## Question # 76357

Lubricating oil enters the tubes of a heat exchanger at 74C and leaves at 34C. The diameter of the tube is 50 mm and the oil flow through the tube at 2.5 m/s.

Input power to the system is 30 kW.

The specific heat capacity of the oil is 2.28 kJ/kgK and the density is 900 kg/m3. Determine:

a. The mass flow rate of the oil.

b. The thermal efficiency of this heat transfer process.

## Answer:

The correlation between mass flowrate *m* and fluid velocity *u* is given by:

$$m = u\rho A, \tag{1}$$

where $\rho$ – fluid density,

$A = \frac{\pi d^2}{4}$ – cross sectional inside tube area,

*d* – inside diameter of the tube.

Substituting into (1) gives:

$$m = 2.5 \cdot 900 \cdot \frac{3.14 \cdot 0.05^2}{4} = 4.42 \text{ m/s}.$$

The heat rate *Q* transferred from the oil is given by:

$$Q = mc_p(t_{in} - t_{out}), \tag{2}$$

where $c_p$ – specific heat capacity of the oil,

$t_{in}$ and $t_{out}$ – respectively inlet and outlet temperature of the oil.

Substituting into (2) gives:

$$Q = 4.42 \cdot 2.28(74 - 34) = 403 \text{ kW},$$

The thermal efficiency is determined by ratio between useful power and available heat rate:

$$\eta = \frac{P}{Q}, \tag{3}$$

where *P* – the input power to the system.

Thus:

$$\eta = \frac{30}{403} = 0.074 = 7.4\%.$$