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Investigation of Rolling and Hard Direction of Magnetic Field Distribution on Grain Oriented M5 Electrical Steel Material

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***Abstract*- This paper describes the idea of the electrical machine design perspective whose aim is latter on to design and development of the copper and aluminum rotor for induction motors to improve the operational efficiency. The study concerns to investigate rolling and hard direction using grain oriented M5 electrical steel material. The result shows very clear idea for identification of rolling and hard direction. It also presented the difference of rolling and hard direction in steel strips based on voltage applied. This paper will provide a contribution to electrical machine design segment and will be a systematic knowledge base for researchers.**

***Keywords*: Silicon Steel, Machine Design, Rolling Direction, Hard Direction etc**

I. INTRODUCTION

The magnetization curve can be qualitatively described in term of the domain theory. It is convenient to treat the curve in three main parts and explain each part in term of the domain theory as shown in Figure 1.

In Figure 1(a) and (b) the first domain process occurs which is a growth of domain which are align favorably with respect to the field and a consequent reduction in sizes of domains which are aligned in direction opposing the field. In Figure 1(c) shows a second mechanism becomes significant. This is domain rotation in which the atomic magnetic moments within an unfavorably aligned domain overcome the anisotropy energy and suddenly rotate from their original direction of magnetization into one of the crystallography easy axis, which is nearest to the field direction. The final domain process as shown in Figure 1(d), coherent rotation takes place. In this process the magnetic moments, which are aligned along the preferred easy axis lying close to the field direction are gradually rotated into the field direction as the magnitude of the field is increased.

A single sheet tester (SST) having closed magnetic path (a closed type of SST) has a problem that measurement accuracy of magnetostriction is considerably affected by electromagnetic force between specimen and yoke. Therefore, an open type has been developed. In order to get uniform flux distribution in sufficiently large region, a compensating magnetizing winding is installed, and a method of waveform control is investigated, in which applied voltages to main and compensating windings are adjusted individually.

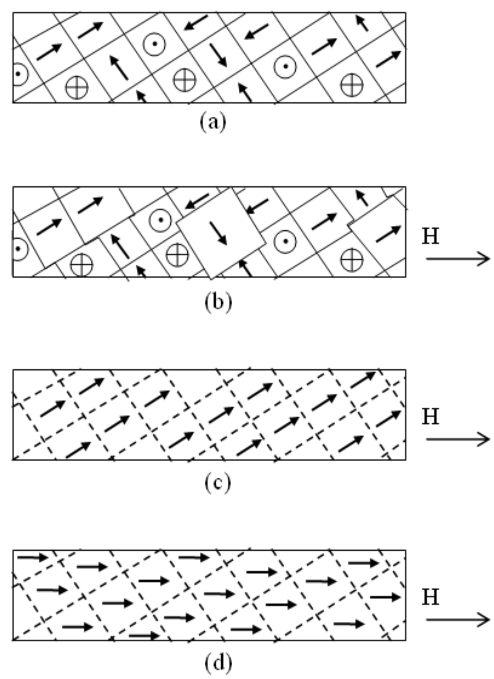

Fig 1. The Magnetic Alignments of the Materials

Figure 2 shows the block diagram of the measurement system used throughout the experiment. This device operates on single sheet samples chosen to be of a size representative of production material properties and large enough to make effects due to cut edges insignificant. Flux closure yoke are used can be single sided or double sided. If single sided yoke, eddy current pools can form in the strip where flux leaves or enters it normal to its surface. With double sided yokes these eddy current effects largely cancel.

