

48550 Electrical Energy Technology

Chapter 6.

Synchronous Machines

Topics to cover:

- 1) *Introduction*
- 2) *Synchronous machine structures*
- 3) *Rotating magnetic field*
- 4) *Equivalent circuit model*
- 5) *Performance as a generator*
- 6) *Performance as a motor*

Introduction

A synchronous machine is an ac rotating machine whose speed under steady state condition is proportional to the frequency of the current in its armature. The magnetic field created by the armature currents rotates at the same speed as that created by the field current on the rotor, which is rotating at the synchronous speed, and a steady torque results.

Synchronous machines are commonly used as generators especially for large power systems, such as turbine generators and hydroelectric generators in the grid power supply. Because the rotor speed is proportional to the frequency of excitation, synchronous motors can be used in situations where constant speed drive is required. Since the reactive power generated by a synchronous machine can be adjusted by controlling the magnitude of the rotor field current, unloaded synchronous machines are also often installed in power systems solely for power factor correction or for control of reactive kVA flow. Such machines, known as *synchronous condensers*, may be more economical in the large sizes than static capacitors.

With power electronic variable voltage variable frequency (VVVF) power supplies, synchronous motors, especially those with permanent magnet rotors, are widely used for variable speed drives. If the stator excitation of a permanent magnet motor is controlled by its rotor position such that the stator field is always 90° (electrical) ahead of the rotor, the motor performance can be very close to the conventional brushed dc motors, which is very much favored for variable speed drives. The rotor position can be either detected by using rotor position sensors or deduced from the induced *emf* in the stator windings. Since this type of motors do not need brushes, they are known as brushless dc motors.

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