International Journal of Scientific Research in Engineering and Management (IJSREM)
Volume: 06 Issue: 06 | June - 2022 Impact Factor: 7.185 ISSN: 2582-3930

Induction Cooker

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***Abstract*—Magnetic induction heating, which takes advantage of high frequency eddy current losses, is a typical technique for heating metallic objects. In the last one to two decades, induction heating has been expanded to the catering business as an induction cooker. The induction cooker is quickly becoming one of the most popular kitchen gadgets. This research focuses on an induction cooker's magnetic field in order to increase its heating effectiveness. A typical induction cooker's magnetic field and heating capabilities are first investigated. Furthermore, the drawbacks of typical induction cookers are identified. To alleviate the shortcomings of traditional induction cookers, a revolutionary coil configuration is proposed. In the meantime, the Finite Element Method is being utilised to model and further analyse the behaviour of the induction cooker. Finally, the proposed induction cooker prototype is built. The findings of standard and new induction cooker experiments are presented and contrasted. The proposed technique can effectively increase the heating performance of a typical induction cooker, according to both modelling and experimental data.**

***Index Terms*—Induction cooker, magnetic field, heating performance, coil**

I. Introduction

Induction cooking has been increasingly popular in families and caterers in recent years because to its inherent benefits, such as great heating efficiency, quietness, and cleanliness. A typical induction burner consists of a metal wok and a magnetic coil. The coil is excited by a medium-frequency (20 kHz to 100 kHz) power source, which produces an alternating magnetic field with eddy currents and hysteresis, which heats the work[1].

Many attempts have been made in the past to improve the performance of induction cookers through study. In reference [2, the inductance and ac resistance of a heat-coil were investigated, and it was discovered that increasing the magnetic field intensity had a significant impact on the coil inductance and ac resistance. Reference [3] provided a design for an induction heating coil based on the transient temperature distribution and power densities of the workpiece during an induction heating operation. Reference [4] looked into the heating efficiency of an induction cooker with and without a ferrite plane. It has been demonstrated that adding a second ferrite plane to an induction cooker increases its heating efficiency. In reference [5, the use of a half-bridge series resonant inverter in an induction cooker was investigated. However, from the perspective of magnetic field analysis and coil format, only a few attempts have been made to improve the heating effectiveness of induction cookers. This study investigates the structure of traditional heating performance as well as the problems that come with it. The traditional coil is a single coil with a uniform distribution of current. The heating distribution of an induction cooker can be mirrored by its magnetic field dispersion. Based on the findings of the inquiry, a novel coil design is provided to overcome these concerns. The FEM (Finite Element Method) is used to replicate the experimental findings of the traditional and proposed induction cookers in order to compare them.

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II. Conventional Induction Cooker

Structure of conventional induction cooker

A conventional induction cooker consists basically of a wok, coil, and driving circuit, as shown in Fig. 1. A flat pancake coil is placed beneath the conductive cooking wok with a thermal insulator between them. Due to eddy currents created by a mediumfrequency current (20 kHz to 100 kHz) in the coil, the wok warms up quickly. The conventional coil is a single coil with even distribution as shown in Fig. 2. If there is current in the coil, the direction of the current at one moment would be like Fig. 2.

A. FEM Simulation of conventional induction cooker

A 3D FEM model, as illustrated in Fig. 3, is developed for simulation to further examine the traditional induction cooker. Because of its poor relative permeability and conductivity, the

Fig. 1. Simplified structure of conventional induction cooker.

Fig. 2. Format of conventional coil

insulator isn't used. The wok and the coil are the two components of the model. The coil is modelled after a traditional coil, which is a single coil with an evenly dispersed current.

