Solution to Problem 204C

Velocity of the flow in the piping $= V/TA^*$

Total head loss in the piping $= \frac{k\rho}{2}\left\{\frac{V}{TA^*}\right\}^2/\rho g$

Therefore the pump head rise must be $= H$ plus $\frac{k}{2g}\left\{\frac{V}{TA^*}\right\}^2$

Therefore the rate of work done by the pump on the fluid

$$= \rho g \times \text{Volume Flow Rate} \times \text{Total Head Rise}$$

$$= \rho g \times \frac{V}{T} \times \left[H + \frac{k\rho}{2g}\left\{\frac{V}{TA^*}\right\}^2\right]$$

$$= \frac{\rho g V}{T}\left[H + \frac{k\rho}{2g}\left\{\frac{V}{TA^*}\right\}^2\right]$$

Therefore the work done by the pump on the fluid $= \rho g V\left[H + \frac{k\rho}{2g}\left\{\frac{V}{TA^*}\right\}^2\right]$

Therefore the work input to the pump shaft $= \frac{\rho g V}{\eta}\left[H + \frac{k\rho}{2g}\left\{\frac{V}{TA^*}\right\}^2\right]$