Abstract

Today researches and energy auditors are concerned about the energy conservation to reduce the effects of global warming by energy saving and thereby reducing the emission of CO₂ in the atmosphere. Also developing country like India is facing energy scarcity even though the continuous increase in the generating capacity. Practical and economical method to meet the supply-demand gap is “energy conservation” and “Demand side management” predominantly for motor driven system which accounts for more than half of the total electrical energy consumption. From demand side, the induction motor can be considered as one of the largest consumers of electrical energy due to its well known advantageous including robustness, reliability, low price and maintenance free operation. The induction motors are used in both industrial and commercial sectors in a wide range of applications, such as fans, compressors, pumps, conveyors, winders, mills, transports, elevators, home appliances and office equipments. The influence of these motors (in terms of energy consumption) in energy intensive industries is significant in total input cost. A small increment in the efficiency of these motors by providing better control or optimum design can result in substantial saving in the long period.

This research presents a proposed new method of improving energy efficiency of a Variable Speed Drive (VSD) for Induction motors. The principles of VSD are reviewed with emphasis on the efficiency and power losses associated with the operation the variable speed motor driven pumping system, particular at part load. Centrifugal pumping system design to operate at its peak efficiency at maximum flow. However maximum flow occurs for very short period of operating cycle and most of the time system operates at part load. Conventional flow control method of throttling valve insert the resistance in pumping system for flow control and results in poor overall system efficiency. VSDs control the flow by proving variable speed pumping operation. This completely removes the throttling of flow and thereby operates the pumping system near best operating efficiency point. With that system maintenance cost also reduces.

Induction motor is a high efficiency electrical machine when working closed to its rated torque and speed. However, at light loads, imbalance in copper and iron losses, results considerable reduction in its efficiency. The part-load efficiency and power factor can be improved by making the motor excitation adjustment in accordance with load and speed. To achieve this objective, the induction motor should either be fed through an inverter or redesigned with optimization algorithms.
The research in the present work is carried out for optimal control of induction motor to achieve maximum efficiency or minimum operating cost. The optimization of induction motor design with Artificial Intelligence (AI) and Nature Inspired Algorithms (NIA) has received considerable attention recently. Moreover, many researchers have focused their research on efficiency optimization of induction motors that are working in industries through optimal flux control. In optimal flux control, there are three main approaches to improve the induction motor efficiency at light loads, namely Loss Model Controller (LMC), search controller and hybrid controller (retain good features of loss model and search control by mixing them). Since the induction motor is a large consumer of electrical energy in the industries and its influence is more in energy intensive industries, it is required to focus industrial loads. Economic analysis of some of the industrial loads such as textile and mining industries are carried out in the present work. To maintain good stability (minimum torque ripples and less overshoots in speed) of the motor during flux adjustment, Fuzzy Pre-compensated Proportional Integral (FPPI) controller is used.

Basically, the motor drive system comprises a Voltage Source Inverter-fed Induction Motor (VSIM): namely a three-phase voltage source inverter and the induction motor. The squirrel-cage induction motor voltage equations are based on an orthogonal d-q reference frame where the coordinates rotate with the controlled source frequency. The work presents a novel fuzzy logic controller for high performance induction motor drive system in indirect field oriented control. The present work is a contribution to improve the overall performance and robustness of an Indirect Field Oriented Control (IFOC) of an Induction Motor (IM) drives. The inputs to the fuzzy logic controller are the linguistic variables of speed error and change of speed error, while the output is change. In this work a comparison between fuzzy logic controller and traditional PI controllers are presented. The results validate the robustness and effectiveness of the proposed fuzzy logic controller for high performance of induction motor drive. SIMULINK software that comes along with MATLAB was used to simulate the proposed model.

A comprehensive literature survey on the induction motor driven systems and efficient control of part-load with VSDs is carried out in the present work. Common sources affecting induction motor efficiency and their solutions to improve it are discussed in brief. An experimental study is investigated on Motor driven Pumping System with over and under voltages to study the negative effects of it on system’s efficiency. Economic analysis carried out justifying application of proposed model and the available potential of efficiency improvement opportunities in the industrial sectors is discussed.