$$T = 5250\left(\frac{693.4}{3600}\right) = 1011 ft \cdot lb_f$$

Answer D

46.75 The output shaft of an engine accelerates from $1000rpm$ at idle to $6000rpm$ at red line in $5seconds$. What is the rotational acceleration?

A. $105\frac{rad}{s^2}$

B. $521\frac{rad}{s^2}$

C. $727\frac{rad}{s^2}$

D. $1000\frac{rad}{s^2}$

Use the definition for rotational acceleration under Rigid Body Rotation. Re-write the derivative expression as a change in rotational velocity over time. No calculus is required.

$$\alpha = \frac{d\omega}{dt}$$

$$\alpha = \frac{\Delta\omega}{t}$$

Subtract to find the change in rotational velocity and convert units to $\frac{rad}{s}$.

$$\Delta\omega = \omega_2 - \omega_1 = 6000rpm - 1000rpm = 5000rpm$$

$$\Delta\omega = 5000\frac{rev}{min}\left(\frac{2\pi rad}{rev}\right)\left(\frac{1min}{60s}\right) = 523.6\frac{rad}{s}$$

Divide by the time to determine the rotational acceleration.

$$\alpha = \frac{523.6\frac{rad}{s}}{5s} = 104.7\frac{rad}{s^2}$$

Answer A

46.76 Superheated steam at $400psia$ and $700°F$ is expanded in a 85% efficient turbine to atmospheric pressure. What is the enthalpy of the saturated mixture exiting the turbine?

A. $1120\frac{Btu}{lb}$

B. $1130\frac{Btu}{lb}$

C. $1140\frac{Btu}{lb}$

D. $1150\frac{Btu}{lb}$

Sketch the turbine. Consider the entering superheated steam as State 1 and the exiting saturated mixture as State 2. Use the Properties of Superheated Steam table to determine the enthalpy and entropy at State 1, which is fully defined since the temperature and pressure are both known.

$$P_1 = 400psia$$

$$T_1 = 700°F$$

$$h_1 = 1362.9\frac{Btu}{lb}$$

$$s_1 = 1.641\frac{Btu}{lb°R}$$

Initially assume isentropic expansion to find the ideal exit quality at State 2.

$$s_2 = s_1 = 1.641\frac{Btu}{lb°R}$$

Use the Properties of Saturated Water and Steam (Pressure) table to look up s_f and s_{fg} at $P_2 = 1atm = 14.7psia$.

$$s_f = 0.3122\frac{Btu}{lb°R}$$

$$s_{fg} = 1.4443\frac{Btu}{lb°R}$$

Rearrange the formula relating entropy and quality from Properties for Two-Phase (Vapor-Liquid) Systems.

$$s_2 = s_f + \chi_2 s_{fg} \rightarrow \chi_2 = \frac{s_2 - s_f}{s_{fg}}$$

$$\chi_2 = \frac{1.641\frac{Btu}{lb°R} - 0.3122\frac{Btu}{lb°R}}{1.4443\frac{Btu}{lb°R}} = 0.92$$

Use the ideal quality at State 2 to determine the ideal enthalpy at State 2. Return to the Properties of Saturated Water and Steam (Pressure) table to obtain the enthalpies h_f and h_{fg} at $P_2 = 14.7psia$.