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Design of High Efficient Induction Motor

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Abstract — ***In this paper, optimal design of three phase squirrel cage induction motor to improve efficiency and power factor and to reduce total loss for variable load application is proposed. It has compared conventional and optimally designed same rating of 3hp (2.2kW) motor. The motor is designed and optimization using mathematically and the simulation results are presented. The mathematically equation is used for optimization and five objective functions namely Stator Copper Loss, Rotor Copper Loss, Stator Iron Losses, Efficiency, and Power Factor are considered. The importance of this work is highlighted by the recent concerns about the need to achieve energy savings in the industry and in the territory sectors. The motor design procedure consists of a system of non-linear equations, which imposes induction motor characteristics and motor performance. This is very useful to optimize the power factor, losses and efficiency of the induction motors.***

Keywords- Induction Motor, efficiency, robustness, power factor, loss

I. INTRODUCTION

The squirrel-cage Induction motors are 90% used in various industrial, domestic and commercial applications. Particularly, the squirrel cage type is simplicity, robustness and low cost, which has always made it very good-looking, and has therefore, captured the leading place in industrial sector. The average load factor of electric motors in both industrial and tertiary sectors is estimated to be less than 60%. However, in some industrial sectors, the average load factor for some motor power ranges can be as low as 25%. Individual motors in those ranges have even lower load factors. Because the motor load factor is an average of motor load during a period (e.g. motor duty-cycle period),

the motor load can alternate between values lower and higher than the motor load factor. As a result of its extensive use in the industry, induction motors consume a considerable percentage of the overall production of electrical energy. The minimization of electrical energy consumption through a better motor design becomes a major concern. The problems in the optimization of the electromagnetic devices are mixed (continuous and discrete) variables and discontinuities in search space.

In this paper, we have modeled the optimal design of an induction motor as a nonlinear multi-objective optimization problem and described three different methods for its solution. When a multi objective problem is treated, each objective conflicts with one another and unlike a single objective optimization, the solution to this problem is not a single one, but a family of solutions known as the Pareto-optimal set. Among these solutions, the designer should find the best compromise, taking into proper account the attributes and characteristics of the handled problem. If the standard non-linear programming (NLP) techniques were to be used in such cases then they would be computationally very expensive and inefficient. Some applications utilizing the standard NLP techniques include the design and control parameter optimization of induction motors.

In recent years, IE has been recognized as potent tools in design optimization of electrical machinery. One of the most important advantages of the IE over the standard NLP techniques is that it is able to find the global minimum, instead of a local minimum, and that the initial attempts with different starting points need not be close to actual values. Another advantage is that it does not require the use of the derivative of the function, which is not always easily obtainable or may not even exist. For example, when dealing with real measurements involving noisy data, the efficiency and power factor improvement is mainly considered.

The aim of this paper is to give a further contribution in the optimum design of a three phase induction motor with efficiency and power factor improvement, using the five objective functions, namely Stator Copper Loss (SCL), Rotor Copper Loss (WRCL), Stator Iron Losses (SIL), Full Load Efficiency (η), and Full Load Power Factor (P.F). Mathematically having the feature of a unique search was then used for optimization processes. A design package has been developed specifically for a three-phase squirrel-cage type induction motor. As per our literature survey, many proposals based on multi objective approaches for the electrical machines design have been uncounted. In this paper, three methods are described and employed for the design optimization of three-phase induction motors, when conflicting objectives are chosen. In this paper a conventional three phase squirrel-cage type induction motor with specifications 3 hp (2.2kW), 400V, star connected and 4 poles is chosen for comparing with our optimally designed motor

II. Use of copper bar in rotor

The metal chosen for the squirrel cage structure of the induction motor has substantial implications to both motor performance and motor manufacturability. Electrical grade copper is used in very large (>250 hp, 200 kW) motors and in some smaller special purpose motors. These are manufactured by a costly and slow fabrication procedure not suitable for production of the millions of integral horsepower and kilowatt motors produced annually. Die casting of the copper would be preferable, but this process has not been economical because of short die life due to copper' s high melting temperature. Use of copper in the rotors in a broad range of sizes of induction motors represents a significant advance in motor technology. This is because the readily available and least expensive improvements to increase motor energy efficiency have been adopted in recent years.. In addition, analyses by motor manufacturers have shown that the copper rotor can be employed to reduce overall manufacturing costs at a given efficiency or to reduce motor weight, depending.

