered damaged. The frying process at high temperatures can cause reactions that reduce the quality of the cooking oil. Some reactions that will occur in oil after being used for frying are the presence of various chemical compounds that are harmful to human health[10].

Paraffin is a traditional ingredient in candle making and is still a popular ingredient today. Paraffin works best for beginners as it melts quickly, is cheap, and easy to color or scent[11]. The wax base forming compounds used in this research are solid paraffin, used cooking oil and citronella. Solid paraffin is the main raw material in candle making[12]. Citronella (Cymbopogon nardus) is one of the NTFP commodities that can produce oil[13]. Lemongrass is still dominant and more commonly used for its oil than other types of lemongrass. Lemongrass contains many nutrients including selenium, manganese, calcium and others[14]. The compounds contained in lemongrass oil include citronella (32-45%), citronellol (12-15%), geraniol (12-18%), geraniol acetate (3-8%) and citronellal astat (2-4%). Citronellal and geraniol compounds are important components contained in lemongrass oil that can produce a distinctive aroma and the price of lemongrass essential oil[14].

2. EXPERIMENTAL

2.1. Chemicals, Equipment and Instrumentation

This research uses an experimental method. In this case, the researcher innovates in the field of renewable energy by testing the use of used cooking oil in making aromatic lamps. Several tools and materials were used for the accuracy experiment. The ingredients are: Paraffin, Used cooking oil, Lemongrass extract, and Stove. The tools used include Scissors, Cutter, Safety pins, Glue, Iron hanger, Candle used cooking oil, Pliers, and Used cans (small and medium).

2.2. Research Procedure

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Some of the steps prepared and carried out in conducting this research are as follows: Candles from used cooking oil. Making candles from used cooking oil is an interesting and environmentally friendly process. First, heat the used cooking oil with charcoal to neutralize the unpleasant odor. Once the oil is hot enough, remove from heat and let it cool. Next, heat the solid paraffin until it melts, making it easy to mix. After that, add lemongrass extract to the used cooking oil that has been cooled, then stir well so that the lemongrass aroma is absorbed well. Mix the used cooking oil that has been mixed with lemongrass extract with the melted liquid paraffin, so that all ingredients are perfectly mixed. Once the mixture is ready, pour it into the prepared mold, and make sure to place the wick in the center of the mold so that the candle can burn well. Finally, let the mixture cool and harden, so that the candle is ready to use.

Make Lamp. Break the neck of the hanger, then break both sides of the hanger so that it forms like a food container handle. after that adjust the size to the small can. the small can was cut ¼ of the top to be used as a place for aromatic candles. take a medium can and split it in half. cut the top of the can so that it has a hole. these cans will later be combined so that they become smaller, inside this can is where the small can of aromatic candles will be placed. after that, thus take another medium can 1, take the hard bottom. this hard bottom, is perforated into a hexagonal shape only the corners. the can that was taken the bottom part earlier, the lid is also removed, then it will be replaced with the bottom can that has been perforated. after being attached, make a pattern on the body of the can to be a motif on the lamp. the can containing the candle container, is attached to the hanger that has been formed, so that the end of the hanger will be used as a clump of cans that have been given a motif. light the candle and turn off the light, then the aromatic lamp is ready to use.

3. RESULTS AND DISCUSSION

3.1. Analysis of Characterization Results

To calculate the total mass of the candle burned at each ratio, the mass burned add up at each time interval by adding up each mass burned at each burning time every 5 minutes. Ratio 1:3 (Parafin : Oil) results in the most mass burned (216 grams) because the dominance of oil makes the candle melt faster and burn quicker. Ratio 2:1 results in the least mass burned (108 grams) because the higher paraffin content makes the candle harder and longer-lasting. Ratio 1:2 and Ratio 3:1 yield varying results, with 180 grams and 72 grams, respectively, showing that candles with more paraffin (3:1) last longer, while those with more oil (1:2) burn faster.

A ratio of 1:2 produces wax with a relatively large mass, namely 5 grams burning every 5 minutes, where the dominance of oil in the composition makes the wax softer and easier to melt, making it suitable for producing a bright flame even though the burning duration is shorter; while a ratio of 2:1 shows a smaller burning mass of wax, an average of 3 grams every 5 minutes, because the higher paraffin content provides stability and hardness to the wax, so that the burning time is longer and ideal for medium burning duration needs. On the other hand, a ratio of 1:3 shows the largest burning mass, namely an average of 6 grams every 5 minutes, with the dominant oil content making the wax very soft and burning quickly, making it less efficient for long-term use and more suitable for bright flames in a short time. Finally, a ratio of 3:1 shows the best efficiency with the smallest burning mass, an average of only 2 grams every 5 minutes; The high paraffin content makes the candle harder, more stable and more durable, making this ratio perfect for long-term burning needs. It is represented in **Figure 1**.

