VOL. 11, NO. 14, JULY 2016 ISSN 1819-6608
ARPN Journal of Engineering and Applied Sciences

www.arpnjournals.com

EXPERIMENTAL OF LOCALIZED FLUX DISTRIBUTION AT THREE PHASE INDUCTION MOTOR STATOR CORE WITH DIFFERENT STATOR SLOT SIZE

N. S. Shariffuddin[1], Y. Yanawati[2], F. Z. Hamidon[1], P. D. Abdul Aziz[1] and N. Saleh[1]
[1]Electrical Technology Section, Universiti Kuala Lumpur British Malaysian Institute, Malaysia
[2]School of Electrical Systems Engineering, Universiti Malaysia Perlis, Malaysia
E-Mail: norshafiqin@unikl.edu.my

ABSTRACT

A three phase induction motor differences of stator slot size is investigated in terms of its localized flux distribution. The search coil induced voltage method is used to analyze the flux distribution in the stator core. For both stator models, the maximum flux density is found near the tooth and minimum towards the outer region of the stator core. By saying so, this investigation shows that if there are differences in the stator slot size, the values of flux density differs as well. The increasing size of stator slot size will give the lower flux density value.

Keywords: three phase induction motor, flux density, stator core.

INTRODUCTION

Induction machine is the most used of all electric motors. It is generally easy to build and cheaper than corresponding dc or synchronous motors. The induction motors is rugged and require little maintenance (Hubert, 2002). The ac induction consists of stationary member, called the stator and the rotating member, called the rotor. AC power is used to energize the stator windings.

A study of stator slot design for induction motor is necessary in order to additional improvement of efficiency and reduces the winding loss and also the total loss. The variations in the stator slot shape can affect the magnetic flux density at the stator core (Jae-Woo Kim and Byung-Taek Kim, 2005). In the stator core, the maximum flux density is occurred at the stator teeth and decrease towards the outer regions of the stator core. This is due to core geometry, which influences the flux and loss distribution (A.J. Moses and N. Tutkun, 2005). In this paper, the experimental of localized flux distribution at three phase induction motor stator core stators with different stator slot sizes is presented.

EXPERIMENTAL METHOD

Two models of the three phase induction motor stators between different stator slot size used in this investigation. The initial model is the stator with slot size 6mm and the optimal model is the stator with slot size 8mm, as shows in Figure-1a & b. The number of the stator slot for both model are 24 slots. The outside and inside diameters were 180 and 68mm, respectively and the tooth length was 13mm. The core material was 0.35mm thickness non-oriented silicon steel sheet, and the total number of lamination was 30. The stator winding was a single layer winding and the number of turn in each stator slot was equal to be 60 turns. The exciting frequency is 50Hz. The 0.1mm wire search coils is used to measuring the tangential and radial components. The coils were threaded through 0.3mm diameter holes sufficiently small to avoid disturbing the flux distribution to any practical extent (A.J. Moses and N. Tutkun, 2005). The drilled process is shown in Figure-2. The search coil positions are designated at stator tooth, stator tooth root and stator yoke, as shown in Figure-3. The distance between the holes is 10mm. The orthogonal search coils were used to detect orthogonal components of flux density using an established method (R.S. Albir, A.J. Moses, 1990). Figure 4 shows the equipment set up for measuring localized flux density under voltage excitation at 1.0, 1.5 and 1.8T. The value of the induced voltage is directly proportional to the change of flux and also the area enclosed by the search coil. Therefore the flux density waveform can be calculated by integrating the voltage induced in the coil,

$$B = -\frac{1}{NA}\int V dt \tag{1}$$

This induced voltage will be calculated as the equation,

$$V_{ind} = 4.44 \times B \times f \times A \times N \tag{2}$$

Where B is the flux density, f is the frequency; A is the cross sectional of the surface of yoke and N is the number of winding turns (Asri.M, 2011). Then, the Matlab software is used to analyze and draw the mesh and contour graph using the data that collected by the search coil.

