International Journal of Innovation and Industrial Revolution
IJIREV
EISSN: 2637-0972

Volume 6 Issue 19 (December 2024) PP. 228-234
DOI 10.35631/IJIREV.619017

INTERNATIONAL JOURNAL OF INNOVATION AND INDUSTRIAL REVOLUTION (IJIREV)
www.ijirev.com

GLOBAL ACADEMIC EXCELLENCE

THE EFFECT OF PARAFFIN WAX CANDLE WITH DIFFERENT PERCENTAGE OF ADDITIVE USED ON BURNING EFFICIENCY OF THE CANDLE

Siti Zairyn Fakurol Rodzi[1], Tengku Fatimah Zahrah Tengku Su Iskandar[2*]

[1] STEM Foundation Centre, Universiti Malaysia Terengganu, Malaysia
Email: siti.zairyn@umt.edu.my
[2] STEM Foundation Centre, Universiti Malaysia Terengganu, Malaysia
Email: fatimahtsi@gmail.com
[*] Corresponding Author

Article Info:

Article history:
Received date: 27.10.2024
Revised date: 11.11.2024
Accepted date: 18.12.2024
Published date: 26.12.2024

To cite this document:

Rodzi, S. Z. F., & Iskandar, T. F. Z. T. S. (2024). The Effect Of Paraffin Wax Candle With Different Percentage Of Additive Used On Burning Efficiency Of The Candle. *International Journal of Innovation and Industrial Revolution*, *6* (19), 228-234.

DOI: 10.35631/ IJIREV.619017

Abstract:

Paraffin wax burned cleanly, burn brighter and was less expensive to produce than other candle fuels, it represented a significant advancement in the candle-making industry. However, since paraffin wax melts easily, most candles manufactured with it are fragile. Many experiments and techniques have shown that stearic acid and paraffin wax could work well together to produce long-lasting candles. This study examines how the proportion of stearic acid added to paraffin wax candles affects the candles' ability to burn efficiently. Few paraffin waxes candles that are, 5%, 10%, and 15% were made in accordance with the various stearic acid percentages. Result shows that, the largest percentage of stearic acid results in the lowest burning rate of 0.00135 cm s^{-1}. It was found that the added additive affected the candles' efficiency of burning after monitoring the burning rate. The findings of this study may be very useful in the production of low-cost, long-lasting candles.

Keywords:

Paraffin Wax, Stearic Acid, Candle, Burning Rate, Burning Efficiency

Introduction

The raw materials used to make paraffin wax are fossil crude oil and alkanes, which are waxy solids at room temperature (Rasmussen et al., 2021). Paraffin, stearin, and beeswax are the

International Journal of Innovation and Industrial Revolution
IJIREV
EISSN: 2637-0972
Volume 6 Issue 19 (December 2024) PP. 228-234
DOI 10.35631/IJIREV.619017
three main ingredients used in the production of candles. The complex mixture of hydrocarbons that makes up paraffin, which is extracted from mineral oil (Aisyah et al., 2020). Candle manufacturing uses a highly refined paraffin that is obtained through filtration, de-oiling, and hydrogenation (Brans et al., 2020). Paraffin is the most appropriate of them for use in all candle-making procedures. Paraffin candles are a more cost-effective solution due to the availability and adaptability of paraffin wax, especially when purchased in large quantities. The best candle in terms of longevity can only be produced by finding the ideal method for creating paraffin wax candles (Kasprzok et al., 2021). According to Furlong, soy wax candles produced the shortest flames, beeswax candles produced flames of an intermediate length, and paraffin wax candles produced the longest flames.

Considering earlier research, the addition of stearic acid was studied where the highest-quality candles are made from spent cooking oil, which is the product of the adsorption of activated carbon and stearin (Anthony et al., 2005; Jamilatun et al., 2022). Hydrolysis of typical animal or vegetable fats and oils yields stearic acid. Solid saturated fatty acids and liquid unsaturated fatty acids are separated by pressing techniques. The chemical grades of stearic acid are then obtained by fractionating the crude stearic acid. The various grades are based on how many times stearic acid is pressed (Danh et al., 2020). The manufacture of candles is among the industries that uses stearic acid the most. It helps in the production of volatile and pillar candles with extended burn times. Based on previous study by Liu, stearic acid is considerably increasing the hardness of waste cooking oil (WCO)-based wax. Stearic acid, as previously mentioned, adds to the hardness of candles, increasing their durability, lowering their likelihood of breaking or crumbling and increases the longevity of the candles (Feng et al., 2019; Khan et al., 2019; Udoh et al., 2021; Rezaei et al., 2022).

