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Design, Implementation & Analysis of Three Phase Asynchronous Induction Motor using MATLAB Simulink

Sandeep kumar[1], Manoj Mishra[2]

[1]Research Scholar, M.Tech Pursuing, Electrical Engg. GGSCMT, Kharar Punjab, India
[2]AP (Electrical Engg.) GGSCMT, Kharar Punjab, India

Abstract:- *Presently days the utilization of Condition Monitoring of electrical machines is expanding because of its capability to diminish working costs, upgrade the unwavering quality of activity and improve administration to clients. Various choices to recognize and analyze blames in acceptance machines have been proposed and actualized in the most recent years. These new choices are portrayed by an online and non-intrusive element, in other words, the ability to distinguish flaws while the machine is working and the ability to work sensor less. These attributes, gotten by the new procedures, recognize them from the conventional ones, which, as a rule, need that the machine which is being dissected isn't attempting to do the finding. The fundamental motivation behind this the article is to overhaul the fundamental options in the recognition of issues in enlistment machines and look at their commitments concurring to the data, they require for the determination, the number and significance of the issues that can be distinguished, the speed to envision a shortcoming and the exactness in the finding. Also, to recognize different such conclusion strategies that can be connected for programmed condition checking of acceptance engines and can be stretched out effectively to other machines also.*

Introduction

An electric motor is an electrical machine that changes over electrical vitality into mechanical vitality. The switch of this would be the transformation of mechanical vitality into electrical vitality and is finished by an electric generator. In ordinary motoring mode, most electric motors work through the association between an electric motor's attractive field and twisting flows to produce power inside the motor. In specific applications, for example, in the transportation business with footing motors, electric motors can work in both motoring and creating or braking modes to likewise deliver electrical vitality from mechanical vitality.

Found in applications as different as modern fans, blowers and siphons, machine devices, family apparatuses, control instruments, and plate drives, electric motors can be controlled by direct flow (DC) sources, for example, from batteries, motor vehicles or rectifiers, or by substituting flow (AC) sources, for example, from the power lattice, inverters or generators. Little motors might be found in electric watches. Universally useful motors with profoundly institutionalized measurements and attributes give the helpful mechanical capacity to modern use. The biggest of electric motors are utilized for ship impetus, pipeline pressure and siphoned stockpiling applications with appraisals coming to 100 megawatts. Electric motors might be grouped by electric power source type, inner development, application, kind of movement yield.

Three-phase enlistment (non concurrent) machines represent around 55 to 60 per cent of worldwide modern power utilization. Aside from the mechanical division, three-phase acceptance motors (non concurrent motor) discover broad use in the open part to drive water system siphons in rustic zones. In an agrarian nation like India, a large number of enlistment motor are driven siphon sets are in activity all through rustic jolt systems. Studies have been directed in India by a few Governmental and nongovernmental organizations that lacklustre showing of three phase acceptance motor siphon sets has been distinguished as a basic factor. Then again Studies [57] demonstrated a high potential for vitality productivity improvement in motor frameworks in creating just as in created nations. In any case, showcase disappointments and hindrances like the absence of capital, higher introductory costs, absence of consideration by plant administrators and absence of intensity quality influence the exhibition of the machines. To conquer these hindrances, approaches have been set up in a few nations, similar to least vitality execution benchmarks (MEPS) [58] that require least execution level for electric motors to enable them to enter in the national market. These have been actualized in numerous nations around the world. In spite of the fact that MEPS can be a powerful device to improve the piece of the overall industry of vitality productive of the Motors, in addition, Policies utilizing a framework enhancement approach joined with limit advancement were executed by many created nations.

