Induction Generator

Aim

To understand the operation of an induction machine as a generator in grid connected and standalone mode.

Theory

Induction machine operates as a motor when its speed (ω_m) lies between 0 and synchronous speed (ω_s), i.e. $0 < \omega_m < \omega_s$. If the machine speed crosses ω_s then the machine operates with negative slip. This means that the rotor field is rotating "ahead of" the stator field. The torque produced is negative and hence the machine is generating power. The complete torque speed characteristics can be seen in the Fig.1

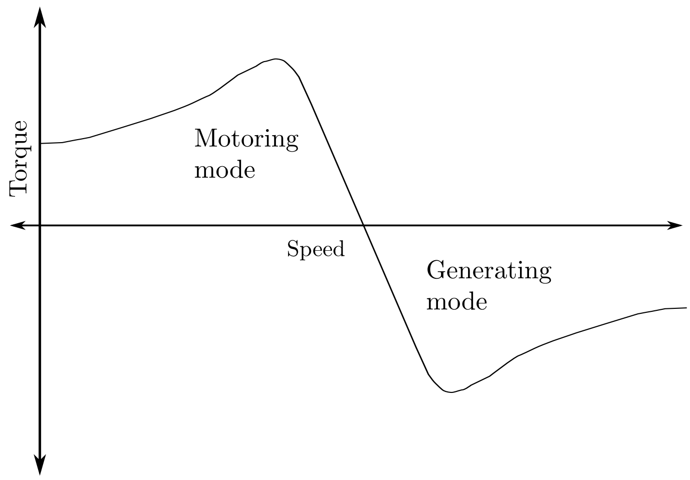

Figure 1: Torque Speed characteristics of induction machine: both in motoring and generating mode

The rotor currents in the induction machine are due to the induced emf in the rotor. There is no *separate excitation* supplied to the rotor. The motor can enter generating mode only of receives reactive power in the form of field supply. Two such cases have been considered here based on the source of reactive power.

Grid-connected Induction Machine

Consider an induction machine connected to the grid. The machine can run as a motor by connecting it to a three phase supply. Note, the machine speed (in motoring mode) is less than the synchronous speed ($\omega_m < \omega_s$). However, if the speed is increased by means of a prime mover to a value greater than ω_s then the machine acts like a generator with power being supplied to the grid. The reactive power needed is drawn from the grid.

Standalone Induction Generator

The standalone induction generator can operate at any speed. Start the induction machine by using a prime mover.The reactive power needed for generator operation is provided using capacitor banks. Switch in capacitor banks across the machine terminals that will excite the induction machine and will enter generating mode. The value of capacitor bank needed for self excitation depends on the parameters of the induction machine.

Procedure

Self-excited Induction Generator

1. Connect the circuit as shown in the Fig. 2.
2. Fix the speed of the induction machine to any value using the prime mover (DC Motor).
3. Switch on the capacitor banks one by one by closing switches S1, S2, S3.
4. Close the switch S4. You can see the bulbs glowing as power is supplied to them by the induction generator.
5. What is the power delivered to the bulbs?

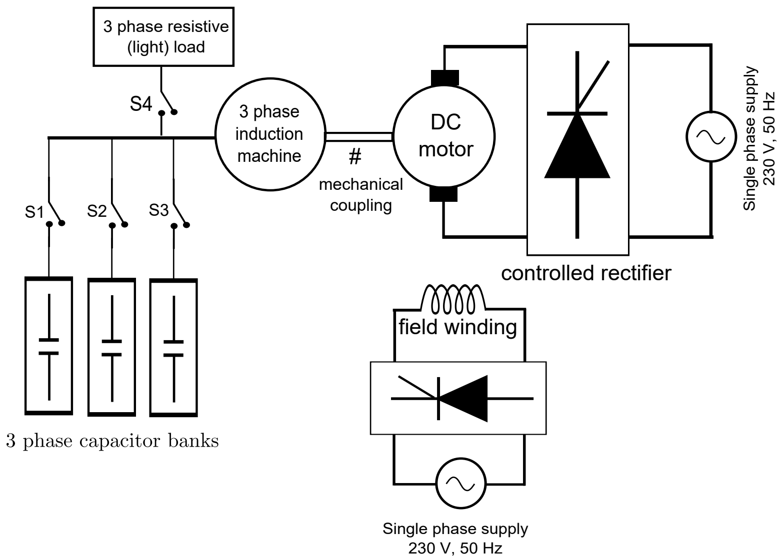

Figure 2: Independently operating (self excited) induction generator

Grid-connected Induction Generator

1. Make circuit connections as shown in Fig.3
2. Start the induction machine using an autotransformer and note the direction of rotation. Reduce the voltage to zero to stop the machine.
3. Start the DC motor. Note the direction of rotation and turn off the dc supply.
4. If the two directions are the same go to the next step. Otherwise, interchange the armature supply terminals of the DC machine. (The same effect can be achieved by interchanging any two of the phase terminals of the induction machine; *why?*).
5. Close the switch S1 and start the induction machine with the autotransformer. Apply full rated voltage.
6. Note the speed of the machine and the sign of power in the power analyzers.
7. Start the DC machine. Increase its speed greater than the *synchronous* speed of the machine. Note the sign of power readings in the power analyzers.

This experiment/chapter was prepared by *R M Ramkumar* (Research Assistant, 2014-17 batch).

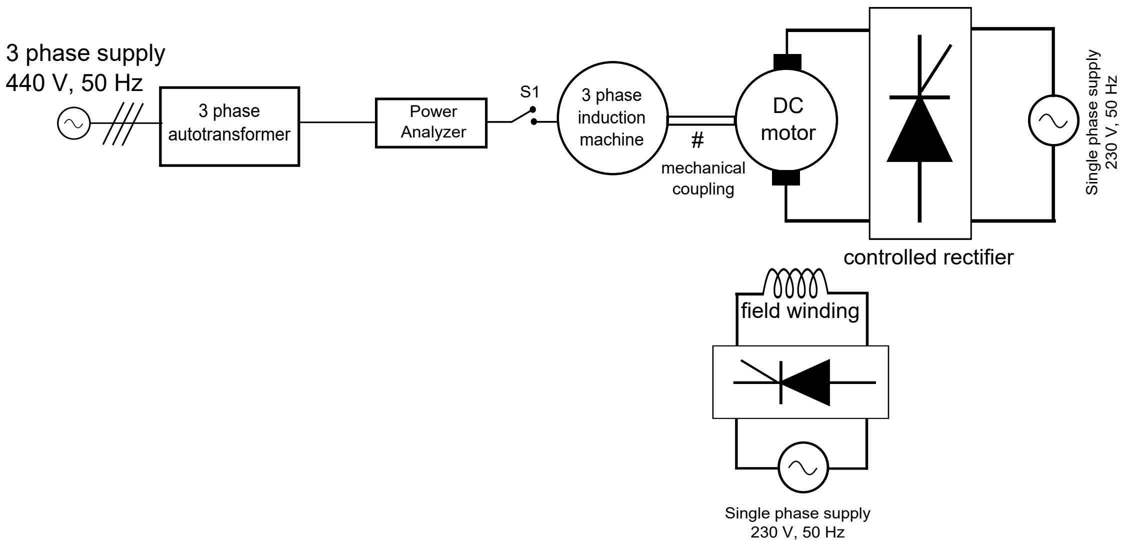

Figure 3: Grid connected induction generator