Researchers will profit from this study since it will enable them to produce long-burning candles, which industrials would choose to purchase over short-burning candles. One of the drawbacks of paraffin wax is it has low melting point. Paraffin candles soften due to their low relative melting points; as a result, it was difficult for them to maintain their shape while burning and the burning rate is high. In order to harden the candle and reduce the rate of burning, it is necessary to identify the type of additive that is used with paraffin. A candle with too much stearic acid may be difficult to light and may tunnel; conversely, a candle with too little stearic acid may burn unevenly and fail to release scent. Knowing how much stearic acid is required to make the greatest candle is therefore ideal. The quantity of additive utilized has not been the subject of much research. The study's goal is to create paraffin wax candles with different amounts of stearic acid ingredient. Thus, the purpose of the study is to make paraffin wax candles using varying proportions of stearic acid additive. Additionally, the impact of the candle's burning efficiency is then being examined.

Materials and Method

This research method involves three main steps. The process for making paraffin wax candles is the initial phase. Additionally, the measurement of the candles' height, mass, and burning rate is provided in the second phase. Following the completion of the research, the final step focusses on gathering and analyzing data from the candles.

Preparation of Control Sample

A laboratory balance is used to weigh 10 g of paraffin wax, as shown in Figure 1. After that, the wax was gradually melted in a 250 ml beaker over a hot plate using a double boiler. It was

International Journal of Innovation and Industrial Revolution
IJIREV
EISSN: 2637-0972
Volume 6 Issue 19 (December 2024) PP. 228-234
DOI 10.35631/IJIREV.619017

then periodically stirred with a spatula set to a temperature range of 100 °C to guarantee even melting. To cool it down, the beaker was taken off the heat source and it was stirred a few minutes. Next, as illustrated in Figure 2, the wick is inserted into the mould and the molten paraffin wax is poured within.

Addition of Different Percentage of Stearic Acid

Different weight percentages of stearic acid; 0.5 g (5%), 1.0 g (10%), and 1.5 g (15%) were used to repeat the experiments. After removing the beaker from the heat source, it is agitated until the temperature falls to between 55 and 70 °C, which is the point at which stearic acid begins to solidify once more. The prepared paraffin candles were allowed to dry for 24 hours at 25 °C.

Figure 1: 10 g of Paraffin Wax

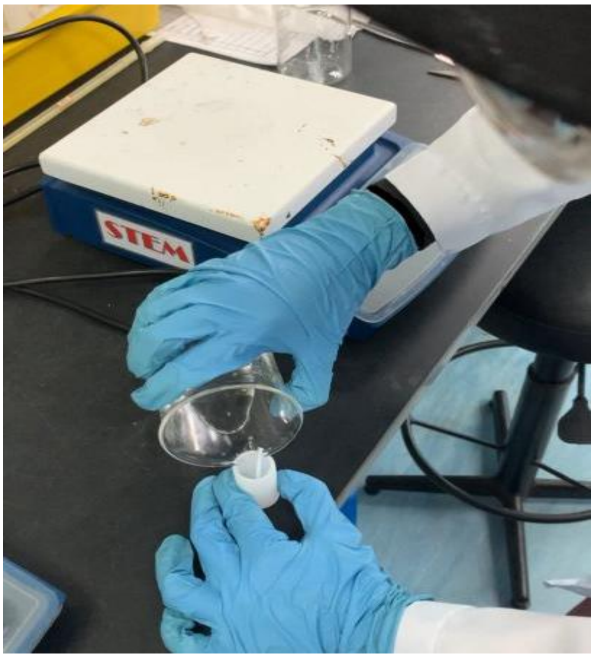

Figure 2: Candle Wick is Placed and Melted Wax is Poured into the Mould

International Journal of Innovation and Industrial Revolution
IJIREV
EISSN: 2637-0972
Volume 6 Issue 19 (December 2024) PP. 228-234
DOI 10.35631/IJIREV.619017

Measurement of Candles

The candles are burned simultaneously for a duration of 1020 s as shown in Figure 3 and the variation in burning was noted. After that, the candles' final height is measured, and Equation 1 is used to determine the candles' rate of burning.

$$Burning\ rate = \frac{height\ (cm)}{time\ (s)} \qquad \text{Equation 1}$$

Figure 3: Candle Burning Process is Recorded for a Duration of 1020 s

Results and Discussion

In order to quantify the impact of an independent variable on a dependent variable, researchers use the experiment technique, which involves controlling or manipulating the independent variable.