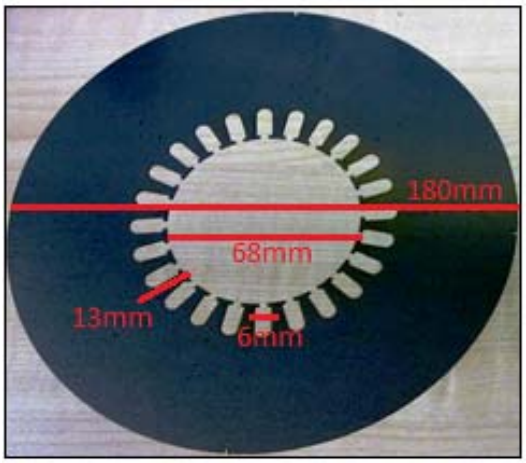

Figure-1a. Stator core with slot size 6mm.

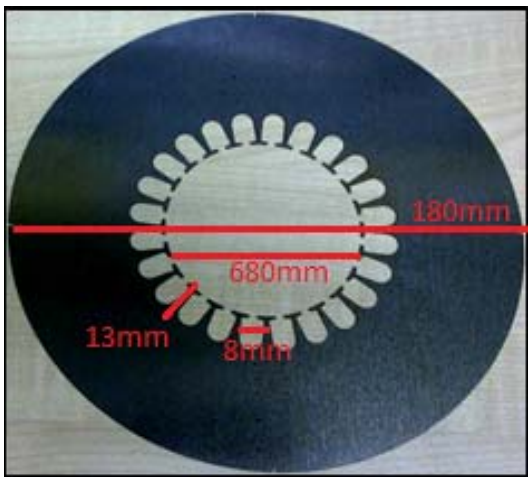

Figure-1b. Stotor core with slot size 8mm.

Figure-2. Drilled process.

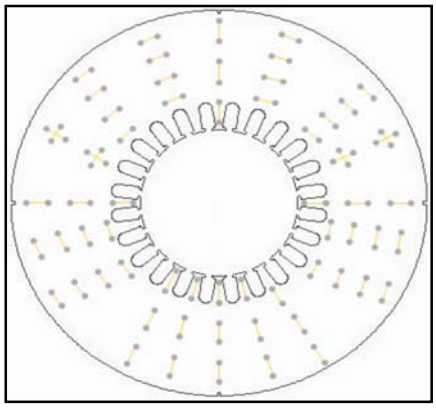

Figure-3. Locations of search coil.

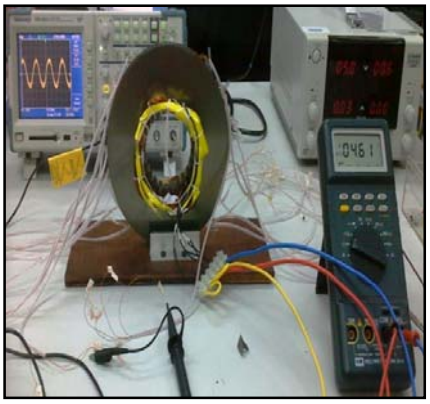

Figure-4. Experiment setup

RESULTS AND DISCUSSIONS

Localised flux density distribution of fundamental component at stator core

The contour graph in Figure-5 until Figure-10 shows the flux line that uniform at the both stators. These flux line is decrease towards the outer regions of the stator core. For both stators, the localised peak flux density is highest and the flux line become closer each other at the stator teeth compare to the flux line at the outer regions of the stator. The mesh graph is related to the contour graph. The red zone at the mesh graph indicate the highest flux density place with is same as the highest value of the localised peak flux density at the contour graph. The flux line intensity is increased from the outer regions to the inner regions of the stator core. For both stators, the flux line intensity of stator magnetised at 1.8T is higher than stator magnetised at 1.0T and 1.5T.

When the stator is magnetized at flux density of 1.0T is shown in Figure-5, the localised peak flux is increase from 0.215T to 0.648T for stator slot size 6mm, while for the stator slot size 8mm, the localised peak flux is increase from 0.209T to 0.63T as shown in Figure-6. Then when the stator is magnetized at flux density of 1.5T as shown in Figure-7, the localised peak flux for stator slot size 6mm is increase from 0.727T to 1.16T and the localised peak flux is increase from 0.714T to 1.14T for

stator slot size 8mm as shown in Figure-8. Finally, when the stator is magnetized at flux density of 1.8T as in Figure-9, the localised peak flux is increase from 0.91T to 1.27T for stator slot size 6mm, while for the stator slot size 8mm, the localised peak flux is increase from 0.883T to 1.26T as shown in Figure-10. From these results, it shows that in increase of stator slot size can decreases the inductance and decrease the magnetic flux density of the stator core. Even thought the results between the both stators are not much different, a minor improvement in this design may effect on energy savings worldwide. As the flux density of the stator slot size 8mm is reduced, the core loss for this stator is also reduced.

