Torque Speed Characteristics of a Blower Load

1 Introduction

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

$$J\frac{\mathrm{d}\omega}{\mathrm{d}t} = T_e(\omega) - T_L(\omega)$$

The performance of the motor is thus dependent on the torque speed characteristics of the motor and the load. The steady state operating speed (ω_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.

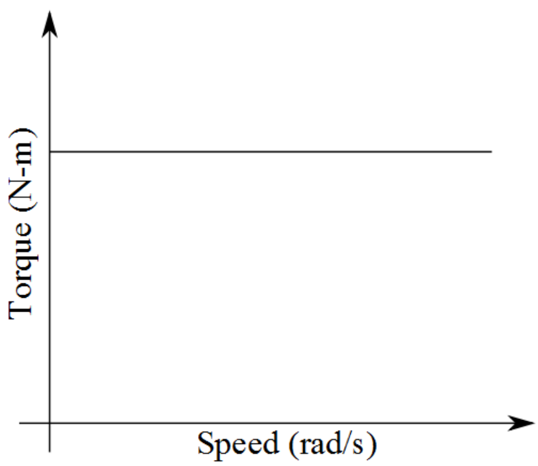

Figure 1: Connection diagram

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.

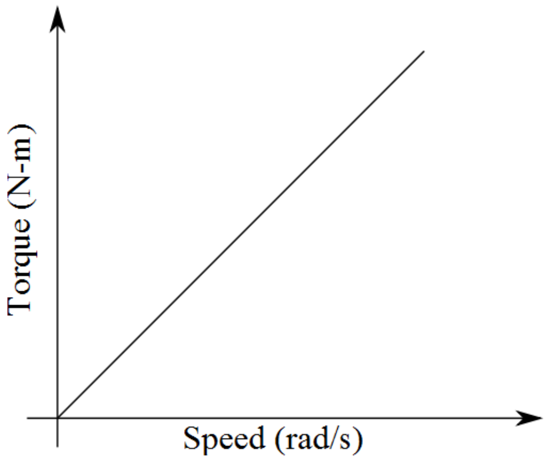

Figure 2: Connection diagram

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.

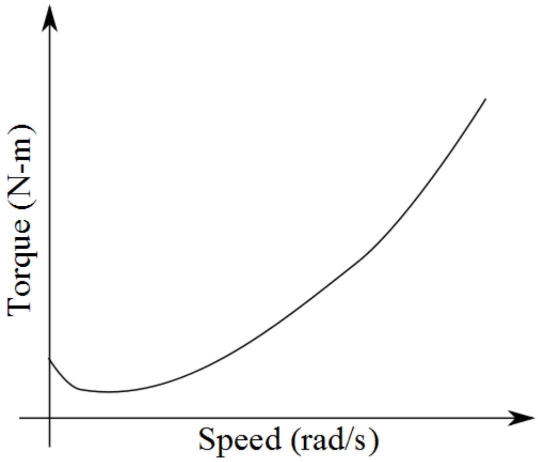

Figure 3: Connection diagram

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.

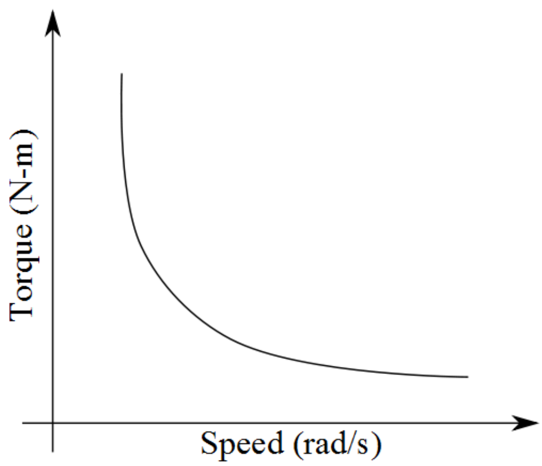

Figure 4: Constant Power Load

2 Circuit Diagram

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.

