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Three Phase Induction Motor: Simulation and Speed Control of Motor Drives

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Abstract – Its durability, low cost and robustness, induction motors are the most popular electric motors. The induction motors, however, are not capable of variable speed operation automatically. This is why older dc motors were found in most electric drives. But modern advances in induction motor speed regulation methods have culminated in their wide-ranging usage in nearly all electric drives. The most frequently used closed loop constant V / f speed control system is a multi-methods for induction power, such as polar shift, frequency variance, variable rotor resistance, variable stator voltage, constant V/f regulation, slip recovery method, etc. The V / f ratio is kept constant in this system, which in turn holds the magnetizing stream constant to hold its maximal torque unchanged. The stator resistance and engine induction (both rotor and stator) should be held low while an induction motor is started to minimise the stable state period and also to avoid jerks during initialization. On the other side, a higher rotor resistance value contributes to fewer jerks and has little effects on the continuous condition duration. The induction vector control research allows for a decoupling research in which the torque and the flow components can be regulated separately (just as in the dc motor). This simplifies the study than the identical circuit per step.

Key Words: Three Phase Induction Motor, Space Vector Modulation, V/F Control

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INTRODUCTION

Regardless of whether it is domestic application or enterprise, motion control is important everywhere. The devices used for this reason are classified as drives. Such a machine is classified as an electric drive since it utilizes electric motors. Different sensors and control algorithms in electrical drives are used to control the engine speed using the necessary speed control methods.

Previously, only dc motors were used for drives involving variable speeds because of the simplicity of speed regulation. The standard speed control methods of an inductive engine were either too costly or too unreliable and thus restricted their use to constant speed drives. Nevertheless, recent developments and the advancement of induction engine speed regulation methods have greatly expanded the usage of induction engines in electrical drives.

INDUCTION MOTOR

Principle: An asynchronous motor if the stator is supplied with 3ph, flux is produced by the stator and transitions from stator to rotor owing to the reciprocal induction flux. The current created in the rotor is induced by short circuit copper bars in the rotor cuts the spinning flux.

As a three-phase supply energises the stator winding, a spinning magnet field is created, revolving around the stator at synchronous Ns pace. This flux splits the stationary rotor through the rotor winding and generates an electromotive power. Due to the short circuits of the rotor windings, there are 8 current flows. Again, when these conductors are put in the magnet region of the stator, the rule of Lenz exerts a mechanical force on them. The rule of Lenz teaches us that the path of rotor currents would be such that they tend to oppose the trigger that induces them. This generates a torque that aims to decrease the relative speed between the rotor and the magnetic field. The rotor also rotates in the same direction as the stream. The relative speed between the rotor and the magnetic field speed thus powers the rotor. Therefore, the Nr rotor speed remains always below the Ns synchronous speed. Induction engines are sometimes called asynchronous engines.

SPEED CONTROL OF INDUCTION MOTOR DRIVES (METHODS)

1. V / f control or frequency control.

2. Changing the number of stator poles.

3. Controlling supply voltage.

4. Change in the resistance of stator and rotor circuit

1. V/F CONTROL OR FREQUENCY CONTROL

We adjust the stator voltage to the degree that the flow is constant as the input frequency changes at the same time such that the ratio V / f is constant. The AC supply is corrected and then added to a PWM inverter to produce a 3-ph variable magnitude AC supply with a preset frequency. The electromagnetic torque of the motor is directly proportional to the stator's magnetic field and the flux generated by the stator is proportional to the voltage and frequency of supply applied. Thus, the torque may be kept steady in the speed spectrum by adjusting the voltage and frequency in the same ratio, flux and hence. This makes constant V / F system the most popular induction engine speed control process.

2. CHNAGING THE NUMBER OF STATOR POLES.

In this scenario, in the scenario of the speed control mechanism, it is very difficult to adjust the stator poles everywhere the time is taken, as there is adjust in the configuration of the induction motor.

3. CONTROLLING SUPPLY VOLTAGE

The stator voltage is to adjust at constant supply frequency as a very simple and economical method of speed regulation. The three-phase stator voltage can be regulated at the line frequency by regulating the inverter switches. The established torque is, as shown from the equation (3,10), proportional to the square of the stator voltage supply and a decrease of the stator voltage would reduce the pace. Thus continuous speed modulation may be achieved without modification of the stator frequency by changing the stator voltage.

4. ADDING RHEOSTAT IN STATOR CIRCUIT

This three phase induction rheostat speed control system is applied to the stator circuit and the rotor circuit lowers as a consequence of this voltage decreases in the case of the three-phase induction motor torque generated by T = sV2 2. If we lower the voltage supply torque, it will also decrease. But for the same load to be given, the torque must stay the same and this can only be done by increasing the slip and reducing the speed if the slip rises. This helps one to monitor the induction motor speed

Factors Affecting Efficiency of Induction Motor Drives

The performance of the induction motor drives such as partial load, harmonics, rewinding, power consistency, parameter variance, etc. is influenced by many factors. The following articles address these considerations briefly.

