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REVIEW PAPER ON CANDLE MAKING MACHINE

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Abstract: Candle manufacturing plays an important role in small-scale and small-scale industries, particularly in developing countries where candles are widely used for religious activities, for decorations in festivals, and in emergency purposes, like if there is shortage of electricity mostly it has been in villages. This review paper presents a comprehensive analysis of existing candle making machine designs with emphasis on fabrication methods, power transmission mechanisms, material selection, cooling systems, and mechanical performance parameters. Various mechanisms such as rack and pinion, pawl and ratchet, cam and follower, and gear drives are examined in terms of productivity, cost, and operational efficiency. The study also compares manual, semi-automatic, and motorized systems to evaluate their suitability for small and medium-scale industries. Based on the literature survey, key challenges including high equipment cost, limited automation, and cooling inefficiencies are identified. The review highlights the need for compact, cost-effective, and energy-efficient machine designs to enhance productivity while reducing labor dependency.

Keywords- Candle making machine, fabrication, rack and pinion, pawl and ratchet, cooling system, small-scale industry.

I. INTRODUCTION

Candles have been an essential part of human civilization from centuries. From providing light in the absence of electricity to serving religious, decorative, and ceremonial purposes, candles continue to hold both functional and cultural importance. A candle is generally defined as a combustible wick embedded in a solid fuel such as wax or tallow, which produces light and sometimes fragrance when ignited. Although modern lighting systems dominate today's world, candles remain widely used in households, festivals, religious practices, and emergency situations.

In countries like India, candles play a significant role during festivals such as Diwali and other religious occasions. Similarly, in many developing regions, candles are still relied upon during power outages or in rural areas where electricity supply is inconsistent. This continuous demand has made candle manufacturing an important small- and medium-scale industry. Beyond traditional plain candles, the market has expanded to include scented, decorative, colored, and customized candles, creating new opportunities for entrepreneurs.

Traditionally, candle making was a manual craft that required simple tools and skilled labor. However, manual production methods are time-consuming, labor-intensive, and often result in inconsistencies in product quality. Issues such as improper wick alignment, uneven cooling, wax wastage, and safety risks can affect both productivity and product performance. The size of the wick, the type of wax used, and the cooling process significantly influence the burning efficiency and overall quality of the candle. Therefore, maintaining precision in each step of production is essential.

With industrial advancement, mechanical and semi-automatic candle making machines have been introduced to improve productivity, reduce labor effort, and enhance uniformity in candle production. These machines typically consist of mold systems, ejection mechanisms, feeding systems, and motion-transmitting components such as gears, pulleys, cams, and ratchet mechanisms. The introduction of such machines has helped bridge the gap between large-scale industrial production and small-scale enterprises.

However, one major challenge observed in many developing economies is the high cost of imported candle making machines. Most available commercial machines are expensive and not easily affordable for small entrepreneurs. This creates a need for cost-effective, locally fabricated, and energy-efficient candle making machines that can operate under standard working conditions while maintaining productivity and quality.

In addition, supporting processes such as wax melting, wax cutting, and mold cooling also influence the overall

efficiency of candle production. Studies related to paraffin wax processing highlight the importance of proper material handling and preparation in ensuring consistent product quality and reduced wastage. Hence, improvements in both machine design and auxiliary processes are essential for achieving better industrial performance.

The present review focuses on the design and development of candle making machines, examining their working principles, components, material selection, mechanical mechanisms, and economic feasibility. The objective is to understand how innovative and low-cost machine designs can enhance productivity, reduce manual effort, and promote sustainable small-scale manufacturing in the candle industry.

II. LITERATURE REVIEW

Candle manufacturing has transitioned from traditional manual moulding techniques to mechanized and semi-automated production systems. Several researchers have focused on improving productivity, reducing cost, and enhancing mechanical efficiency of candle making machines for small and medium-scale industries.

A fabrication-based approach to candle machine development was presented in International Research Journal of Engineering and Technology (IRJET), where a cost-effective candle making machine was designed to reduce dependency on imported equipment. The authors emphasized the use of locally available materials such as mild steel for structural components and aluminium moulds for better heat dissipation. The study incorporated gear mechanisms, pulley systems, and an ejection assembly to improve operational efficiency. The developed machine significantly reduced production cost compared to imported models while maintaining productivity. Design modification and performance improvement were further addressed in International Journal of Scientific Research in Science Engineering and Technology (IJSRSET). The researchers focused on structural optimization through rack and pinion mechanisms, shaft design, bending moment analysis, and water cooling systems. The cooling arrangement enhanced wax solidification rate and improved overall output. Reduction in moving parts and improved lubrication mechanisms contributed to durability and ease of maintenance. Another significant contribution was reported in International Journal of Advances in Engineering and Management (IJAEM) , where the authors implemented pawl and ratchet mechanisms along with eccentric cam and follower systems for controlled die rotation and winding operation. Detailed mechanical design calculations for shaft diameter, torque transmission, and stress analysis were carried out using SAE 1030 material. The study concluded that the mechanized winding system reduced labor cost, minimized floor space requirement, and increased production rate. Earlier developments in candle manufacturing mechanization date back to the 19th century, where mould-based machines significantly improved production capacity. Advances in compression moulding techniques and paraffin wax processing further enhanced structural quality and burn performance of candles. Additionally, vegetable oil-based candle formulations were patented to promote eco-friendly alternatives in candle production. The use of candles as a basic source of lighting continues to be important in many developing regions, particularly where electricity supply is unreliable. In countries like Bangladesh, frequent power shortages have encouraged the search for low-cost and locally adaptable candle production methods. Traditionally, candle manufacturing has relied on conventional fuels such as kerosene, gas, or electricity to melt wax. Although these methods are simple, earlier studies have pointed out several limitations, including high fuel consumption, safety concerns, smoke generation, and the need for constant supervision during the melting process. These drawbacks have motivated researchers to explore alternative energy sources for wax melting and candle production.

