Analyzing And Testing Of Performance Of DSWIM By ANSYS Maxwell

Anagha Soman, Dr. Rajesh Holmukhe, Dr. D.G..Bharadwaj

Abstract: Induction motors owing to their rugged construction, reasonable cost, efficient performance, Low maintenance and decent reliability in performance in varying loading situations are the most wanted machines in industrial as well agriculture sector. The researcher hence is keen towards making it better and better in the performance. The advancement here proposes a common cage rotor of conventional induction motor with two separate stators windings wound with different number of poles. The paper here presents the thorough analysis of Dual stator winding Induction machine (DSWIM) using Finite element method (FEM). ANSYS Maxwell and RMxprt are the tools used for the design and analysis of DSWIM.A detail design sheet is the result of RMxprt which includes basic parameters as well the performance parameters of the machine. The 3-dimensional and 2-dimensional construction as well electromagnetic behaviour (Flux plots) can be found through ANSYS Maxwell. This design as well simulation helps in correcting any construction or performance flaw in the machine long before it actually can damage it.

Index Terms: Dual stator winding Induction machine, DSWIM, FEM, ANSYS Maxwell , RMxprt , Flux plots, skew.

1 INTRODUCTION

Dual stator winding Induction machine is analyzed and studied thoroughly in this paper. The construction of the machine is exactly similar to that of conventional cage rotor Induction machine except for the fact that there are two stato windings housed in the same magnetic circuit. Hence, two different torques are produced and hence the resulting speed will now be controlled by varying the two different torques [1]. The torque-speed characteristics hence can be manipulated with more flexibility. The analysis of machine can be done in two ways i.e. treating it as two different induction machines connected to the same shaft or the DSIM motor is considered as a six-phase induction motor [3]. The most commonly used and widely practiced is this multi-speed machine. Considering the individual stator winding, conventional Induction machine is simulated using RMxprt and the dual stator Induction motor using Maxwell 2D.

2 DUAL STATOR INDUCTION MACHINE DRIVE

The proposed Induction machine drive consists of a stator having two separate (electrically isolated) windings and a die-cast cage rotor (made up of aluminium). As per [1], the stator windings if are wound in pole ratio of 1:3, local saturation can be avoided, extra stator losses can be minimized and the magnetic material requirement is optimized. Both the stator windings are fed separately by two different auto transformers in case of 50 Hz supply and through two different Variable frequency drives in case of variable frequency supply. Rotor being a standard die-cast squirrel cage one, fluxes produced by both the stator windings gets coupled with that produced by the rotor thus producing the resultant torque.

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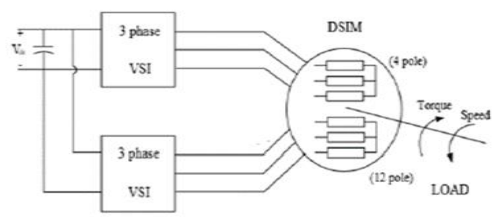


Fig.1 *DSIWIM*

DSWIM acts like two different conventional Induction machines coupled mechanically through a shaft because of the decoupling effect produced by the two stator windings wound for different number of poles. Few assumptions considered throughout the analysis of the DSWIM are as follows

- Very low inter bar rotor current
- Two stator windings are electrically isolated
- Both the stator windings are sinusoidally distributed
- Air gap is uniform around the rotor
- Saturation is too low

3 RMXPRT AND MAXWELL 2D

Finite element method involves an exhaustive number of Integro differential equations to be solved. But when FEA is to be applied to electrical machine design and analysis, owing to the non-linear parameters of an electrical machine geometry, the same equations become mathematically too complex. This is because electrical machines have a complex construction and the materials used are composite so their electromagnetic behaviour is also complex. So the partial differential equations involved can be solved either by conventional hand calculations or by digital computer programming. But a better tool for this is FEM. Finite element analysis packages available in market are ANSYS Maxwell 2D/3D, FLUX 2D, Infolytica Motors Solve, SPEED, Comsol Multiphysics, Quick_eld, JMag Designer, etc. The biggest advantage of ANSYS is that it uses Multi-physics simulations. It is easier to implement it in a complete ANSYS environment. As far as electromagnetics is concerned, ANSYS has a well established workflow of RMxprt, PExprt, Maxwell 2D, Maxwell 3D, Twin builder (Simplorer) along with Optimetrics for optimization. It is capable of both 2D and 3D simulations for both electric and magnetic fields. It has static, frequency and time domain FEM solvers. It also has a

3D Modeler. High performance computing features to accelerate simulation computations. There are specific advantages with respect to each product but that would be very extensive and complicated to tabulate here.

