(*ii*) Maximum power density,

$$\frac{P_{max}}{A} = \frac{8}{27}\rho V_i^3$$

$$= \frac{8}{27} \times 1.226 \times (15)^3 = 1226 \text{ W/m}^2.$$

(*iii*) Assuming efficiency, $\eta = 35\%$

Actual power density,

$$\frac{P}{A} = 0.35 \times 2068.87 = 724 \text{ W/m}^2$$

(*iv*) Total power produced,

$$P = \text{Power density} \times \text{Area}$$

$$= 724 \times \frac{\pi}{4}(120)^2$$

$$= 8184 \times 10^3 \text{ W} = 8184 \text{ kW}$$

(*v*) Torque at maximum efficiency

$$T = \frac{2}{27}\frac{\rho D V_i^3}{N}$$

$$= \frac{2}{27} \times \frac{1.226 \times 120 \times (15)^3}{(40/60)} = 55170 \text{ N}$$

(*vi*) Maximum axial thrust

$$F_{x_{max}} = \frac{\pi}{9}\rho D^2 V_i^2$$

$$= \frac{\pi}{9} \times 1.226 \times (120)^2 \times (15)^2$$

$$= 1385870 \text{ N}$$

4.7. WIND TURBINE OPERATION AND CONTROL

The power output of a wind mill is proportional to square of its diameter a cube of the wind velocity.