المكائن

اعداد : أ. باسم محمد

Synchronous motor

-2-

Type of synchronous motor

1:Non-Excited Synchronous Motor

These motors don't require external excitation for their magnetic field. Common types include:

ذات ممانعة متغاوتة ذات عزم اقل وبسافة بالتصميم

Reluctance Synchronous Motors: The rotor is made of a material with varying magnetic reluctance. These motors are efficient but have less torque and are simpler in design.

دوار ذا حساسية هيسترية عالية في المحركات ذات التحكم الدقيق في السرعة

Hysteresis Synchronous Motors: Utilize a rotor made from a material that has a high hysteresis loss. They are used in applications requiring precise control over speed

1. **Power Output:** The mechanical power output is a function of torque and synchronous speed:

$$P_{out} = T \times \omega_s$$

- P_{out} = Output mechanical power (W)
- T = Torque (N·m)
- ω_s = Synchronous angular velocity (rad/s)

.

تتطلب اثارة خارجية وهي انواع

① ذات ممانعة

② ذات هيسترة

(Synchronous Frequency):

$$N_s = \frac{120 \times f}{P}$$

- N_s = Synchronous speed in revolutions per minute (RPM)
- f = Frequency of the supply (Hz)
- P = Number of poles of the motor

.1 **Efficiency (η):** The efficiency of the motor is the ratio of output power to input power:

$$\eta = \frac{P_{out}}{P_{in}} \times 100$$

- η = Efficiency (%)
- P_{out} = Output mechanical power (W)
- P_{in} = Input electrical power (W)

.1 **Power Output:** The mechanical power output is a function of torque and synchronous speed:

$$P_{out} = T \times \omega_s$$

- P_{out} = Output mechanical power (W)
- T = Torque (N·m)
- ω_s = Synchronous angular velocity (rad/s)

2- Direct Current (DC)-Excited Synchronous Motors

محرك متزامن بتيار DC

These motors require an external DC power source to energize the rotor. Some types include:

Permanent Magnet Synchronous Motors (PMSM): Use permanent magnets on the rotor instead of an electromagnet, making them highly efficient. They are commonly found in electric vehicles, robotics, and appliances.

استخدام مغناطيس دائمي على الكفاءة في المركبات الكهربائية والروبوتات

Brushless Synchronous Motors: These motors are similar to PMSM but operate without brushes, reducing maintenance needs.

نفس النوع الطرگاه بس بدون فرشاة

Wound Field Synchronous Motors: Have electromagnets on the rotor powered by an external DC source. They are widely used in large industrial machines, such as compressors and pumps

2. Electromagnetic Torque:

The torque generated in a DC-excited synchronous motor depends on the interaction between the rotor's magnetic field (from the DC excitation) and the stator's magnetic field:

$$T = \frac{3 \times V \times E_f \times \sin(\delta)}{\omega_s \times X_s}$$

$$P_{out} = T \times \omega_s$$

- P_{out} = Mechanical power output (W)
- T = Torque (N·m)
- ω_s = Synchronous angular velocity (rad/s)

3-Hybrid Synchronous Motor

These motors combine characteristics of both permanent magnet and reluctance motors, providing good performance in terms of torque, efficiency, and control. They are used in precise applications like CNC .machines and automation

Each type of synchronous motor is tailored for specific applications based on their design, efficiency, and torque characteristics

- **Reluctance torque:** This torque is generated by the tendency of the rotor to align with the stator field, minimizing the magnetic reluctance:

$$T_r = \frac{1}{2} \times (L_d - L_q) \times I_s^2 \times \sin(2\delta)$$

2. Total Torque (Combination of Permanent Magnet and Reluctance Torque):

The total torque generated by a hybrid synchronous motor is the sum of two components:

- **Torque due to the permanent magnet (PMSM torque):**

$$T_{pm} = \frac{3 \times V \times E_f \times \sin(\delta)}{\omega_s \times X_s}$$

Total torque (T_total) is:

$$T_{total} = T_{pm} + T_r$$

3. Mechanical Power Output:

The power output of the motor can be calculated as the product of the total torque and the angular velocity:

$$P_{out} = T_{total} \times \omega_s$$

- P_{out} = Mechanical power output (W)