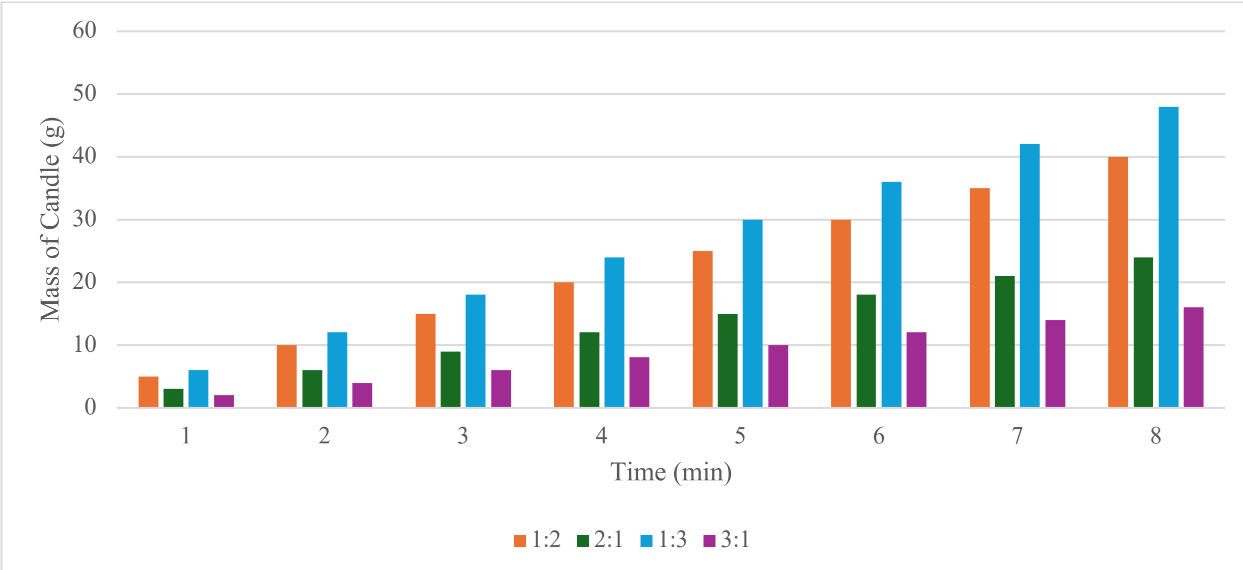

Figure 1. Increasing mass of candle with variation of paraffin : oil effect

3.2. Analysis of Characterization Results of Lamps Using Ordinary Candles with Candles from Used Cooking Oil

The use of aromatherapy lamps not only serves as decoration, but is also believed to improve physical and mental health, help reduce stress, improve sleep, and create a more comfortable atmosphere. In addition, these lamps are often used in various places such as spas, hotels, and homes to create a pleasant and relaxing atmosphere. The data obtained in the experiment of making aromatic lamps using candles from used cooking oil with lemongrass extract, then compare the lamps with various differences in the ratio in the manufacturing.

The calculation average rate of rotation per time interval by the method:

$$Time = number\ of\ rounds\ (final\ number\ of\ rounds - previous\ number\ of\ rounds\ in\ 5\ minutes)$$

To calculate the rotation rate of the aromatic night light in the context of the Carnot cycle, the candle rotation rate data to compare the performance of the night light using ordinary candles and aromatherapy candles. Carnot Engine Efficiency Formula:

$$\eta = 1 - \frac{T_C}{T_H}$$

where: T_C = cold reservoir temperature (in Kelvin)

T_H = hot reservoir temperature (in Kelvin)

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Inspite of the Carnot cycle efficiency for both types of candles is not much different, where ordinary candles have a slightly higher efficiency at 12% compared to 11% for aromatherapy candles, this shows that ordinary candles can convert the chemical energy stored in the fuel into light energy slightly better than aromatherapy candles. In other words, ordinary candles are able to utilize existing resources more efficiently, thus providing added value to users.