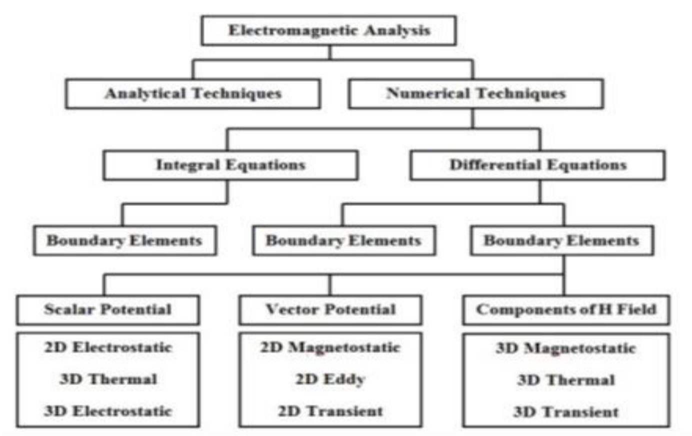


Fig.2 *Sequence of solution in electromagnetics*

For machine design engineers, ANSYS Maxwell is an useful tool for analyzing electromagnetic as well electromechanical devices.FEA helps in finding electric, magneto static, eddy current and transient issues/ faults. Maxwell 2D is an application of Maxwell's equation [15], [16], [17].

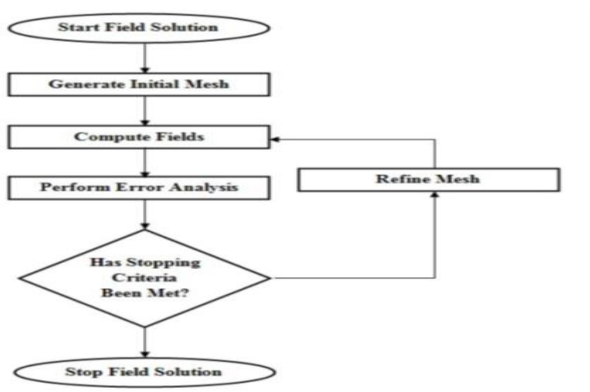


Fig.3 *Steps in FEM software*

RMxprt is a template-based design tool to facilitate electrical machine designers. Maxwell 2D and RMxprt together can give a customized machine design as per specific requirement (high efficiency, low cost, good power factor). Calculations of machine performance and initial sizing decisions can be done in a few seconds which otherwise would have taken a few days by hand calculations. The RMxprt design can be imported in MAXWELL including geometry, materials and boundary conditions.

4 RMXPRT DESIGN

A 1.2kW, 3-phase squirrel cage Induction motor is designed and analyzed. Rotor is die casted and is made up of aluminum.

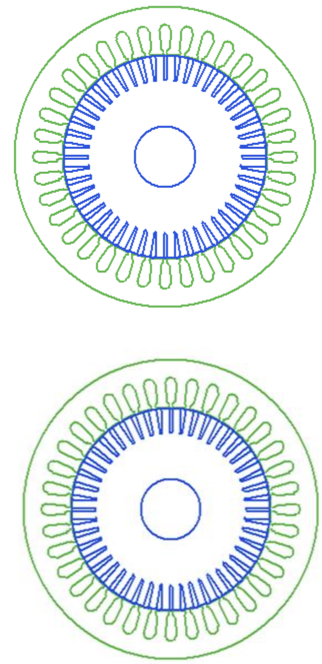


Fig.4 4- *Pole stator-rotor geometry*

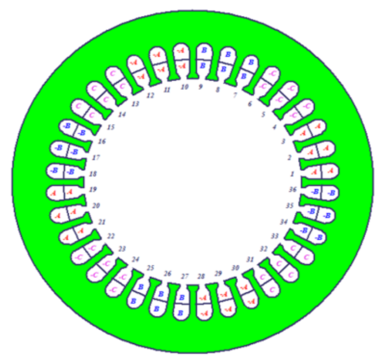


Fig.5 4- *Pole winding*

The results of RMxprt for 4 pole winding is as shown below

Rated speed	*1486.56 rpm*
Torque	*11.8661*
Total losses	*401.074*
Power factor	*0.871537*
Efficiency	*81.7785*
Output power	*1.2kW*

Similarly, for 12-pole design by RMxprt is as follows:

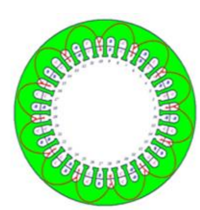


Fig.6 12- *pole winding*

And the results for 12 pole by RMxprt are:

Rated speed	*465.06rpm*
Torque	*36.9618*
Total losses	*1398.44*
Power factor	*0.613243*
Efficiency	*56.2784*
Output power	*0.7kW*

3 DSWIM DESIGN USING MAXWELL 2D

The RMxprt design can then be directly exported to MAXWELL 2D .