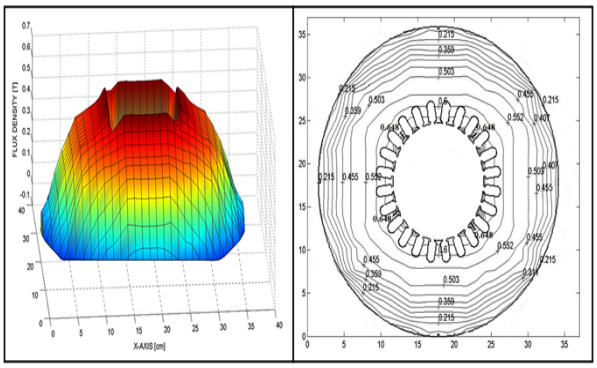

Figure-5. Mesh and contour graph for distribution of fundamental component of peak flux density for stator slot size 6mm model at 1.0T.

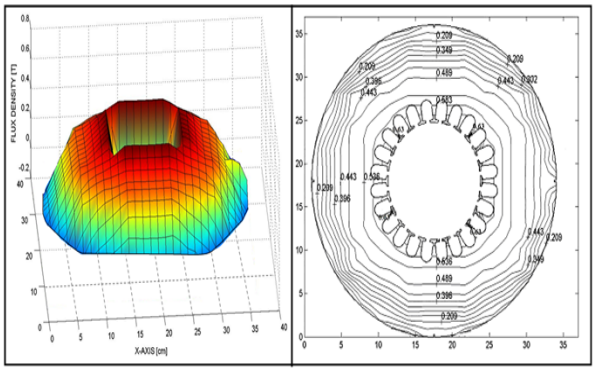

Figure-6. Mesh and contour graph for distribution of fundamental component of peak flux density for stator slot size 8mm model at 1.0T

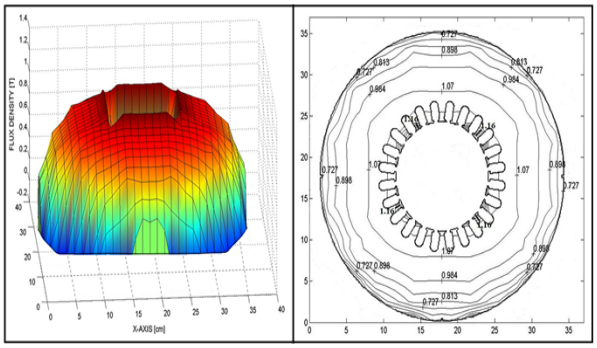

Figure-7. Mesh and contour graph for distribution of fundamental component of peak flux density for stator slot size 6mm model at 1.5T.

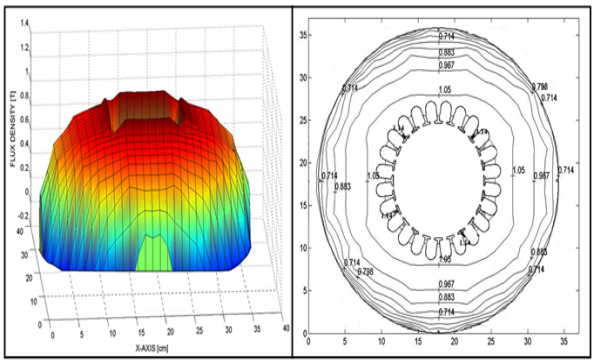

Figure-8. Mesh and contour graph for distribution of fundamental component of peak flux density for stator slot size 8mm model at 1.5T.