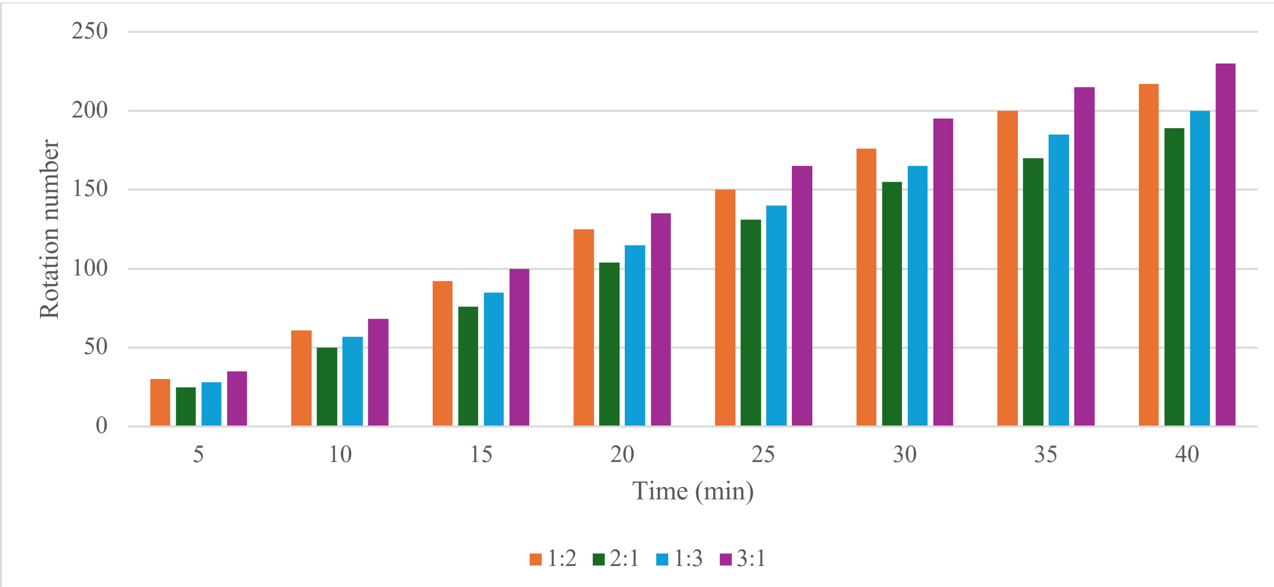

Figure 2. Variaton of paraffin : oil effect to rotation number of lamp

The data presented illustrates the relationship between time (in minutes), the ratio of paraffin to oil mixture, and the number of revolutions generated. In general, the data show an increase in the number of revolutions over time at all mixture ratios. This indicates that the revolution process is dynamic and continues throughout the duration of the experiment. Each ratio shows a consistent pattern of increase, although there are variations in the number of revolutions depending on the ratio of paraffin to oil mixture. The gradual increase in the number of revolutions over time indicates that the system remains active and does not experience a decrease in performance during the experiment. This may be related to the stability of the mechanism or the effect of the material mixture that increases the efficiency of the revolution. For example, at a ratio of 3:1 (where the paraffin content is more dominant), the number of revolutions generated in a certain time interval tends to be higher than other ratios. This ratio produces a greater number of revolutions at the 40th minute, indicating that paraffin contributes significantly to the propulsion or smoothness of the revolutions in the system. The comparison between the ratios of paraffin and oil mixtures shows a clear effect on the number of revolutions. The ratio of 3:1 (more paraffin) consistently produces the highest number of revolutions in each time interval. The ratio of 2:1 also performs well, although its number of revolutions is slightly lower than 3:1. In contrast, the ratios of 1:2 and 1:3, where the oil content is more dominant, produce lower number of revolutions at the same time.

From these findings, it can be concluded that a higher proportion of paraffin plays a significant role in increasing the number of revolutions. This is most likely due to the physical and chemical properties of

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paraffin which may be more effective in reducing friction or increasing thrust during the rotation process. Conversely, a higher oil content may provide an excessive lubricating effect, thereby reducing the rotation efficiency. The bar graph visualizing the tabular data further clarifies the pattern of increasing number of revolutions over time. This graph not only confirms that the revolutions increase consistently for each ratio, but also shows the performance differences between ratios. The height of the bar at a given time indicates the number of revolutions achieved, while the difference in height between bars for different ratios at the same time reflects the effect of the mixture ratio on the rotation results. If an imaginary line is drawn to connect the tops of the bars on the graph for each ratio, the slope of the line will give an indication of the rate of increase in revolutions. The ratio with the steepest line indicates a faster rate of increase in revolutions, which in this case is the ratio of 3:1. This shows that this ratio not only produces a higher number of revolutions, but also has a greater rate of rotation acceleration than other ratios.

4. CONCLUSION

The composition of the candle has a significant effect on the burning rate, which is important in the creation of a moving nightlight with aromatherapy candles, utilizing the Carnot cycle principle. The 1:3 ratio (paraffin:oil), which is more oil-dominant, results in the fastest and most efficient burn, with the highest amount of candle mass burned after 40 minutes. This is suitable for applications that require rapid burning, such as in the creation of a moving nightlight that utilizes the Carnot cycle to convert heat into mechanical energy for movement. In contrast, the 3:1 ratio (paraffin:oil) produces a harder and more durable candle, with less mass burned, making it more suitable for long-term use and stable movement. The 1:2 and 2:1 ratios provide a balance between burn duration and light intensity, allowing them to be chosen based on specific needs. The selection of the appropriate candle ratio is crucial in creating an efficient and stable movement effect in the moving nightlight, according to the principle of converting heat energy into mechanical energy in the Carnot cycle. Based on the tests, regular candles are a better choice for aromatic night lights. Market candles, typically made of paraffin, have a higher melting point and longer burn time compared to homemade candles using used cooking oil, paraffin, and citronella extract. Regular candles are more energy-efficient and stable, as paraffin is a non-reactive hydrocarbon, while used cooking oil contains oxidized compounds and residues that affect burning. These residues can lead to quicker burning, smoke, and residue production. Although aromatherapy candles, with citronella extract, help reduce stress, regular candles are superior in terms of burn time and stability, making them a better light source for night lights.

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