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Elimination Of Flywheel Of A Process Machine Using Induction Motor Modelling Fed By Inverter

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Abstract

In earlier days, variable speed control was performed by D.C. motors and for induction motors, bulky flywheel was needed for the same purpose. Today, due to advance control technique and the development of power electronic devices, induction motor can be run as variable speed drives, without flywheel. For this we need to control the input side of the induction motor. This has resulted in the utilization of inverter circuits for variable speed control of induction motor.

Also flywheel is connected between the induction motor and load to equalize the torque. But flywheel is large and heavy and therefore bulky. It also produces many difficulties. Therefore we need to eliminate the flywheel and compensate for the torque in the absence of flywheel. Hence, input side of induction motor must be controlled to produce desired torque at the output. This paper presents the control of input side of induction motor fed by PWM (Pulse Width Modulation) inverter.

1. Introduction

Over the past recent years, power electronics has played an important role to control and obtain any desired output. Inverter is one such electronic device. The main purpose of PWM inverter here is to control input frequency of three phase induction motor. This is mainly because induction motor can be only control over a certain range because of its fixed supply frequency. Due to advancement in electronics control and circuitry, this control is easily achievable. With this type of control, the torque and ultimately the speed can be controlled

2. Flywheel

Flywheel is an energy storing device and is connected between the induction motor and the load. The main purpose of flywheel is to store the energy when it is abundant, and to release the stored energy in the absence or shortage of supply. But flywheel comes with major disadvantages. Flywheel has its initial as well as running cost high. It produces torsional oscillations and vibrations which contribute to noise. Also presence of large flywheel affects other components, working properly. This leads to component fatigue, resulting into failure of equipments.

To avoid such problems flywheel must be eliminated. But in the absence of flywheel, induction motor must produce the torque required by the load as in the presence of flywheel. Therefore, input side of the induction motor must be controlled such that it produces the desired torque at the output.

3. PWM Inverter

Inverters are the circuits that convert D.C. to A.C supply. The basic principle of PWM inverter is to compare the sinusoidal wave with the triangular wave and compare it in the comparator.

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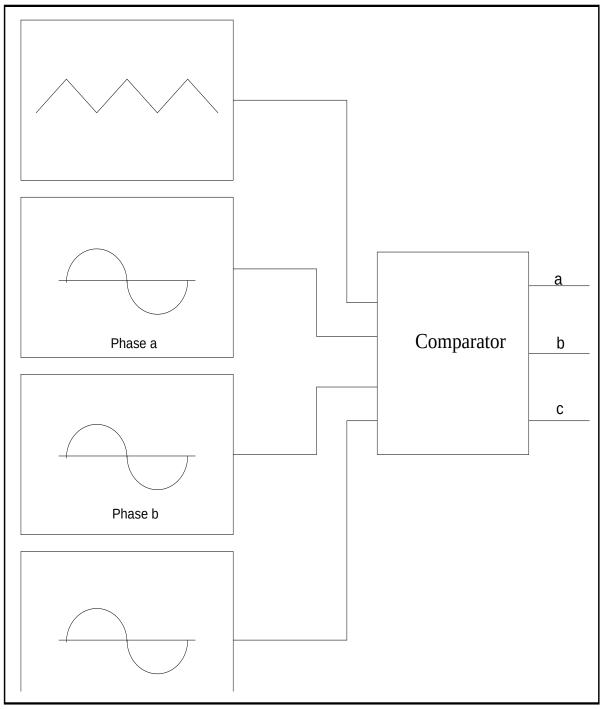

Figure 1. Comparison of triangular wave with the three phase sinusoidal phases

Here, the triangular frequency is kept at 2500 Hz. The three sine waves are compared in the comparator and the pulses are obtained. Pulse Width Modulation inverter is used to control the speed and the torque of three phase induction motor. Pulse Width Modulation (PWM) provides a way to decrease total harmonic distortion (THD) of load current. Filter requirements for harmonics reduction are reduced with PWM inverter, also control of output amplitude can be done with PWM inverter. The on and off occurrence are determined by comparing sinusoidal (modulating) wave with triangular (carrier) wave. The sine wave determines the frequency of output waveform, while the carrier signal determines the switching frequency of the switches.
The output is obtained in the form of pulses which drives the inverter. The switching sequence is decided by voltage signal. The voltage phase which is greater at any instant, switches of that phase are turned on respectively.