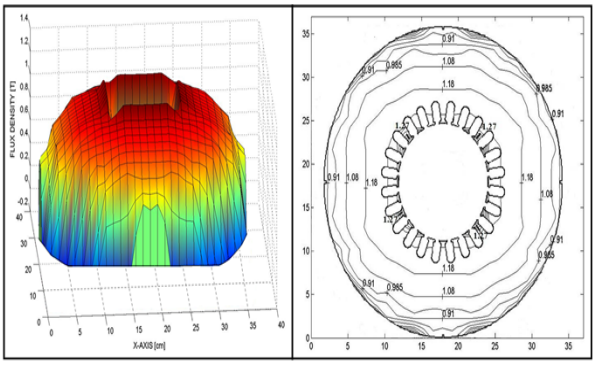

Figure-9. Mesh and contour graph for distribution of fundamental component of peak flux density for stator slot size 6mm model at 1.8T.

VOL. 11, NO. 14, JULY 2016 ISSN 1819-6608
ARPN Journal of Engineering and Applied Sciences

www.arpnjournals.com

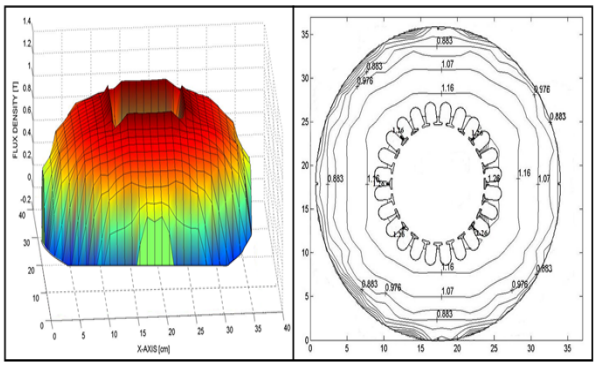

Figure-10. Mesh and contour graph for distribution of fundamental component of peak flux density for stator slot size 8mm model at 1.8T.

Overall flux density distribution at the stator core

In order to take account of the average peak in-plane flux density in the stator core when the stator core is magnetized at 1.0T, 1.5T and 1.8T, the stator core geometry is sub-divided into regions of teeth, inner core back and outer core back as shown in Figure-11.

Figure-11. Subdivided of stator core geometry for average peak in-plane flux density in the stator core at 1.0T, 1.5T and 1.8T, 50Hz.

Figure-12 shows the comparison of average fundamental of peak in-plane flux density at different regions for both stators when the stator core is magnetized at 1.0T. From this figure, it is shows that by increasing the stator slot size 6mm to 8mm, the average of fundamental magnetic flux density at the teeth regions is reduced 1.56%. At the inner core back regions, the magnetic flux density of stator slot size 8mm is 5.77% lower comparing to the stator slot size of 6mm. While at the outer core back regions, the magnetic flux density of stator slot size 8mm is 7.7% lower comparing to the stator slot size of 6mm.
When the stator core is magnetized at 1.5T, the average of fundamental magnetic flux density at the teeth regions is reduced 1.72% when increasing the stator slot size from 6mm to 8mm. At the inner core back regions, the magnetic flux density of stator slot size 8mm is 2% lower comparing to the stator slot size of 6mm. While at the outer core back regions, the magnetic flux density of stator slot size 8mm is 2.63% lower comparing to the stator slot size of 6mm. The comparison of average fundamental of peak in-plane flux density at different regions for both stators is shown in Figure-13.

The comparison of average fundamental of peak in-plane flux density at different regions for both stators when the stator core is magnetized at 1.8T is shown in Figure-14. From this figure, it is shows that by increasing the stator slot size 6mm to 8mm, the average of fundamental magnetic flux density at the teeth regions is reduced 1%. At the inner core back regions, the magnetic flux density of stator slot size 8mm is 1.8% lower comparing to the stator slot size of 6mm. While at the outer core back regions, the magnetic flux density of stator slot size 8mm is 2.15% lower comparing to the stator slot size of 6mm.