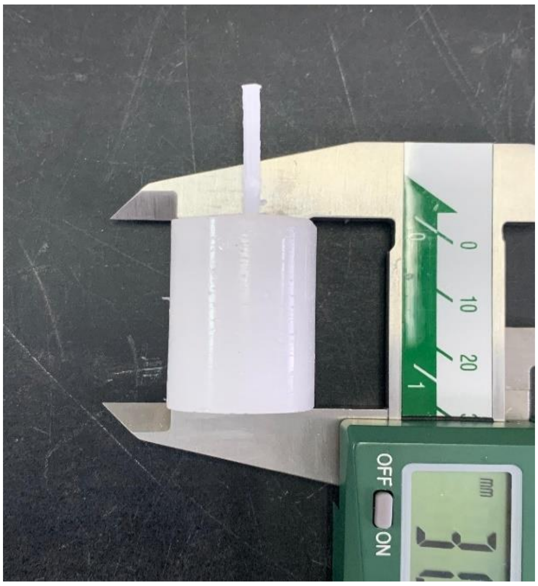

Figure 4: Candle Initial Height is Measured Using Vernier Calliper

International Journal of Innovation and Industrial Revolution
EISSN: 2637-0972
IJIREV
Volume 6 Issue 19 (December 2024) PP. 228-234
DOI 10.35631/IJIREV.619017

Effect of Different Percentage of Stearic Acid on Burning Rate of Candle

The candles' height was measured before and after the burning process as shown in Figure 4 using a vernier caliper, the height and mass of the completed candles were determined while the burning rate was computed.

Table 1: Initial Height, Final Height and Percentage Difference of Candle

Candle	Initial height (cm)	Final height (cm)	Percentage Difference (%)
1	5.02	3.33	33.7
2	5.02	3.43	31.7
3	5.02	3.54	29.5
4	5.02	3.64	27.5

Drawing conclusions from Table 1, it can be stated that the candle with the highest percentage of stearic acid, 15% has the lowest percentage difference in height which is 7.5%. Meanwhile the candle with the lowest percentage of stearic acid, 0% has the highest 33.7%. This suggests that when more stearic acid is added, the candles melt more slowly and the height difference between them reduces.

Table 2: Percentage of Stearic Acid and the Burning Rate of Candle

Candle	Percentage of Stearic Acid (%)	Burning Rate of Candle (cm s^{-1})
1	0	0.00166
2	5	0.00156
3	10	0.00145
4	15	0.00135

The burning rate of candles with varying percentages of stearic acid used is shown in Table 2. In the meantime, Figure 5 depicts a graph with a decreasing burning rate, with 0.00166 cm s^{-1} at the highest rate and 0.00135 cm s^{-1} at the lowest. Equation 1 is used to compute the candle's burning rate. It may be used to determine that a larger proportion of stearic acid results in a lower burning rate, meaning that as stearic acid is added to paraffin wax, the candle will burn for a longer period of time. Rislianti reported that the candle burns longer and has a more consistent, long-lasting flame when more stearic acid is added to the paraffin wax.

International Journal of Innovation and Industrial Revolution
IJIREV
EISSN: 2637-0972
Volume 6 Issue 19 (December 2024) PP. 228-234
DOI 10.35631/IJIREV.619017

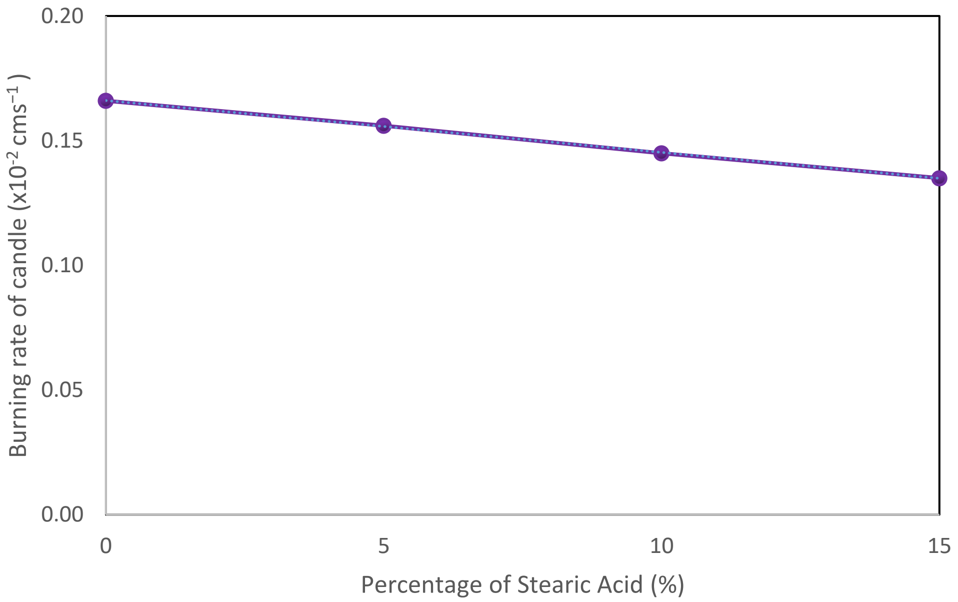

Figure 5: Burning Rate of Candle Versus the Percentage Amount of Stearic Acid

Conclusion

This investigation involved producing candles with varying percentages of stearic acid and observing the results. The findings demonstrated that the stearic acid ingredient, which is added to candles, modifies the melting point of the wax, hence controlling the pace of burn. At 15%, the largest percentage of stearic acid results in the lowest burning rate of 0.00135 cm s^{-1}, whereas at 0%, the highest burning rate is 0.00166 cm s^{-1}. As a result, it was possible to ascertain how stearic acid affected the candle; the more stearic acid added to paraffin wax, the slower the candle burned. It is possible to find out if the dye in the candles will affect how efficiently they burn, so it is highly recommended that this experiment be repeated in the future with scent and colour added.