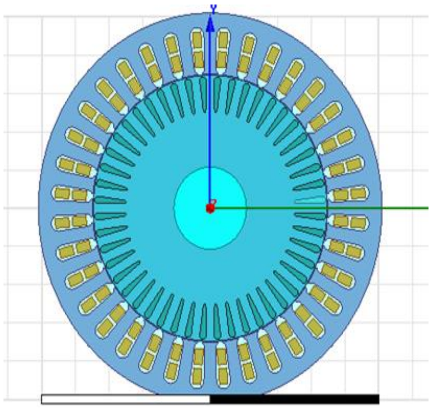


Fig.7 *DSIM GEOMETRY*

The magnetic flux density can be seen as follows,

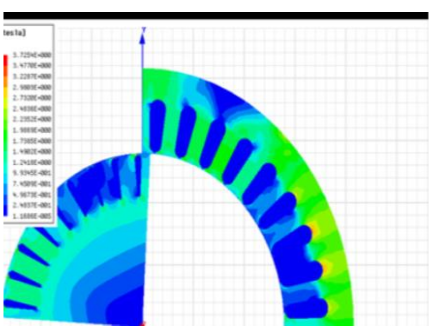
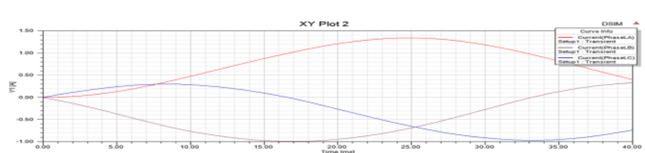
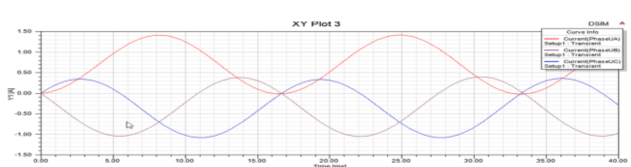


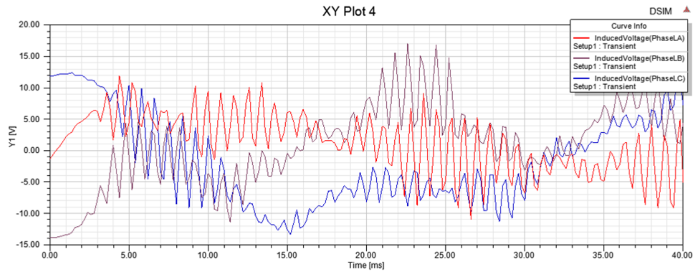
Fig.8 *Magnetic flux density*

4 PERFORMANCE CHARACTERISTICS

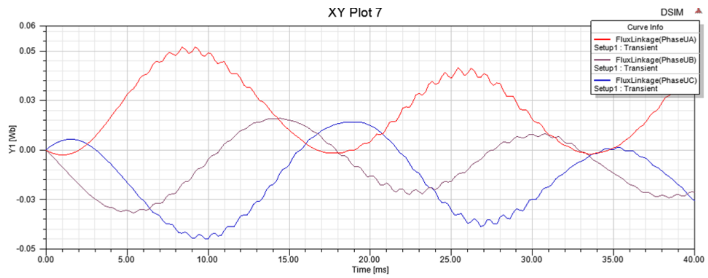
Various graphs depict the performance of the machine are as follows,







Induced voltage



Flux Linkage

5 CONCLUSION

Need of finite element modelling of machines is discussed and Review of various FEA based softwares is given. The finite element model of fabricated machine using Maxwell 2D is given. The comparison of results of field tests on fabricated machine and simulation show that the results are nearly same.. Also comparison between various Supply conditions of DSWIM is discussed on the basis of results obtained from Maxwell 2D. Applications of dual stator winding Induction machines are yet to be explored but the results shown here are promising enough to carry an extensive research in future.

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