Torque Speed Characteristics of a Blower Load

1 Introduction

The speed dynamics of a motor is given by the following equation

\[ J \frac{d\omega}{dt} = T_e(\omega) - T_L(\omega) \]

The performance of the motor is thus dependent on the torque speed characteristics of the motor and the load. The steady state operating speed \((\omega_e)\) is determined by the solution of the equation

\[ T_m(\omega_e) = T_e(\omega_e) \]

Most of the loads can be classified into the following 4 general categories.

1.1 Constant torque type load

A constant torque load implies that the torque required to keep the load running is the same at all speeds. A good example is a drum-type hoist, where the torque required varies with the load on the hook, but not with the speed of hoisting.

![Figure 1: Connection diagram](image)

1.2 Torque proportional to speed

The characteristics of the charge imply that the torque required increases with the speed. This particularly applies to helical positive displacement pumps where the torque increases linearly with the speed.
1.3 Torque proportional to square of the speed (fan type load)

Quadratic torque is the most common load type. Typical applications are centrifugal pumps and fans. The torque is quadratically, and the power is cubically proportional to the speed.

1.4 Torque inversely proportional to speed (const power type load)

A constant power load is normal when material is being rolled and the diameter changes during rolling. The power is constant and the torque is inversely proportional to the speed.
An induction motor (IM) is coupled with a blower as shown in Figure 5. The IM is fed from an AC drive which provides a variable frequency supply. In this experiment, we vary the frequency of the output of the drive in order to run the blower at various speeds. The watt meter readings $P_1$ & $P_2$ are used to calculate the input power. The torque can be calculated as follows

$$T = \frac{P_1 + P_2}{\omega}$$

This gives us only an approximate value for load torque as $P_1$ & $P_2$ includes core losses and copper losses as well.

### 3 Procedure to determine the torque speed characteristic of a Blower Load

Refer to Figure 5.

1. Turn on the supply
2. Set the frequency and turn on the AC drive.
3. Note down the readings of P1, P2 & $\omega$.
4. Repeat the procedure with increase in frequency.
5. Calculate the torque and plot torque vs speed.

4 Ratings

<table>
<thead>
<tr>
<th>Frequency (Hz)</th>
<th>Voltage (V)</th>
<th>Power (kW)</th>
<th>Current (A)</th>
<th>Speed (rpm)</th>
<th>Power factor</th>
</tr>
</thead>
<tbody>
<tr>
<td>50</td>
<td>415, Delta</td>
<td>2.2</td>
<td>4.4</td>
<td>1435</td>
<td>0.85</td>
</tr>
</tbody>
</table>

Table 1: Three Phase Induction Motor

<table>
<thead>
<tr>
<th>Input Voltage</th>
<th>Output Voltage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Single Phase</td>
<td>230 V</td>
</tr>
<tr>
<td>Three Phase</td>
<td>0 - 220 V</td>
</tr>
</tbody>
</table>

| Current | 13.5 A | 7.5 A |
| Frequency | 50 Hz | 0 - 200 Hz |

Table 2: AC Drive

5 Results

![Figure 6: Torque v/s Speed](image-url)
Figure 7: Power v/s Speed