Over the past few decades, solar thermal technology has gained attention as a sustainable and affordable solution for small-scale industrial applications. Researchers working at the Solar Energy Research Centre (SERC) under Jagannath University have demonstrated that solar collectors can effectively generate sufficient heat for domestic and small commercial processes. Earlier investigations by Md. Kamrul Alam Khan and his collaborators focused on the design and performance analysis of solar concentrators, including linear Fresnel reflecting systems. These systems were originally studied for applications such as water heating, steam generation, and drying processes. The findings from those works established that solar concentrators could achieve considerable thermal efficiency under the climatic conditions of Bangladesh.

Building on this foundation, subsequent studies introduced the concept of solar-based candle production. The bucket-type solar candle machine, developed and tested by researchers including K. A. Khan, represents an important step in adapting solar thermal collectors for small-scale manufacturing. Unlike conventional open-flame heating, the solar system uses a flat-plate or concentrating collector to trap and retain heat inside a closed melting chamber. Insulation materials such as glass wool and glazing layers are incorporated to reduce heat loss and improve efficiency. Comparative performance evaluations have shown that double-glazed systems generally perform better than single-glazed models, particularly under clear sky conditions.

The literature also highlights the role of concentrating collectors, especially Fresnel reflecting concentrators, in enhancing thermal performance. A Fresnel reflector uses multiple narrow mirror strips arranged in a planar configuration to focus sunlight onto a receiver surface. Previous experimental work reported that such systems can significantly increase the temperature of the absorber plate, enabling faster melting of paraffin wax. These findings support the argument that concentrator-based designs may be more efficient than simple flat-plate bucket systems, especially when higher production capacity is desired.

In addition to system design, several researchers have discussed the properties and suitability of different wax materials for candle production. Paraffin wax remains the most widely used material due to its low cost, consistent burning characteristics, and ease of molding. However, concerns have been raised about its origin as a petroleum by-product and its environmental implications. On the other hand, beeswax has been recognized as a natural and renewable alternative, offering cleaner burning and longer-lasting candles, although at a higher cost. Studies comparing these materials suggest that the choice of wax depends largely on economic considerations and intended market demand.

Performance assessments of solar candle production systems have generally focused on efficiency, melting rate, and daily output under varying weather conditions. Experimental results reported in earlier works indicate that efficiency improves with higher solar radiation and better insulation.

Seasonal variations, cloud cover, and wind speed also influence overall productivity. Some researchers have recommended increasing the absorber surface area or incorporating double glazing to enhance heat retention and increase daily candle output.

From an economic perspective, the literature emphasizes the low fabrication cost and minimal operating expense of solar candle machines. Since solar energy is freely available, recurring fuel costs are eliminated. This makes the technology particularly attractive for rural and low-income communities. Several studies have suggested that small-scale solar candle production can create employment opportunities, including for women and physically challenged individuals, thereby contributing to local income generation.

Overall, the existing body of research demonstrates steady progress in integrating solar thermal technology with small-scale candle manufacturing. Early work established the thermal feasibility of solar collectors, while later studies adapted these systems specifically for wax melting and candle molding. Although improvements in efficiency and design are still possible, the literature clearly supports solar-based candle production as an environmentally friendly, economically viable, and socially beneficial alternative to conventional methods.

Overall, the reviewed literature indicates that most research efforts focus on cost reduction, compact machine design, mechanical efficiency, and suitability for small-scale industries. However, limited work has been reported on automation integration, energy optimization, and advanced corrosion-resistant materials for prolonged machine life.

III. OBJECTIVES OF THE STUDY

1. To study existing designs and fabrication methods of candle making machines.
2. To analyze different power transmission mechanisms and material selection used in machine construction.
3. To evaluate cooling systems and mechanical design parameters affecting productivity and performance.
4. To compare manual and motorized machines in terms of cost, efficiency, and labor requirement.
5. To identify improvements for developing a compact, cost-effective, and efficient candle making machine suitable for small-scale industries.

IV. CONCLUSION

This review study analyzed various candle making machine designs focusing on fabrication techniques, mechanical mechanisms, material selection, and cooling systems. The literature indicates that most machines are designed to reduce cost and improve productivity for small and medium-scale industries. Mechanisms such as rack and pinion, pawl and ratchet, cam and follower, and gear drives play a significant role in improving motion control and production rate. Proper material selection and cooling arrangements enhance durability and solidification efficiency. However, many existing designs remain semi-mechanized, with limited automation and energy optimization.

Overall, there is a clear need for compact, economical, and mechanically efficient candle making machines that can provide higher productivity with reduced labor dependency.

V. FUTURE SCOPE

Future research can focus on:

1. Integration of automation and programmable control systems for improved precision and productivity.
2. Development of energy-efficient and low-power consumption designs.
3. Use of advanced corrosion-resistant and lightweight materials to enhance durability.
4. Optimization of cooling systems for faster wax solidification and reduced cycle time.
5. Implementation of ergonomic and safety improvements for user-friendly operation.
6. We can also add the Hinges in the mould to make the process more smoother.
7. Advancements in these areas can significantly improve the performance, affordability, and commercial viability of candle making machines for small-scale entrepreneurs.

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