Partial Loading

The 3-way induction engines are primarily used with all electrical AC drives due to their inherent advantages: robustness, durability, comparatively low costs and ease of service. These devices provide years of operation (around 20 years) when correctly picked, controlled and managed. In general, the induction engine manages an industrial load of around 70% on a utility, which implies it is crucial to pay greater attention to the full performance of such AC derives. Basically, when run close the rated speed and torque, high performance activity of induction machines can be accomplished. The substantial development in system parts, architecture and fabrication methods will further increase the motor performance in induction.

Harmonics

The function of the inverter driven induction motor at high frequencies contributes to losses due to two forms of harmonics:

1) Space harmonics referred to as stray losses.

2) The time harmonics in the excitation of a converter added to the unit, resulting in losses of time harmonic.

Stray Losses

The air flow difference of the space wave harmonics allows the system to experience street losses (high frequency errors). The key triggers of these harmonics are the differences in the position of stators and rotor slots and the mmf phase harmonics. These losses are related to the specific motor frequency and can be predicted to rise with the increase in the fundamental motor frequency.

High Frequency Time Harmonic Losses

An significant problem in today's electronic power management is the impact of time-harmonic frequency rise on harmonic motor losses. There are also valid explanations for control and motor acoustic noise, which justify for the strong inverter frequency of the carrier. Contrary to these claims, large engine losses may be induced by the carriers' large time harmonic frequency.

Rewinding

If the engine dies, fast repair and replacement are primarily two methods of avoiding output losses in front of engine customers. Excellent materials will reach optimum performance as in the previous stage, but the bad rewind contributes to higher energy usage and a shorter life due to higher ambient temperatures.

After rewinding the induction machine performance and power factor will greatly effect. The producer and consumer can then retain an appropriate register with no loss of load and pace during selling and buy. These reports may be valuable for rewinding effect measurement.

Unbalance Supply Voltage

While supplied by unequalled terminal voltages, induction motor output (speed and torque profile) is adversely affected. The accessible 1950 literature indicates that researchers concentrated on 3-fold induction motor output in voltage imbalances in relation to total current drawn, current imbalance factor, torque ripples, productivity and factor loss, rate loss, overheating isolation damages or computer failure factor [39].

Equal magnitudes and phase angle of 1200 in three stages, reflect the 3-fold mechanism in equilibrium. Every divergence from the parameters specified contributes to a system mismatch. The statistical concept of imbalance can be presented according to various criteria, including the Association of National Electrical Manufacture (NEMAs), the College of Electrical and Electronic Engineers (IEEE's) and IECs.

Voltage Sags

The RMS voltage drop in the associated power grid for short term is known as a "voltage decline." This issue in power quality is primarily attributed to machine failures. This is also likely due to loose links and the immediate start of heavy loads (the broad starter motor draws a strong in-rush current). For this phenomenon, the IEC term is "dip." Voltage decay triggers significant process problems and often vulnerable electrical loads sometimes go or shut down, which contributes to low quality items and severe production savings as well as a spike in engine temperature.

Parameter Variation

Both education and researchers performed a large amount of efficiency tests in order to monitor AC drives and DC drives effectively and precisely. The study brings them to the vector control principle. AC drive vector control is somewhat close to individual torque and flux control. The high efficiency of an induction engine can be accomplished by vector power. The methods of vector control are very susceptible to the variance of system parameters. However, with temperature and magnetic core saturation the motor parameters change. Computer flux is calculated offline in the direction of vectors by parameters that may be mistake attributable to parameter variations. If the vector controller does not change the error, the system output can be degraded by steady state error and transient speed and torque oscillations.

Modelling of Induction Motor Drive

The mathematical model of the drive mechanism comprises the induction engine model, PWM inverter models, PI speed controls and comprehensive engine and inverter failure models. The modelling expectations of the drive method are as follows.

1) The inductive motor's three-phase stator windings are balanced and generate Magneto Motive Force (MMF) spread sinusoidally in vacuum.

2) The DC link voltage accessible at inverter input terminals is considered to be free of ripple.

3) The three-phase sinusoidal currents moving through the engine are often presumed clear of ribbons.

4) Inverter and converter flipping transients are ignored.

5) Between switching system change times is small.

6) Three-phase converter input currents are sinusoidal

CONCLUSION

The induction motor can be operated by increasing the frequency with the V / f ratio control system. But in this situation, if we adjust the frequency, the voltage still adjusts on the secondary side. The amount of supply voltages is also minimal relative to high speeds at low levels. The supply voltage decreased automatically to preserve a steady V / F ratio. The torque is thus minimized since the torque is directly equal to the voltage square. This is also not an effective speed control system. We may therefore say that we can adjust the resistance of the induction motor speed function. In this step, we can raise the rotor resistance to reach the optimum starting torque. But the copper loses in the running state are raised because of high resistance. The performance of the motor is thus limited. We may therefore assume that it does not play a major role in speed regulation and we must search for more methods.

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