The key tested to expand the presentation level of these machines incorporates to broaden the application zone of variable – speed electric drive furthermore, to coordinate the drive and the determined burden to get the most extreme effectiveness lastly to build the exhibition of the of the machines itself by Modified interior plan. Any machine is structured in the market as per the presentation criteria and efficiency. In this way, the objectives of the specialist ought to be to choose the most proficient motor as per the use of the work. The decision of the Electric motor ought to be the beginning phase of any appearance so as to decrease the power request and cost. Whenever the machine is begun, there is an motor warming point and it is fundamental not to surpass a cutoff which, finally, will finish with the disappointment of the motor. This can be maintained a strategic distance from by decreasing the misfortunes in the stator and rotor of the machine. At the point when the motor isn't running at its appraised power, its exhibition is diminished which prompts expanded vitality utilization. So as to spare the vitality assets the European Union [58] expressed that in 2020 all motors in the field must be under Motor proficiency marking plan (EFF1). The point of this plan is to accentuate to every single motor client, the significance of proficiency. At the end of the day elite motors, and that is conceivable with an altered plan. It is assessed that a full Implementation of proficiency improvement choices could lessen overall power request by around 7 per cent [59] International Energy Agency (IEA 2008). The capacity of this office is to advance global cooperation on vitality innovation. Electric motors drive both center modern procedures, similar to presses or rolls and assistant frameworks, as packed air age, ventilation or water siphoning in the provincial zones. These motors are used all through every single modern branch. Electric motors are the fundamental hotspot for the arrangement of mechanical Energy in industry. Size classes differ between motors with short of what one kW and huge modern Motors with a few MW evaluated control. In later, numerous examinations recognized enormous vitality productivity possibilities in electric motors and motor frameworks with many sparing choices appearing short recompense times and staggering expense adequacy with the legitimate plan.

In any case, interests in improving the vitality execution of electric motor frameworks are frequently postponed or dismissed for elective speculations. Various obstructions and market disappointments were observed to be in charge of that. Among them is an absence of consideration of the plant chief, Principal-specialist quandaries, higher starting expense for proficient motors and some more. Especially in creating nations, access to capital and beginning greater expenses of vitality productive motors are an important boundary. Much of the time, broken motors are rewound and reused despite the fact that motor rewinding frequently lessens its exhibition. This chance of high vitality proficiency potential has additionally been perceived by approach creators, who have progressed in the direction of conquering the obstructions since the 1990s. As an outcome, approaches, similar to least models and motor marking plans, were presented in numerous nations around the globe. Moreover, vitality review plans and limit advancement programs that emphasis on framework enhancement was set up.

Notwithstanding, after over a time of vitality execution approach on motor frameworks, impressive vitality effectiveness potential can, in any case, be watched, e.g., by putting resources into increasingly productive motors or introducing inverters to all the more likely control the motor. Market change projects demonstrated that they effectively changed the motor advertise towards higher execution, while new developing motors with significantly higher execution are going to enter the imprint

Induction Motor

The induction motor is a sort of AC Motor; it is called an induction motor in light of the fact that the working standards depend on electromagnetic induction. The vitality is changed through the turning attractive fields in an induction motor. The three-phase current in the stator side make an electromagnetic field which associates with the electromagnetic the field in the rotor bars, and after that the resultant torque will be created by the Lorentz' law. Hence, the electrical vitality could be changed into mechanical vitality. Induction motors are the favored decision for mechanical applications due to their rough structure, low cost and simple upkeep [13].

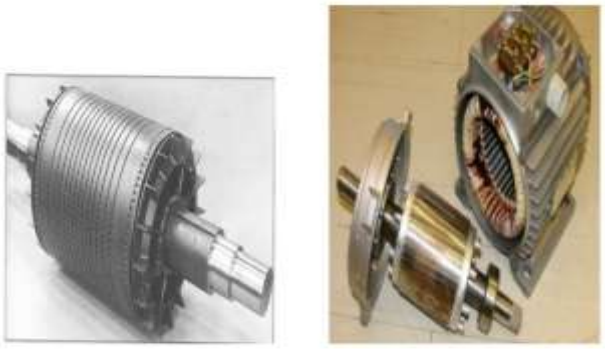


Figure 1.4. Induction Motors [14]

Following Table gives a comparison in between three types of AC motors with various parameter which will help in to understand the concept furthermore:

Parameters	PM Motors	SR Motors	Induction Motors
Overload capacity (%)	300	300-500	300-500
Volume	Small	Small	Medium
Mass	Light	Light	Medium
Manufacturing costs	High	Medium	Medium
Control Performance	Good	Good	Good
Reliability	Better	Good	Good
Range of speeds (r/min)	4K-10K	More than 15K	12K-20K
Peak efficiency (%)	95-97	90	94-95
Power density	High	Higher	Medium
Load efficiency (%)	85-97	78-86	90-92

Table 1.1: comparison in between three types of AC motors with various parameter

The PMSM is a prominent hopeful in view of its powerful thickness; high productivity also, reduced volume. However, the weakness is the attractive materials utilized in the PMSM is extremely costly, and they should be very much kept up for the reason of magnet erosion or demagnetization. The SRM is another promising contender for EV applications, due to its straightforward structure, shortcoming tolerant activity, and wide the speed goes at consistent power. In any case, the detriments of the SRM are its high torque swells and low productivity [11, 15]. Because of these investigates, the enlistment Motor is considered as the best possibility for the majority of EVs applications [3, 5]. Canny, solid and marketed control frameworks of AC enlistment Motors are being created dependent on power electronic gadgets and advanced sign preparing (DSP) innovation.

