TORQUE SPEED CHARACTERISTICS

The two oppositely directed torques and the resultant torque can be shown effectively with the help of Torque-Speed characteristics. It is shown in the Fig.2.

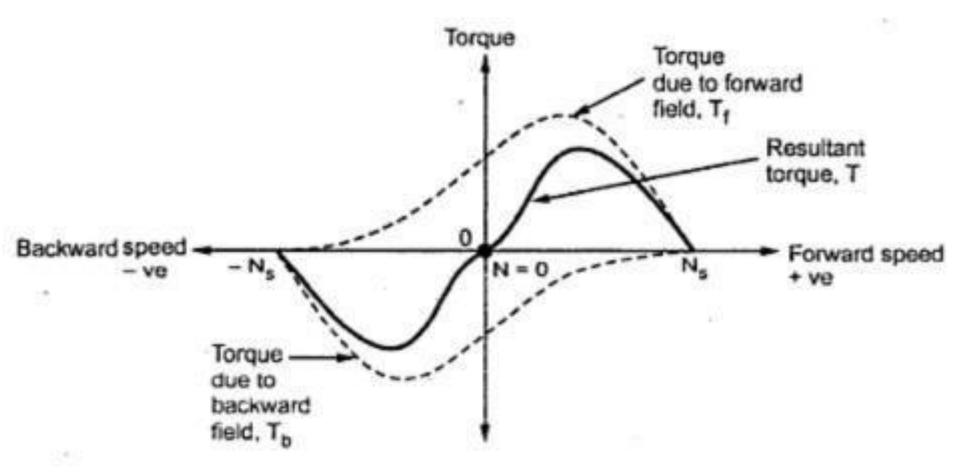


Fig.5.2.1 **Torque-speed characteristic**

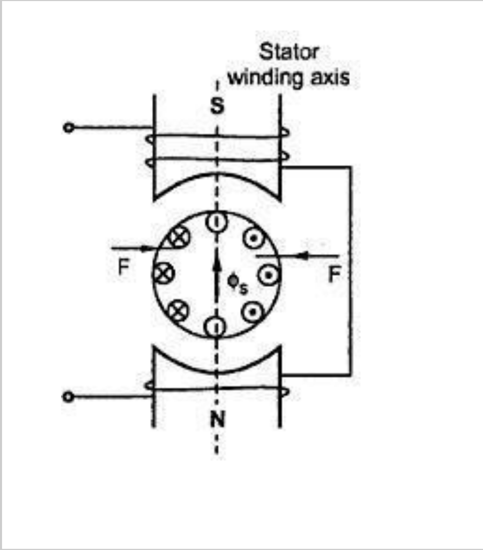
It can be seen that at start N = 0 and at that point resultant torque is zero. So single phase motors are not self starting.

However if the rotor is given an initial rotation in any direction, the resultant average torque increase in the direction in which rotor initially rotated. And motor starts rotating in that direction. But in practice it is not possible to give initial torque to rotor externally hence some modifications are done in the construction of single phase induction motors to make them self starting.

Another theory which can also be used to explain why single phase induction motors is not self starting is cross-field theory.

Cross Fieldtheory

Consider a single phase induction motor with standstill rotor as shown in the Fig. 1. The stator winding is excited by the single phase a.c. supply. This supply produces an alternating flux Φ_s which acts along the axis of the stator winding. Due to this flux, e.m.f., gets induced in the rotor conductors due to transformer action. As rotor is closed one, this e.m.f. circulates current through the rotor conductors. The direction of the rotor current is as shown in the Fig. 1. The direction of rotor current is so as to oppose the cause producing it, which is stator flux Φ_s.



Now Fleming's left hand rule can be used to find the direction of the force experienced by the rotor conductors. It can be seen that when Φ_s acts in upward direction and increasing positively, the conductors on left experience force from left to right while conductors on right experience force from right to left. Thus overall, the force experienced by the rotor is zero. Hence no torque exists on the rotor and rotor can not start rotating.

We have seen that there must exist two fluxes separated by some angle so as to produce rotating magnetic field. According to cross field theory, the stator flux can be resolved into two components which are mutually perpendicular. One acts along axis of the stator winding and other acts perpendicular to it.

Assume now that an initial push is given to the rotor anticlockwise direction. Due to the rotation, rotor physically cuts the stator flux and dynamically e.m.f. gets induced in the rotor. This is called speed e.m.f. or rotational e.m.f. The direction of such e.m.f. can be obtained by Fleming's right hand rule and this e.m.f. in phase with the stator flux Φ_s. The direction of e.m.f. is shown in the Fig. 2. This e.m.f. us denoted as E_{2N}. This e.m.f. circulates current through rotor which is I_{2N}. This current produces its own flux called rotor flux Φ_r. This axis of Φ_r is at 90^o to the axis of stator flux hence this rotor flux is called cross-field.

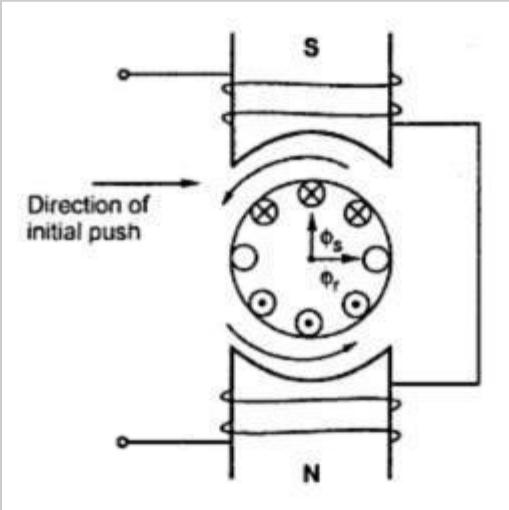


Fig.5.2.2 Direction of rotation

Due to very high rotor reactance, the rotor current I_{2N} and Φ_r lags the rotational e.m.f. by almost 90^o .

Thus Φ_r is in quadrature with Φ_s in space and lags Φ_s by 90^o in time phase.

Such two fluxes produce the rotating magnetic field.

The direction of this rotating magnetic field will be same as the direction of the initial push given. Thus rotor experiences a torque in the same direction as that of rotating magnetic field i.e. the direction of initial push. So rotor accelerates in the anticlockwise direction under the case considered and attains a sub-synchronous speed in the steady state.