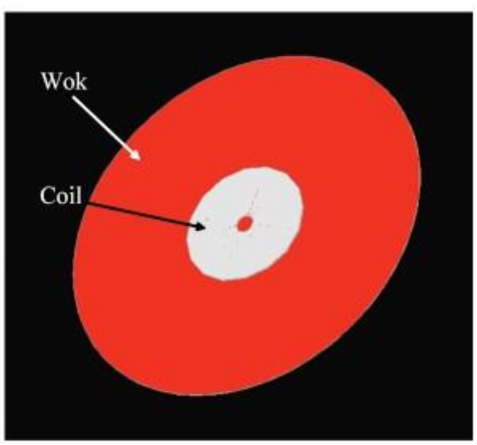

Fig. 3. 3D FEM model of conventional induction cooker

The flux density B amplitude curve versus the wok's midline is shown in Figure 4. The magnetic field is unequal, and the cross-sectional view given in Fig 4b shows only a single peak on each side of the centre, indicating a small area of high magnetic field.

the simulation result of the magnetic field distribution on the traditional induction cooker model. In Fig. 4, the magnetic field concentrates in a narrow ring area with a single peak, indicating the same issue. For field densities greater than 0.6T, the ring size is less than 20

All of the simulation findings reveal that the magnetic field

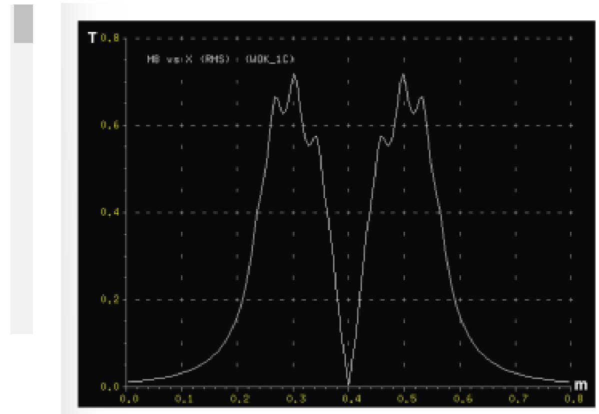

Fig. 4. Magnetic field vs. midline of work.

of a traditional induction cooker is uneven and localised, resulting in localised hot patches and poor heating performance, as well as the heating surface ageing quickly and inefficient heat transfer.

III. Proposed Work

A. *Novel coil proposed*

A novel coil configuration is presented to solve the disadvantages of the standard induction cooker and improve its heating performance. By using the formula, you can calculate the magnetic field strength and magnetomotive force F. (1). Figure 6 shows the MMF F(x) across the coil of a standard induction cooker as a function of the distance x from the edge.

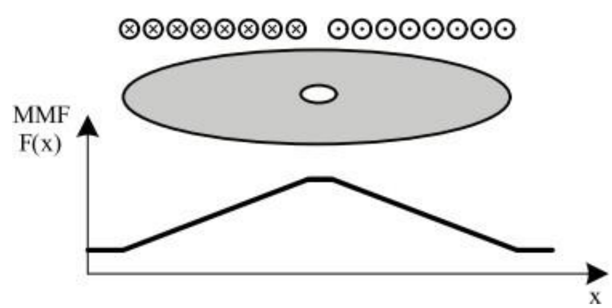

Fig. 5. MMF of conventional coil

The magnetic field of the inner and outside positions of the wok needs to be enhanced, according to the analysis of a conventional induction cooker. When the current remains constant, the magnetic field can be modified by altering N and lm from (1). Increase the number of coil turns in the relevant area to improve the low magnetic field. Figure 7 depicts an example of the innovative coil format. It's also known as a variable turn pitch coil. Although this coil is still a single coil, the turn density varies across the coil, affecting the magnetic field in different areas.

To compare the conventional coil in Fig. 2 with the proposed coil in Fig. 7, take half of the coil and compare it to the proposed coil in Fig. 7. The differences between these two coil

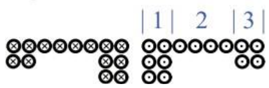

Fig. 6. Variable turn pitch coil.

configurations are seen in Table 1. Figure 8 shows the MMF F(x) across the proposed induction cooker coil as a function of the distance x from the edge. The MMF of the inner and outer positions of the coil has risen, as can be shown.