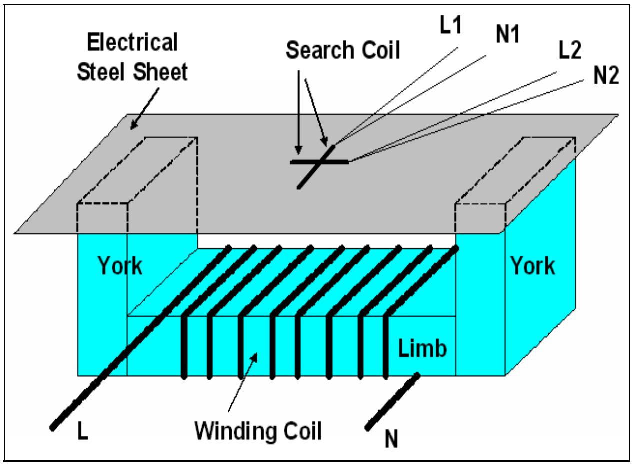

Fig 2. Single Sheet Tester with Single Yoke

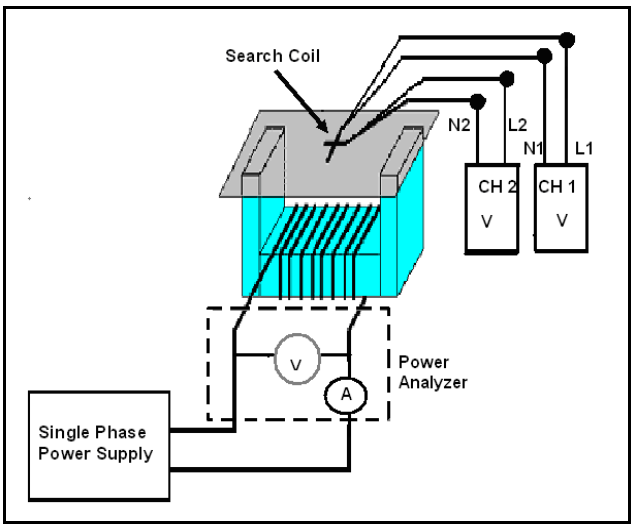

Fig 3. Overall Circuit Diagram for Single Sheet Tester

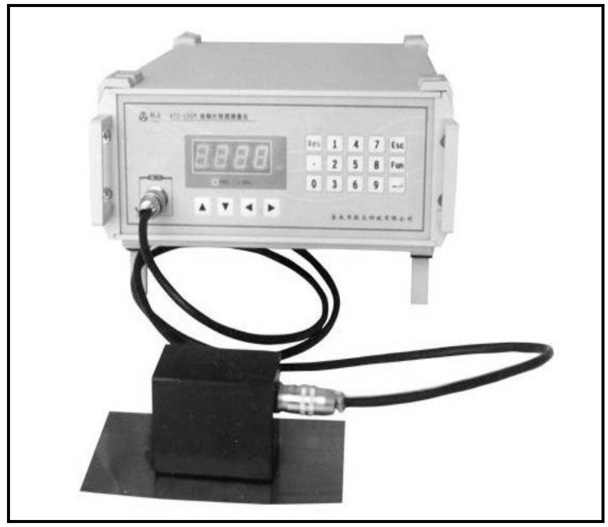

Fig 4. Circuit diagram iron loss tester on lamination

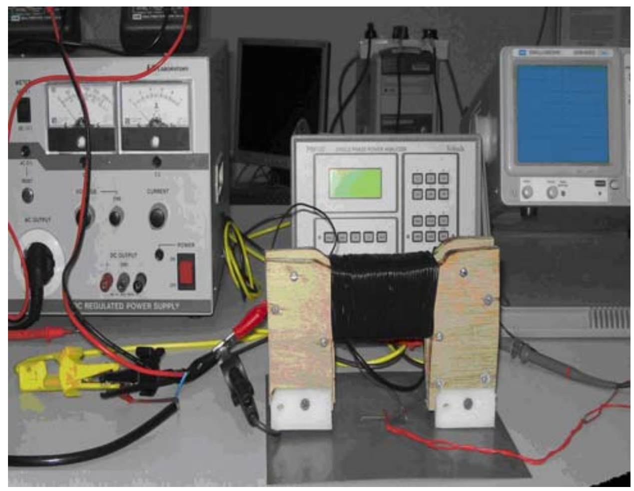

Fig 5. Experimental setup in Research Cluster

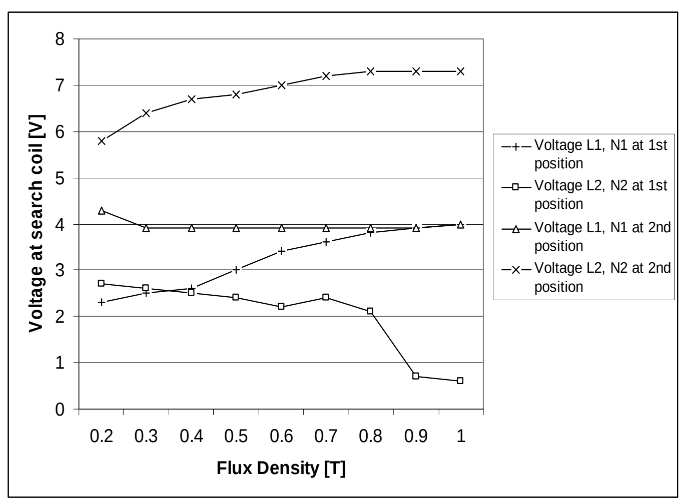

Fig 6. Voltage at Search Coil VS Flux Density

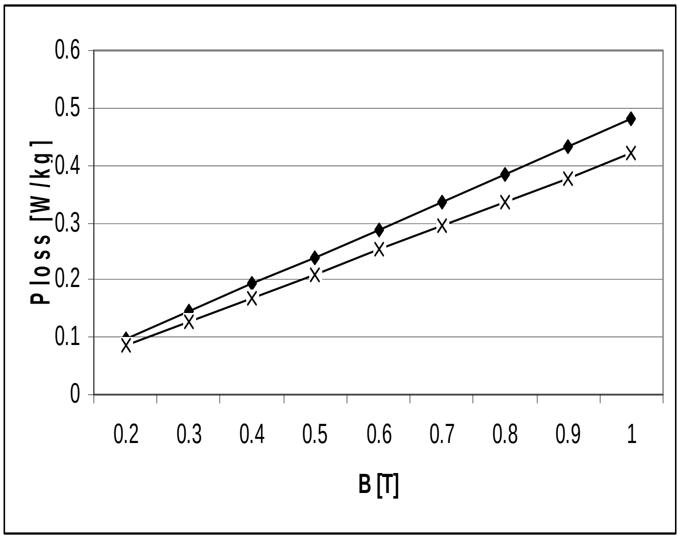

Fig 7. Nominal Loss vs Flux Density

II DISCUSSION

The voltage, current and power loss at the single sheet tester will increase when the flux density increase, but the voltage at the search coil is different both for easy and hard direction. From Figure 6, it is noted that the voltage of search coil L1N1 more than the voltage of search coil L2N2 at the 1st position and the voltage of search coil L1N1 less than the voltage of search coil L2N2 at the 2nd position. From the two positions it is clear that the voltage of search coil L2N2 at 2nd position more than the voltage of search coil L1N1 at 1st position. From the overall result it is showed the easy direction is single sheet tester direction at the 2nd position. Different voltages occur at the search coil cause domain structure in the lamination strip material.

III. CONCLUSION

Grain oriented M5 material based practical approach for efficient machine design perspective has been proposed. The main objectives of this paper to investigate rolling and hard direction using grain oriented M5 electrical steel material.

The following conclusion could be made based on this experiment,

- It is found that depending on lamination strip position, the rolling and hard direction can be determined.
- Rolling direction based on Figure 6, is found at 2nd position (L2N2 and L1N1).
- It is also found that rolling direction shows the higher voltage than hard direction (Figure 6)
- It is also found that the waveform of hard direction is much distorted compared to waveform of rolling direction.

For hard direction will produce higher power loss than the rolling direction as shown in Figure 7.

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