Modeling of Induction Motor on MATLAB

Design and Implementation of the Asynchronous Three phase motor is done on MATLAB Simulink R2018a. For this we have introduced different load conditions of torque to the designed Asynchronous motor which are as follow:

Types of torques available in the induction motor

T_a = Gross mechanical torque or motor torque.

T_{lost} = loss torque due to friction, wind age and iron losses

T_L = load torque

$T_a = T_{lost} + T_L$

Power ($P_{out} = T_L * \omega$)

$$T_L = \frac{P_{out}}{\omega}$$

$$P_{out} = {}^{4000Watts}/_{7500\ Watts}$$

$$\omega = \frac{2\pi n}{60}$$

$$\omega = \frac{2\pi * 1430}{60}$$

$$= 149.69\ rad/sec$$

$$T_L = \frac{4000}{149.67}$$

$$T_L = 26.72\ Nm$$

$$\frac{T_L}{2} = 13.36Nm$$

$$\frac{T_L}{4} = 6.68Nm$$

Similarly, for the Pout = 7500 watts we can calculate the Torque Load Conditions as follow:

$$\omega = \frac{2\pi n}{60}$$

$$\omega = \frac{2\pi * 1440}{60}$$

=150.72 rad/sec

$$T_L = \frac{7500}{150.72}$$

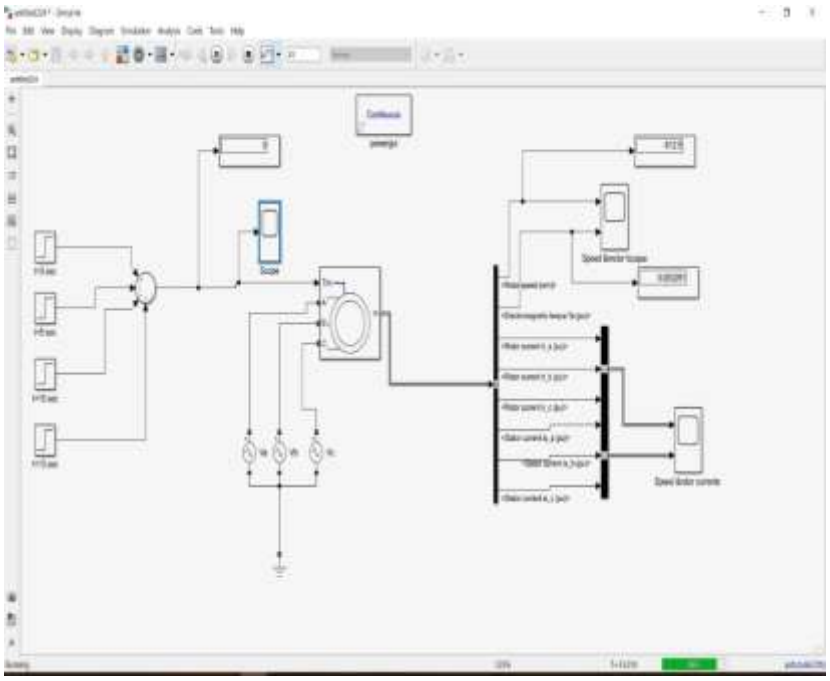
$$T_L = 49.76\ Nm$$

$$\frac{T_L}{2} = 24.6Nm$$

$$\frac{T_L}{4} = 12.44\ Nm$$

On the basis of the above calculations we have achieved the following results:

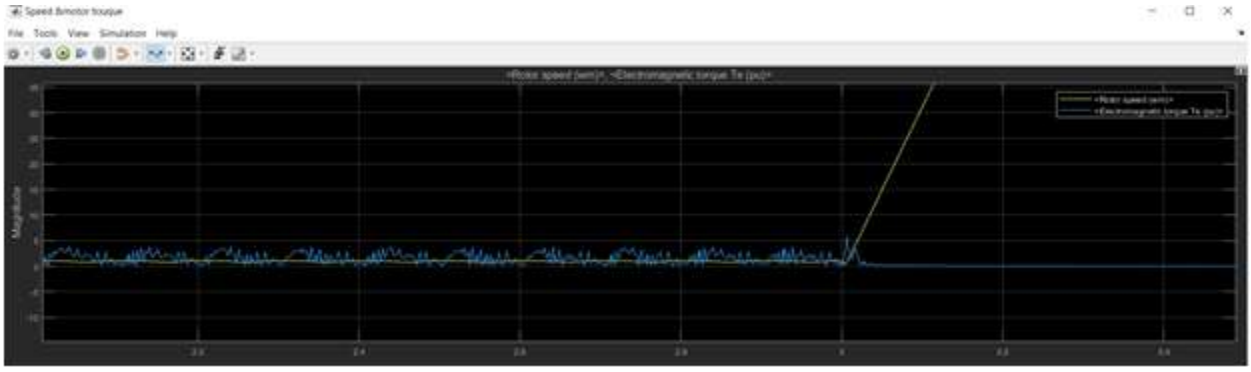
Model Designed in MATLAB Simulink is shown below with various output graphs.



Model of Asynchronous Three Phase Induction Motor on MATLAB Simulink.

Results

During the simulation of the model of asynchronous three phase induction motor we found that during the different load condition given to the motor speed and torque of the motor varies and the analysis of the output is shown in the figures below



Analysis of Speed and Torque for different load Conditions.

According to the figure shown above the motor speed and motor torque can be analyzed with respect to the simulation time.

At T=3 when there is full load on the motor.

Speed of the motor will decrease as indicated in the figure with yellow line and torque of the motor will increase.

At T= 5 When there is half load on the motor.

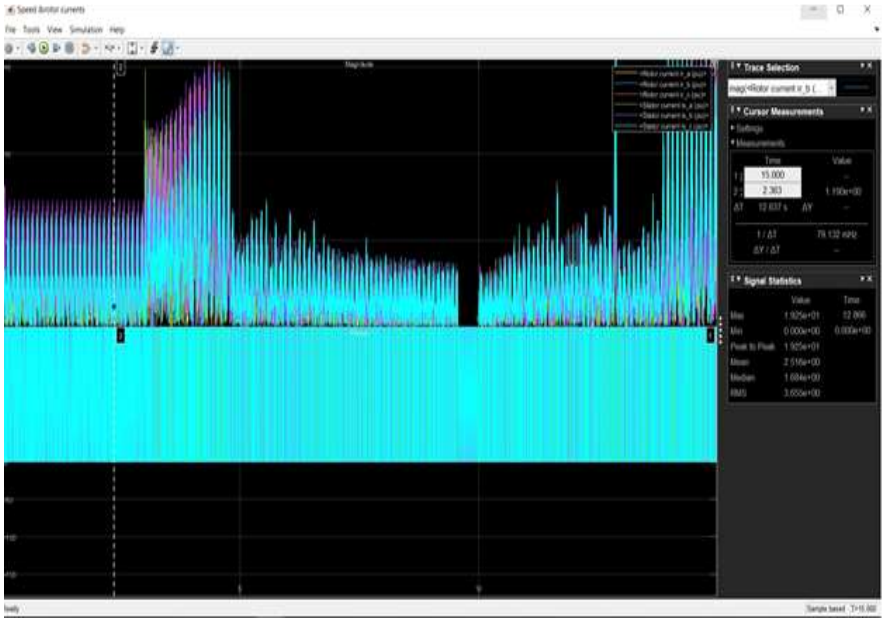
Speed of the motor will start increase and torque will start decreasing.

At T=10 when there is ¼ load on the motor.

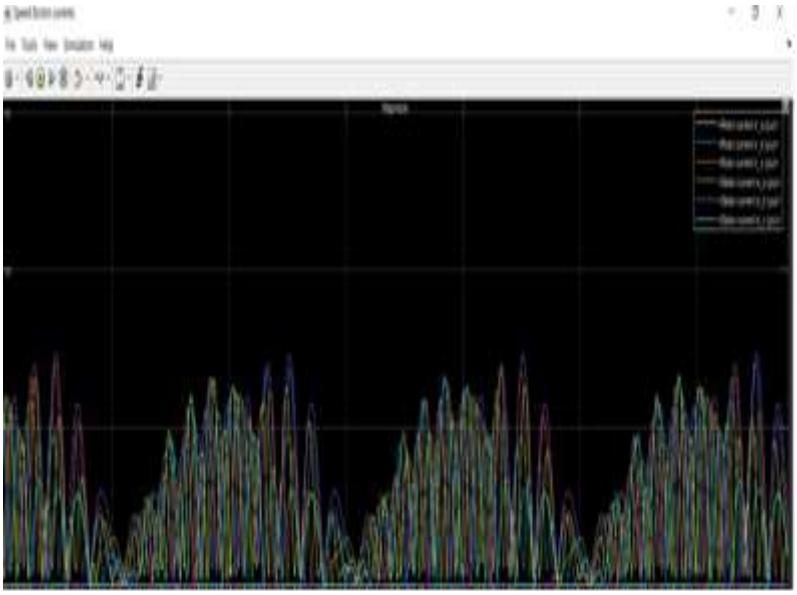
The speed of the motor will further increase and the torque will keep in decreasing.

