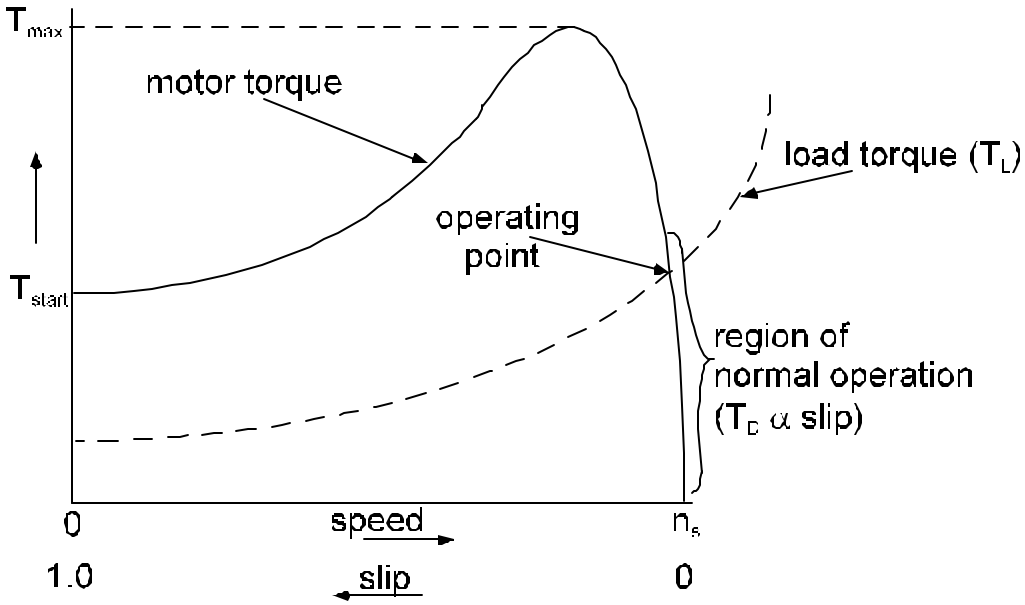
Induction motor characteristics

The starting current for an induction motor is several times the running current and the starting pf is much lower than the pf at rated speed.

Both of these features tend to cause the supply voltage to dip during start-up and can cause problems for adjacent equipment.

The torque-speed/slip characteristic of a general purpose induction motor is shown below along with a typical mechanical load torque.

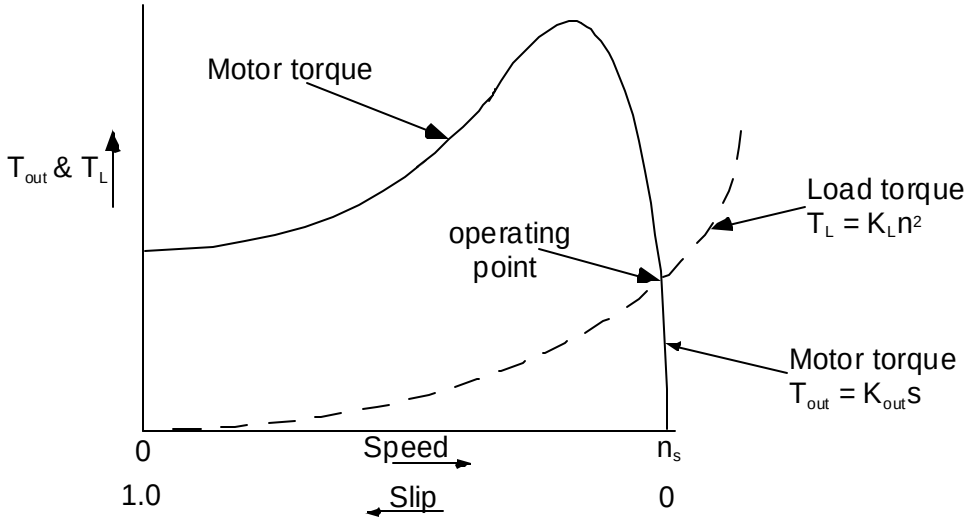
The rated torque is usually slightly smaller than the starting torque so that loads can be started when rated load is applied. The curve has a definite maximum value which can only be supplied for a very brief period since the motor will overheat.



The motor/load combination will operate at the intersection of their torque-speed curves. For general purpose induction motors this will typically correspond to a value of slip in the range of 0.02 to 0.08. When slip is relatively small, torque will be proportional to slip, and this feature is commonly used when determining the motor load and operating speed.

