Single-Phase Motors

1 Introduction

Single phase motors are the most familiar of all electric motors because they are extensively used in home appliances, shops, offices etc. It is true that single phase motors are less efficient substitute for 3-phase motors but 3-phase power is normally not available except in large commercial and industrial establishments. Since electric power was originally generated and distributed for lighting only, millions of homes were given single-phase supply. This led to the development of single-phase motors. Even where 3-phase mains are present, the single-phase supply may be obtained by using one of the three lines and the neutral. Single-phase induction motors are usually two-pole or four-pole, rated at 2 hp or less, while slower and larger motor can be manufactured for special purposes. They are widely used in domestic appliances and for a very large number of low power drives in industry. The single phase induction motor resembles, three-phase, squirrel-cage motor except that, single phase induction motor has no starting torque and some special arrangement have to be made to make it as self starting. We shall focus our attention on the construction, working and characteristics of commonly used single-phase motors.

2 Types of Single-Phase Motors

Single-phase motors are generally built in the fractional-horsepower range and may be classified into the following four basic types:

1. Single-phase induction motors

(i) split-phase type (ii) capacitor start type (iii) capacitor start capacitor run type (v) shaded-pole type

2. A.C. series motor or universal motor

3. Repulsion motors

(i) Repulsion-start induction-run motor (ii) Repulsion-induction motor

4. Synchronous motors

(i) Reluctance motor (ii) Hysteresis motor

3 Single-Phase Induction Motors

A single phase induction motor is very similar to a 3-phase squirrel cage induction motor. Unlike a 3-phase induction motor, a single-phase induction motor is not self starting but requires some starting means. The single-phase stator winding produces a magnetic field that pulsates in strength in a sinusoidal manner. The field polarity reverses after each half cycle but the field does not rotate. Consequently, the alternating flux cannot produce rotation in a stationary squirrel-cage rotor. However, if the rotor of a single-phase motor is rotated in one direction by some mechanical means, it will continue to run in the direction of rotation. As a matter of fact, the rotor quickly accelerates until it reaches a speed slightly below the synchronous speed. Once the motor is running at this speed, it will continue to rotate even though single-phase current is flowing through the stator winding. This method of starting is generally not convenient for large motors. Figure 1 shows picture of single phase induction motor.

Figure 1 Single phase induction motor.

4 Construction of single phase induction motor

The construction parts on of single phase induction motor consist of main two parts: stationary stator and revolving rotor. The stator separate from rotor by small air gap have ranges from 0.4 mm to 4 mm depends to size of motor.

4.1 Stator

The single-phase motor stator has a laminated iron core with two windings arranged perpendicularly, One is the main and the other is the auxiliary winding or starting winding as showing in the figure 2. It consists of a steel frame which encloses a hollow, cylindrical core made up of thin laminations of silicon steel to reduce hysteresis and eddy current losses. A number of evenly spaced slots are provided on the inner periphery of the laminations.

Figure 2 Stator of single phase induction motor.

4.2 Rotor

The rotor, mounted on a shaft, is a hollow laminated core having slots on its outer periphery. The winding placed in these slots (called rotor winding) may be one of the following two types:

(i) Squirrel cage rotor:

It consists of a laminated cylindrical core having parallel slots on its outer periphery. One copper or aluminum bar is placed in each slot. All these bars are joined at each end by metal rings called end rings [See Fig. 3]. This forms a permanently short-circuited winding which is indestructible. The entire construction (bars and end rings) resembles a squirrel cage and hence the name. The rotor is not connected electrically to the supply but has current induced in it by transformer action from the stator. Those induction motors which employ squirrel cage rotor are called squirrel cage induction motors. Most of single phase induction motors use squirrel cage rotor as it has a remarkably simple and robust construction enabling it to operate in the most adverse circumstances. However, it suffers from the disadvantage of a low starting torque. It is because the rotor bars are permanently short-circuited and it is not possible to add

any external resistance to the rotor circuit to have a large starting torque. In this type of rotor the bars conductor are skew to reduce the noise.

Figure 3 Squirrel cage rotor.

(ii) Wound Rotor:

It consists of a laminated cylindrical core and carries a single-phase winding, similar to the one on the stator. The open ends of the rotor winding are brought out and joined to three insulated slip rings mounted on the rotor shaft with one brush resting on each slip ring. The two brushes are connected to a single-phase star-connected rheostat as shown in Figure 4. At starting, the external resistances are included in the rotor circuit to give a large starting torque. These resistances are gradually reduced to zero as the motor runs up to speed. The external resistances are used during starting period only. When the motor attains normal speed, the two brushes are short-circuited so that the wound rotor runs like a squirrel cage rotor.

Figure 4 wound rotor of single phase induction motor.