At T=13 when there is no load on the motor.

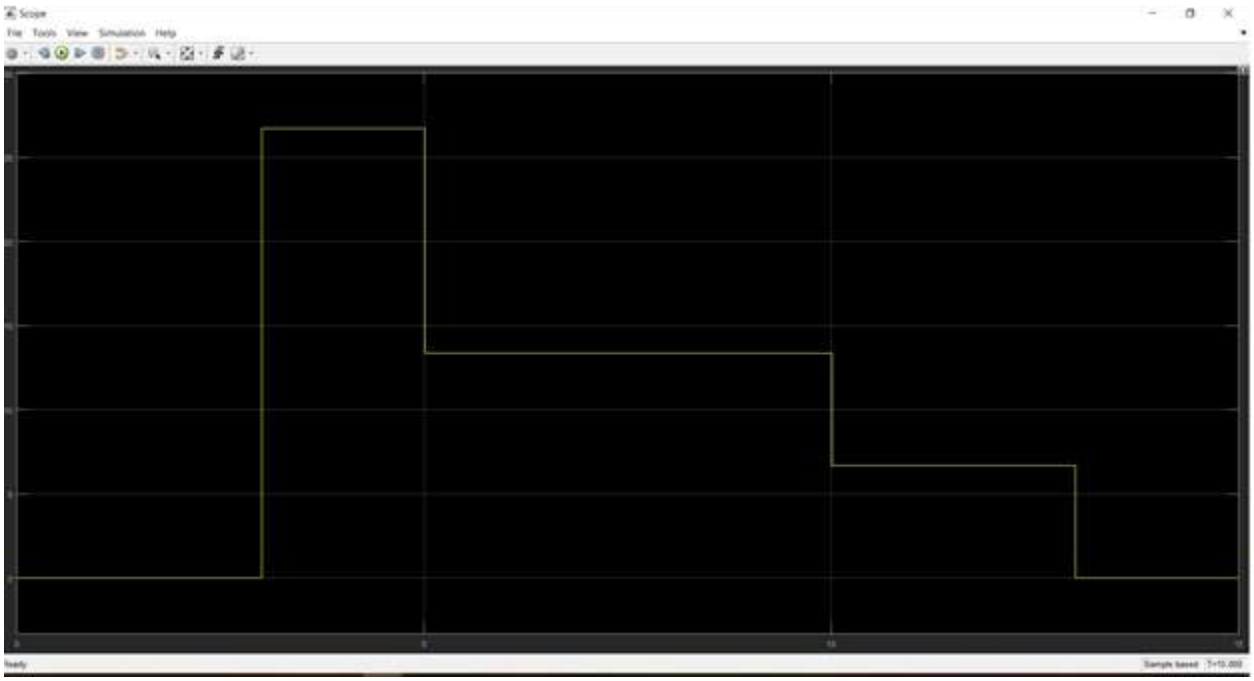
The speed of the motor will increase and torque will decrease.



Stator and Rotor Currents for the motor at different time cycles according to the different load conditions.



Elaborated image of Stator Current for the motor



Load variation graph of the motor at different load conditions

CONCLUSIONS

By adopting known, proven concepts, it is possible to design and implement the Three phase induction motor (Asynchronous Motor). For this we worked on the MATLAB Simulink MATLAB provided a platform where we can design and implement these kind of experiments with mathematical calculation. In the presented thesis work we have provided the motor with different load conditions which further showed us the complete working of the motor and helped us to understand the working with the help of various graphs. As shown in the results chapter.

The following conclusion could be made from is:

- The developed software provides good support for the desired parameters calculations.
- This software also provides a good support for the students who are learning the design process of electric motors.
- Such type of software can also be used for designing energy efficient machine as a future scope.
- This software can also be used to calculate the optimize parameters of electric machine

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