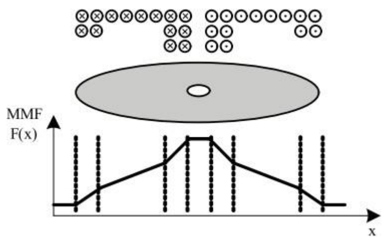

Fig. 7. MMF of proposed coil

B. FEM simulation of proposed induction cooker

As illustrated in Fig. 9, a 3D FEM simulation model for the suggested induction cooker is created. Except for the coil, which is a variable turn pitch coil, all of the specifications are the same as the type of conventional induction cooker. The

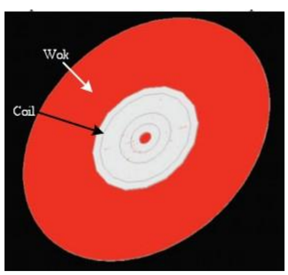

Fig. 8. 3D finite element model of proposed induction cooker

flux density B amplitude curve versus the wok's midline is shown in Fig. 10. The magnetic field has vastly improved, with greater areas of high and consistent magnetic field.

Figure 11 shows the magnetic field distribution simulation results for the suggested induction cooker model with variable turn pitch coil. Instead of concentrating in a narrow ring, the magnetic field covers a larger region of the induction wok, considerably improving the induction cooker's heating ability. The simulation results show that using the proposed variable turn pitch coil in an induction cooker can significantly increase the heating area size and thermal evenness. The proposed coil format has the potential to overcome the problem associated with traditional induction cookers.

IV. Conclusion

This research examines the typical induction cooker's heating capabilities and limits. Because typical induction cookers

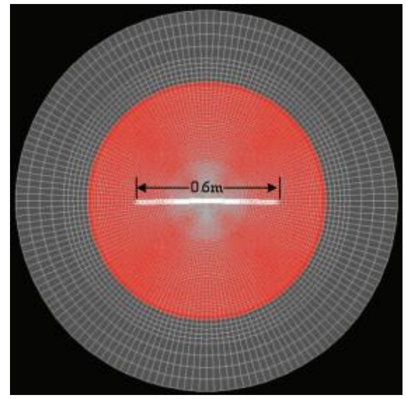

Fig. 9. Planform of the model.

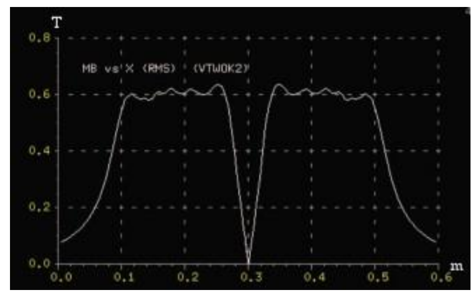

Fig. 10. Magnetic field vs. midline of wok.

have poor thermal distribution and limited heating areas, their magnetic field dispersion is investigated using FEM simulation. A variable turn pitch coil configuration is presented to address the difficulty of the traditional induction cooker. The magnetic field distribution of the induction cooker with the suggested coil is seen using FEM simulation. The validity of the innovative coil format and the correctness of the FEM simulation results are next verified by experiments. The following are the advantages of the proposed induction cooker, as well as their explanations.

- Static picture mode: This setting determines whether the incoming images should be treated as distinct and unrelated (True) or as a video stream (False) (False). We'll set it to False, which indicates that after detecting hands in a video frame, the algorithm will localise the landmarks and just monitor them in consecutive frames without triggering another detection until it loses track of any of the hands.
- Better heating performance than a standard induction cooker at a lower cost.
- The proposed coil can be easily implemented without the use of any additional components thanks to a simple modification of a normal coil.
- Except for the coil, there is no need to replace the driving circuit, control, or any other elements of a traditional induction cooker.

V. ACKNOWLEDGMENT

The authors would like to express their gratitude to the Department of Mechanical Engineering, The Arya Institute of Engineering and Technology, for their invaluable assistance in the preparation of this study.

VI. REFERENCES

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