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A Fuzzy Based Improved Efficiency Optimization Technique for V/f Controlled Induction Motor Drive Considering Core Losses

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***Abstract*— This article proposes a novel technique for lowering losses that occur during the operation of induction motor drives. This strategy is accomplished by exploiting the basic variable voltage variable frequency controller. Additionally, the impacts of core losses and changes in magnetizing inductance are taken into consideration within the framework of the method that has been provided. The dynamic values of core loss resistance and magnetizing inductance are utilized to enhance the operational slip that occurs during online operation. Through the utilization of a fuzzy-based V/f controller, this is done to obtain the best possible performance of the dynamic induction motor drive. In terms of practical applications, the method that has been proposed is an ideal choice because it is both basic and precise. To validate the approach that has been provided, the relevant simulation findings are supported by appropriate experiments that have been carried out in a realistic induction motor that has a capacity of one kilowatt.**

Keywords—Induction motor, efficiency optimization, V/f controller, Fuzzy logic.

I. INTRODUCTION

Induction motors dominate the market of electrical motors in modern industries. Motor utilization does not always require the delivery of its maximum load torque during operations. Therefore, the operational efficiency of the induction machine can fluctuate under different operating conditions. Accurately calculating the electrical losses of an induction machine has consistently been a high priority to enhance the machine's operational efficiency. The issue of efficiency has emerged as a significant concern for researchers over the past twenty years, as they strive to meet the global need for more effective utilization of electric energy. This is crucial since induction motors are the main users of electric energy in contemporary industry. Improving the effectiveness of induction motors has become a significant area of research recently. Therefore, efforts are being made to discover methods to decrease losses and enhance the efficiency of incorporation by addressing the non-linear nature of core losses [1]. The technique described in reference [2] outlines three ways to enhance motor efficiency: a) suitably selecting and developing the motor, b) enhancing the waveforms produced by voltage source inverters, and c) implementing an optimization control mechanism. Precisely determining the machine's magnetic properties, such as magnetizing and leakage inductances, is essential for comprehending how core losses affect online parameter identification [3-4]. In the range of [5-8], numerous methodologies have been devised to get a superior speed drive for a basic machine model, disregarding the resistance caused by core losses. Two basic approaches to reducing the amount of power that is lost by electric machines are presented in the research literature. These approaches are parameters-based methods and online parameters search optimization methods [9-10]. By enhancing the motor excitation as a function of the load that increases in a monotonically increasing manner, it is possible to improve both the efficiency and the power factor. The loss model, which incorporates the effect of leaking inductance, was considered in [11]. Nevertheless, the current resulting from iron loss was disregarded to simplify the analysis. It is the voltage that is across the air gap that is responsible for the iron losses. Because the current that is caused by iron loss cannot be ignored in the high-speed zone, the losses that are computed are not precise [12-13]. The concept of reducing losses in induction motors by excitation control originated from the development of the power factor controller [14-16]. Subsequently, researchers have thoroughly examined the performance of the induction motor drives when the magnetic field is lowered [17], and have also determined the possible energy savings for an entire system [18-19]. Based on the findings of these investigations, it has been established that the gain in efficiency is limited and that this strategy is not economically viable for a variety of applications. When it comes to achieving the most economical performance for a specific torque and speed, variable speed drives that use induction motors require a specific combination of excitation voltage and frequency. This combination is unique and has been documented in reference [20]. The primary focus is on enhancing the motor's efficiency and minimizing power loss. This is achieved through optimizing the motor's physical design [21] and enhancing its performance [22] using closed-loop controls.

The author of this research has examined the method of enhancing efficiency to design an induction motor drive from an industrial perspective. Optimal efficiency control often leads to operating at flux levels far lower than the rated value. In such circumstances, the drive system exhibits subpar dynamic performance and experiences a significant decrease in its maximum readily attainable torque. Accurate modeling of electrical and magnetic losses must take into account the nonlinearity effects of induction motor drives. The objective of this study is to explore a straightforward approach for determining all electrical losses in an induction machine, taking into account the non-linear core losses and the incremental change in slip. The precise method is evaluated by doing the no-load test, the blocked rotor test, and the core-loss resistance test at several different flux levels while keeping the frequency constant. An uncomplicated yet effective solution to the efficiency issue is illustrated through experimentation and theatrical presentation. An investigation is conducted on the proposed creative approach to enhance efficiency, specifically focusing on the correlation between core loss resistance and slip. The system is analyzed to evaluate its stability and dynamic reactivity. Through the use of both actual and simulated data, the paper that was submitted proves that the proposed method is both accurate and beneficial.

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