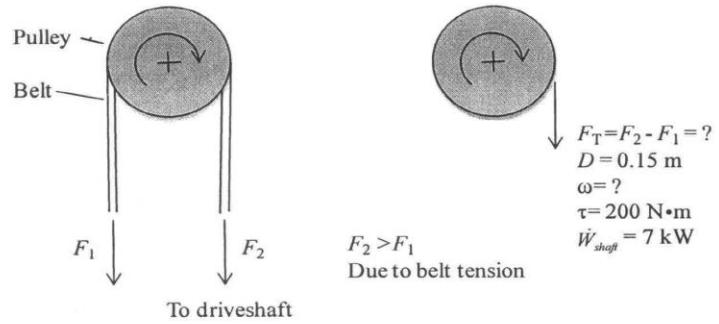
PROBLEM 2.37

Known: Pulley turns a belt rotating the driveshaft of a power plant pump with known torque and power transmitted.

Find: Determine the net force applied by the belt on the pulley, in kN, and the rotational speed of the driveshaft, in RPM.

Schematic and Given Data:



Engineering Model:
(1) The rotational speed of the pulley and drive shaft are assumed to be equal.
(2) Net tangential force (F_T) on the pulley is due to belt tension (see schematic).

Analysis:

The net force, in kN, applied by the belt on the pulley is calculated using the torque and the diameter of the pulley as follows

$$\tau = F_T\left(\frac{D}{2}\right) \text{ or } F_T = \frac{2\tau}{D} = \frac{2(200\text{N}\cdot\text{m})}{0.15\text{m}}\left|\frac{1\text{ kN}}{1000\text{N}}\right| = 2.67\text{ kN} \longleftarrow$$

Using Eq. 2.20, the rotational speed of the driveshaft, in RPM, is determined using assumption 1, power transmitted, and torque as follows:

$$\dot{W}_{\text{shaft}} = \tau\omega \quad \text{or} \quad \omega = \frac{\dot{W}_{\text{shaft}}}{\tau} = \frac{7\text{kW}}{200\text{N}\cdot\text{m}}\left|\frac{1000\frac{\text{J}}{\text{s}}}{1\text{kW}}\right|\left|\frac{1\text{N}\cdot\text{m}}{1\text{J}}\right|\left|\frac{60\text{s}}{1\text{min}}\right|\left|\frac{\text{rev}}{2\pi\text{ radians}}\right| = 334.2\text{ RPM} \longleftarrow$$