Example

A three-phase induction motor is rated: 2.4 kV, 200 hp, 3456 rpm. It is used to drive a compressor rated: 250 hp, 3600 rpm. The power input of the compressor is directly proportional to speed^3 (speed cubed). Neglect rotational losses and determine the hp output of the motor and its speed in rpm when connected to the compressor.



Solution

Ignoring rotational losses means $P_{out} = P_D$ and $T_{out} = T_D$.

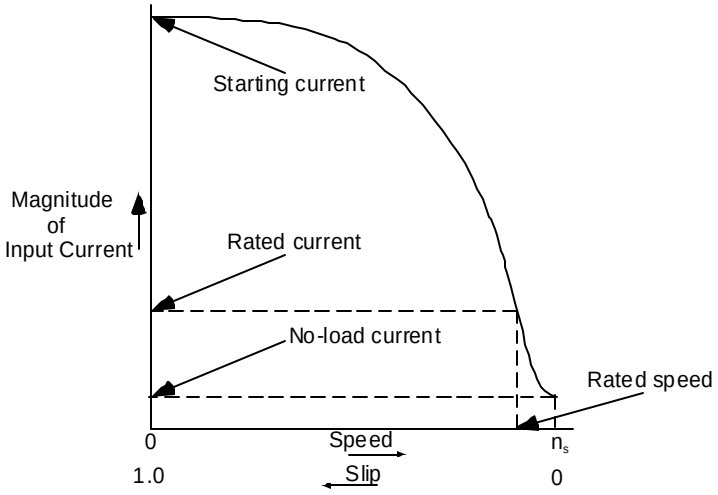
We have to determine the x-y co-ordinates of the operating point as shown in the figure. This means that we have to build equations for torque vs speed for the motor and the compressor.

The power input to the compressor is proportional to speed cubed.. This means that the torque is proportional to speed squared.

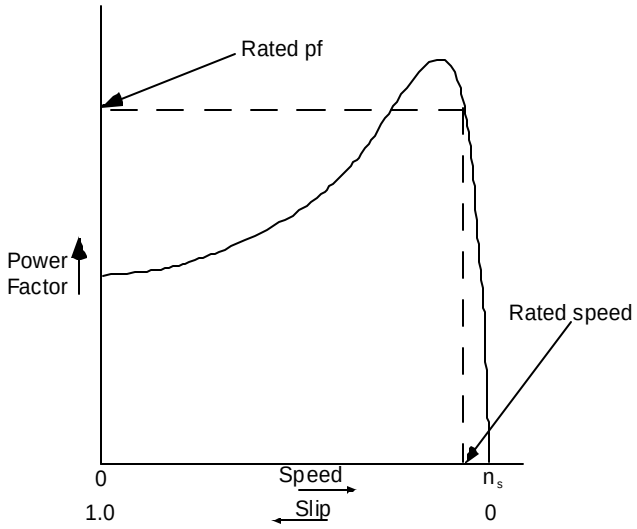
Rated conditions

Non-rated conditions

Important characteristics of induction motors

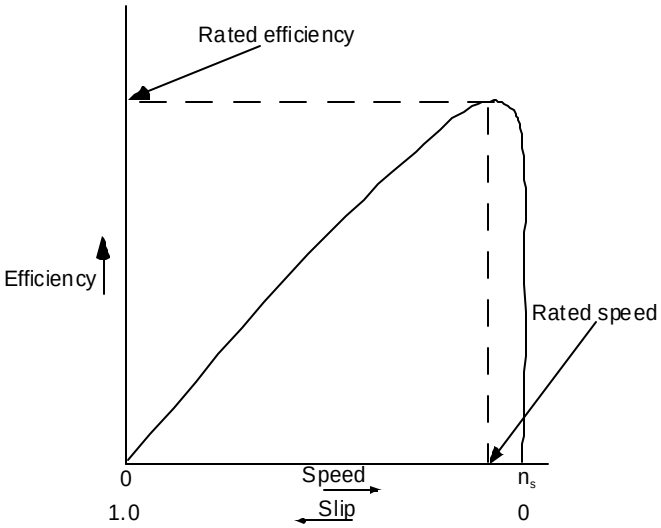


Starting current is several times larger than the rated current since the back emf induced by Faraday's law grows smaller as the rotor speed increases.



The pf may also be plotted against speed. Note the drop in power factor past rated conditions.

If motors are underloaded excessive pf correction will be required.



The efficiency-speed curve starts at zero and rises nearly directly proportional to speed until max. η is reached.

Efficiency then drops sharply as the motor approaches no-load. Installing an oversized motor wastes power.