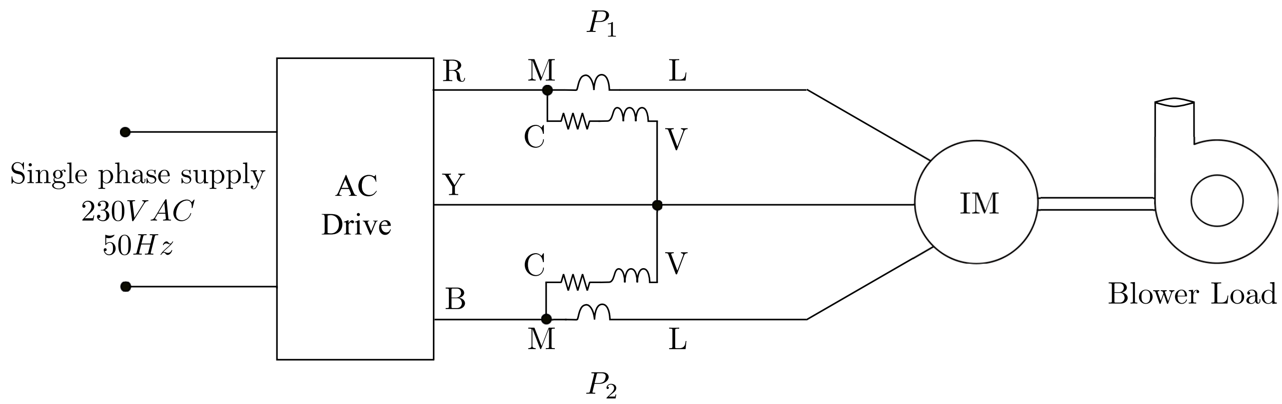

Figure 5: Connection diagram

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 & ω.
4. Repeat the procedure with increase in frequency.
5. Calculate the torque and plot torque vs speed.

4 Ratings

Frequency (Hz)	Voltage (V)	Power (kW)	Current (A)	Speed (rpm)	Power factor
50	415, Delta	2.2	4.4	1435	0.85

Table 1: Three Phase Induction Motor

	Input	Output
Voltage	Single Phase 230 V	Three Phase 0 - 220 V
Current	13.5 A	7.5 A
Frequency	50 Hz	0 - 200 Hz

Table 2: AC Drive

5 Results

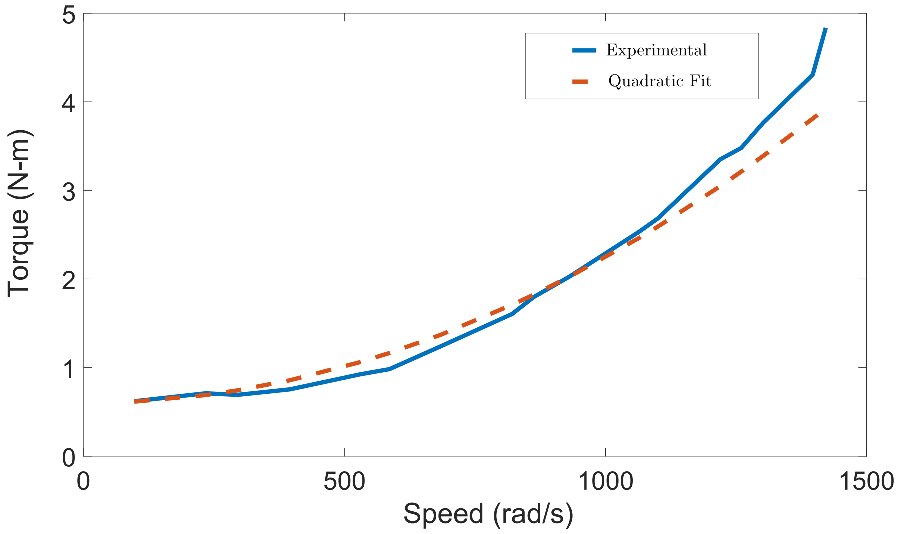

Figure 6: Torque v/s Speed

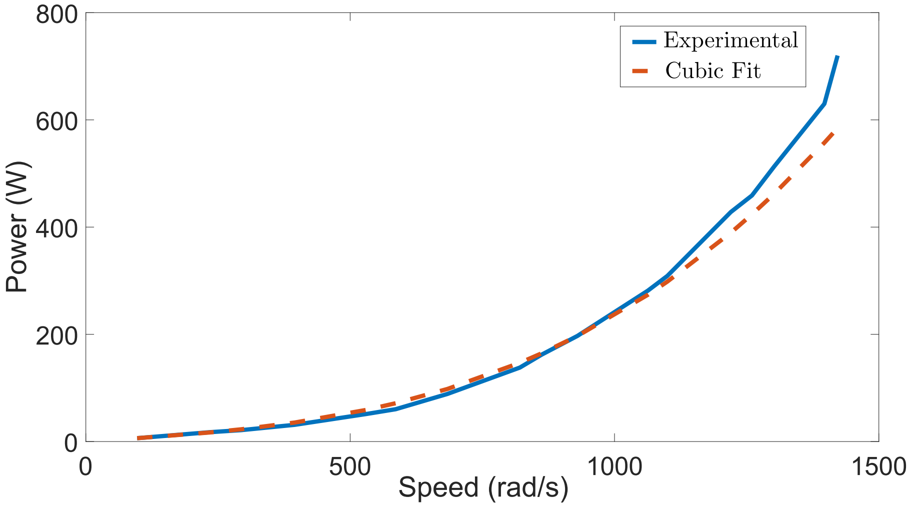

Figure 7: Power v/s Speed