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4. Simulation Diagram

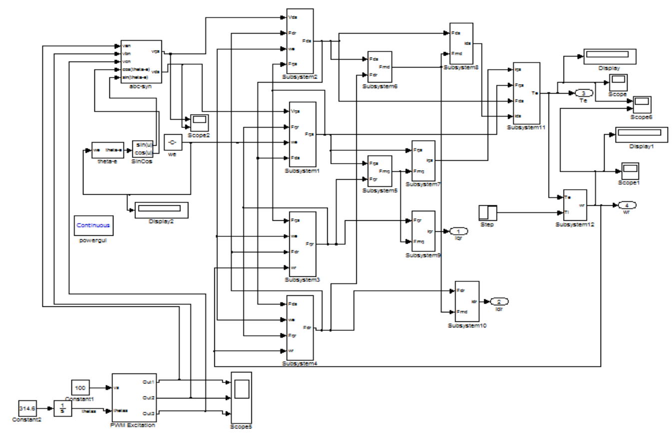

Figure 2. Simulation diagram of induction motor modelling fed by inverter

The above figure shows the induction motor modelling and the inverter to feed the induction motor. Induction motor modelling is done because the induction motor has inherent coupling effect. Therefore change of one parameter will affect the other parameter. Therefore, de-coupling of parameters is necessary for the ease of control. Hence, induction motor modelling helps to de-couple the parameters and PWM inverter helps to control the input side of induction motor.

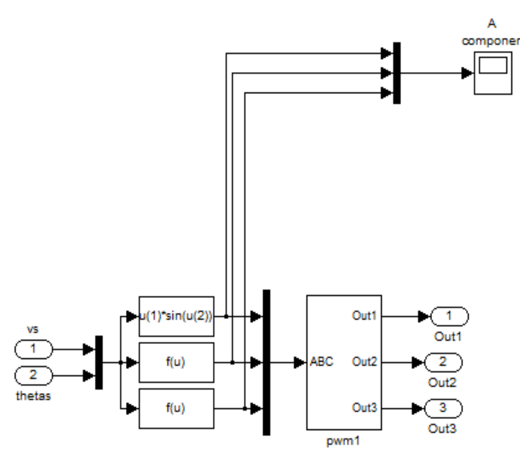

Figure 3. Simulation diagram of mathematical PWM inverter

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5. Simulation Results

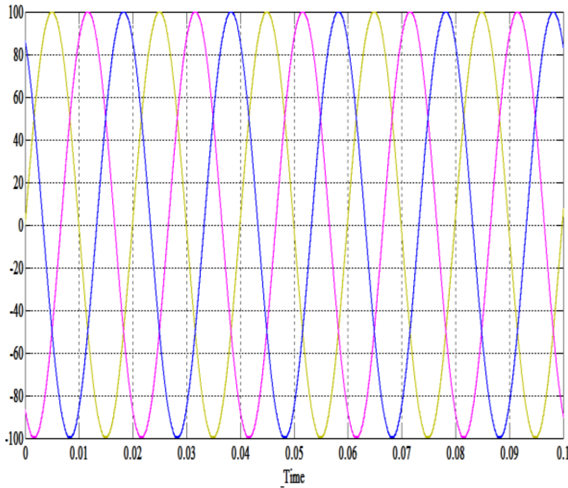

Figure 4. Three phase sinusoidal voltages.

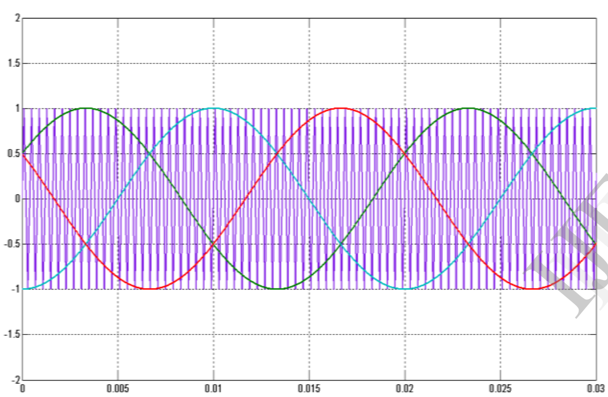

Figure 5. Comparison of three phase sinusoidal voltage waves with the triangular (carrier) wave.

The frequency of the carrier wave is kept at 2500 Hz. Therefore, by changing the amplitude of the voltages, the output can be changed.

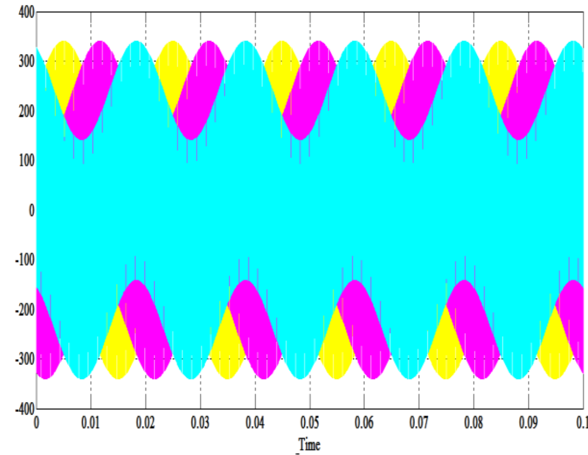

Figure 6. Sinusoidal PWM signal generator.