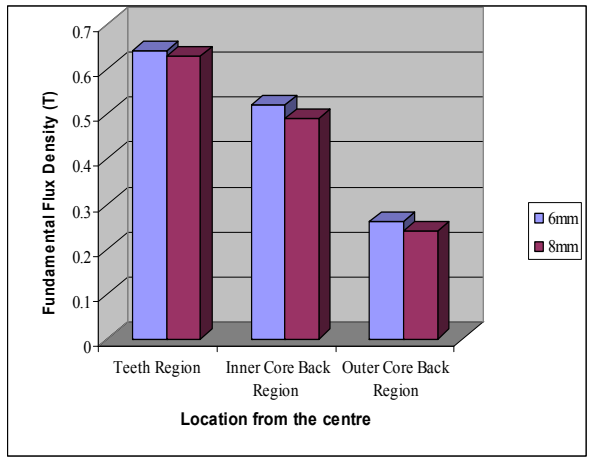

Figure-12. Comparison of average fundamental components of peak in-plane flux density at the different regions for both stators core model at 1.0T, 50Hz

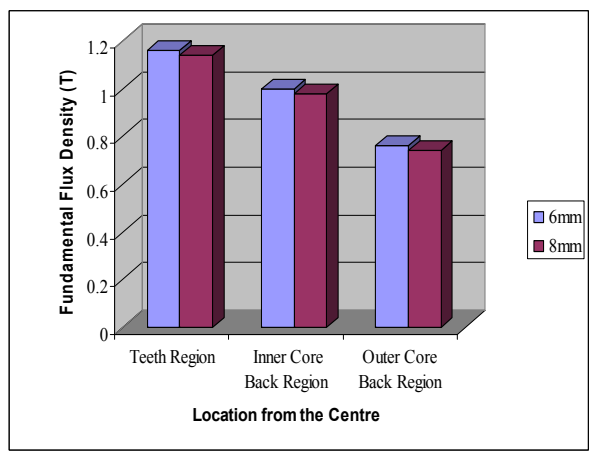

Figure-13. Comparison of average.

Fundamental Components of Peak In-plane Flux Density at the Different Regions for both Stators Core Model at 1.5T, 50Hz

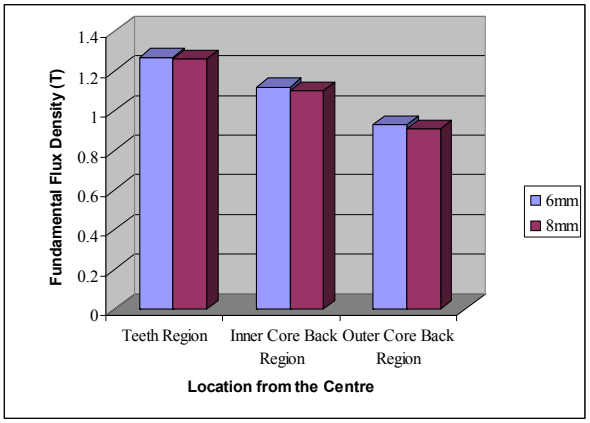

Figure-14. Comparison of average fundamental components of peak in-plane flux density at the different regions for both stators core model at 1.8T, 50Hz

CONCLUSIONS

The experimental of localized flux distribution three phase induction motor stators core between different stator slot sizes using search coils induced voltage method was proposed. We may conclude from the experiment that the increasing size of stator slot size will give the lower flux density value. As the flux density of the stator slot size 8mm is reduced, the core loss for this stator is also reduced.

REFERENCES

A.J. Moses, N. Tutkun, Localised losses in stator laminations of an induction motor under PWM excitation, Journal of Materials Processing Technology 161 (2005) 79-82.

Asri, M. 2011. Flux density and power losses distribution in stator core of 0.5hp there phase AC induction motor. Msc Thesis, Universiti Malaysia Perlis.

Hubert, C. I. 2002. Electric Machines Theory, Operation, Application, Adjustment, and Control. Columbus, Ohio: Prentice Hall.

Jae-Woo Kim, Byung-Taek Kim, Optimal Stator Slot Design of Inverter-Fed Induction Motor in Consideration of Harmonic Losses, IEEE Transactions on Magnetics, 41 (2005) 2012-2015.

R.S. Albir, A.J. Moses, Improved DC bride method employed to measured local power loss in electrical steels and armorphous material, J. Magn. Magn. Mater. 83 (1-3) (1990) 553-554.