Acknowledgements

The author would like to acknowledge the STEM Foundation Centre, Universiti Malaysia Terengganu (UMT) to provide the excellent lab chemicals and equipment.

References

Aisyah, S., Effendi, Z., & Hawalis, S. N. (2020). Optimasi Pembuatan Lilin Aromaterapi Berbasis Stearic Acid Dengan Penambahan Minyak Atsiri Cengkeh (Syzygium Aromaticum). *Jurnal Hexagro, 4(1)*, 73-82.

Anthony, H., Matthew B., & Scott E. D., (2005). Characterization of Candle Flames. *Journal of Fire Protection Engineering 15(4)*, 265-285.

Anwar, J., Shafique, U., Waheed-uz-Zaman, M. S., Dar, A., Farooq, R., & Hassan, M. (2009). Effect of Different Additives on Burning Efficiency of the Candles. *World Applied Sciences Journal, 7(3)*, 340-342.

Brans, R. (2020). Candle makers. Kanerva’s Occupational Dermatology, 1789-1792.

Dahn, P., Tri N. P., & Do T. K., (2020). Preparation and Characterization of Naturally Scented Candles Using the Lemongrass. *Materials Science Forum, 977*, 212-217.

Volume 6 Issue 19 (December 2024) PP. 228-234
DOI 10.35631/IJIREV.619017

Feng G., Ozaki Y., & Nishimura K., (2019). Experimental study on flame stability limits of lithium ion battery electrolyte solvents with organophosphorus compounds addition using a candle-like wick combustion system. *Combustion and Flame*, 207, 63-70.

Furlong, A. J., Haelssig, J. B., & Pegg, M. J. (2023). Impact of candle wicks and fuels on burning rate, flame shape, and melt pool diameter. *Combustion and Flame, 249,* 112628.

Jamilatun, S., Luthfiani, I. N., Putri, D. P., Pitoyo, J., & Rahayu, A. (2022). The Effect of Variations of Stearin Mass and Used Cooking Oil From Purification with Activated Carbon on the Quality of The Candle. *Agroindustrial Technology Journal*, *6(1)*, 35-57.

Kasprzok, L., Boussert, S., Rivera, J., & Cretté, S. (2021). Case study: Characterization of 19th century candles from maritime archaeological environments with FTIR, NMR, and GC–MS. *Journal of Archaeological Science: Reports, 35,* 102711.

Khan, K. A., Ali, M. H., Obaydullah, A. K. M., & Wadud, M. A. (2019). Production of candle using solar thermal technology. *Microsystem Technologies, 25,* 4505-4515.

Liu, Y., Liu, M. Y., Qi, Y. X., Jin, X. Y., Xu, H. R., Chen, Y. X., & Su, H. P. (2022). Synthesis and properties of wax based on waste cooking oil. *RSC advances*, *12(6)*, 3365-3371.

Rasmussen, B. B., Wang, K., Karstoft, J. G., Skov, S. N., Køcks, M., Andersen, C., Wierzbicka, A., Pagels, J., Pedersen, B. P., Glasius, M., & Bilde, M. (2021). Emissions of ultrafine particles from five types of candles during steady burn conditions. *Indoor air*, *31(4)*, 1084-1094.

Rezaei, K., Wang, T., & Johnson, L. A. (2002). Hydrogenated vegetable oils as candle wax. *Journal of the American Oil Chemists' Society*, *79(12)*, 1241-1247.

Rislianti, V. A., Rijai, L., & Aryati, F. (2021, December). Formulasi Lilin Aromaterapi Berbahan Aktif Minyak Atsiri Sereh Wangi (Cymbopogon winterianus) dan Jeruk Lemon (Citrus limon): Aromatherapy Candle Formulation with Active Ingredients of Citronella (Cymbopogon winterianus) and Lemon (Citrus limon) Essential Oils. *In Proceeding of Mulawarman Pharmaceuticals Conferences* (Vol. 14, pp. 312-318).

Udoh, A. P., Akpan, A. U., & Akpan, D. J. (2021). Metal Ion Improved Properties of Burning Candle. *European Journal of Advanced Chemistry Research, 2(4)*, 1-5.