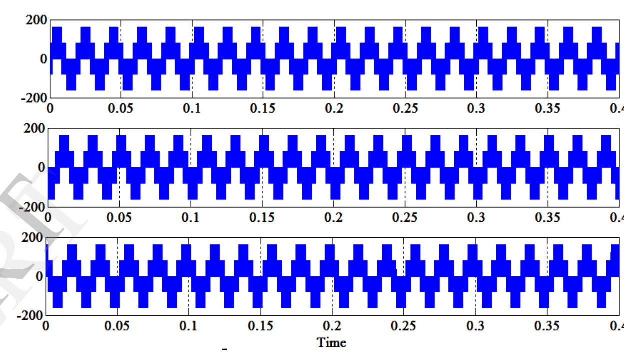

Figure 7. Three-phase output of the inverter

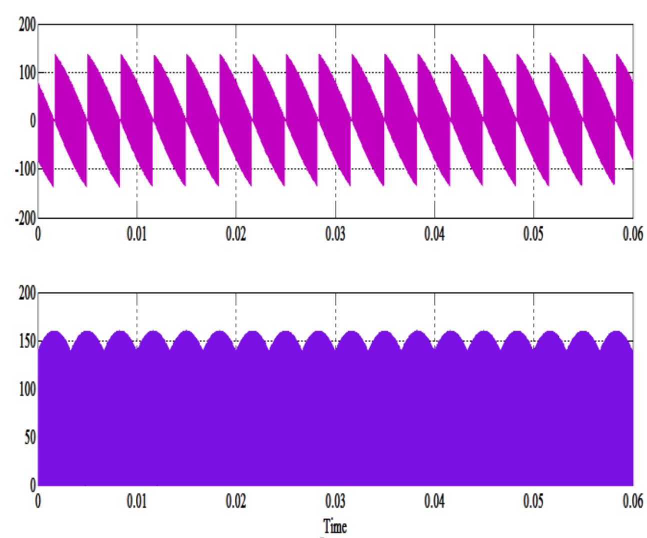

Figure 8. Simulation results of d-q axis of voltages

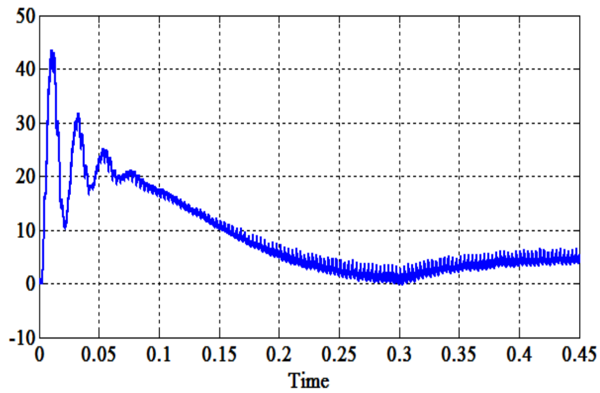

Figure 9. Simulation result of induction motor torque

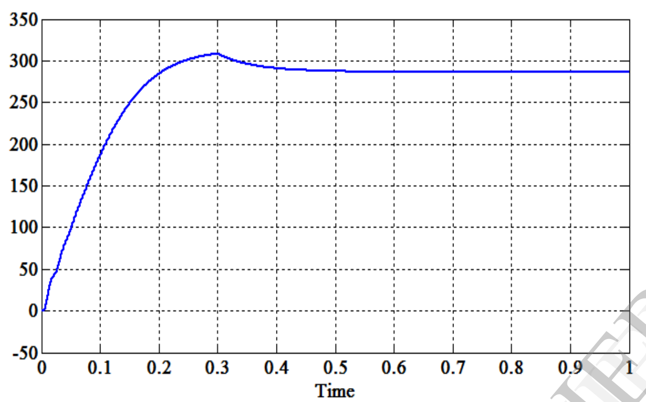

Figure 10. Simulation result of induction motor speed

6. Conclusion

The PWM inverter feeding the induction motor is simulated and the results are obtained. In PWM inverter, the triangular wave is compared with the sinusoidal wave. The triangular frequency is kept at 2500 Hz. Therefore, by changing the three phase sinusoidal wave, the frequency and ultimately the output can be changed. Hence, PWM inverter is required to change the frequency to match the electromagnetic torque with the load torque.

7. References

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