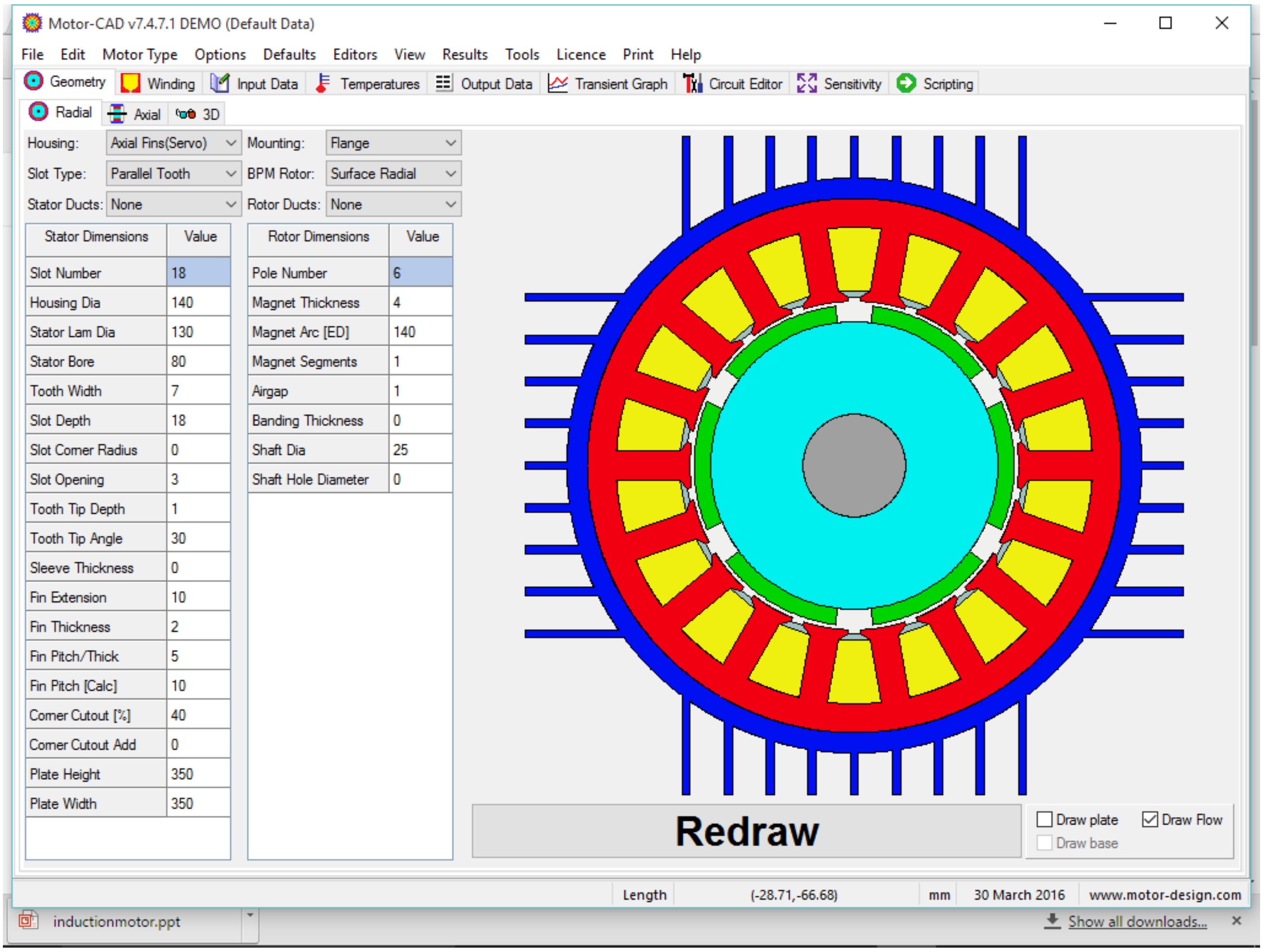

Fig. 1 View of copper rotors for the considered motors

Electric motor efficiency is the measure of the ability of an electric motor to convert electrical energy to mechanical energy; i.e., kilowatts of electric power are supplied to the motor at its electrical terminals, and the horsepower of mechanical energy is taken out of the motor at the rotating shaft. Therefore, the only power absorbed by the electric motor is the losses incurred in making the conversion from electrical to mechanical energy

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