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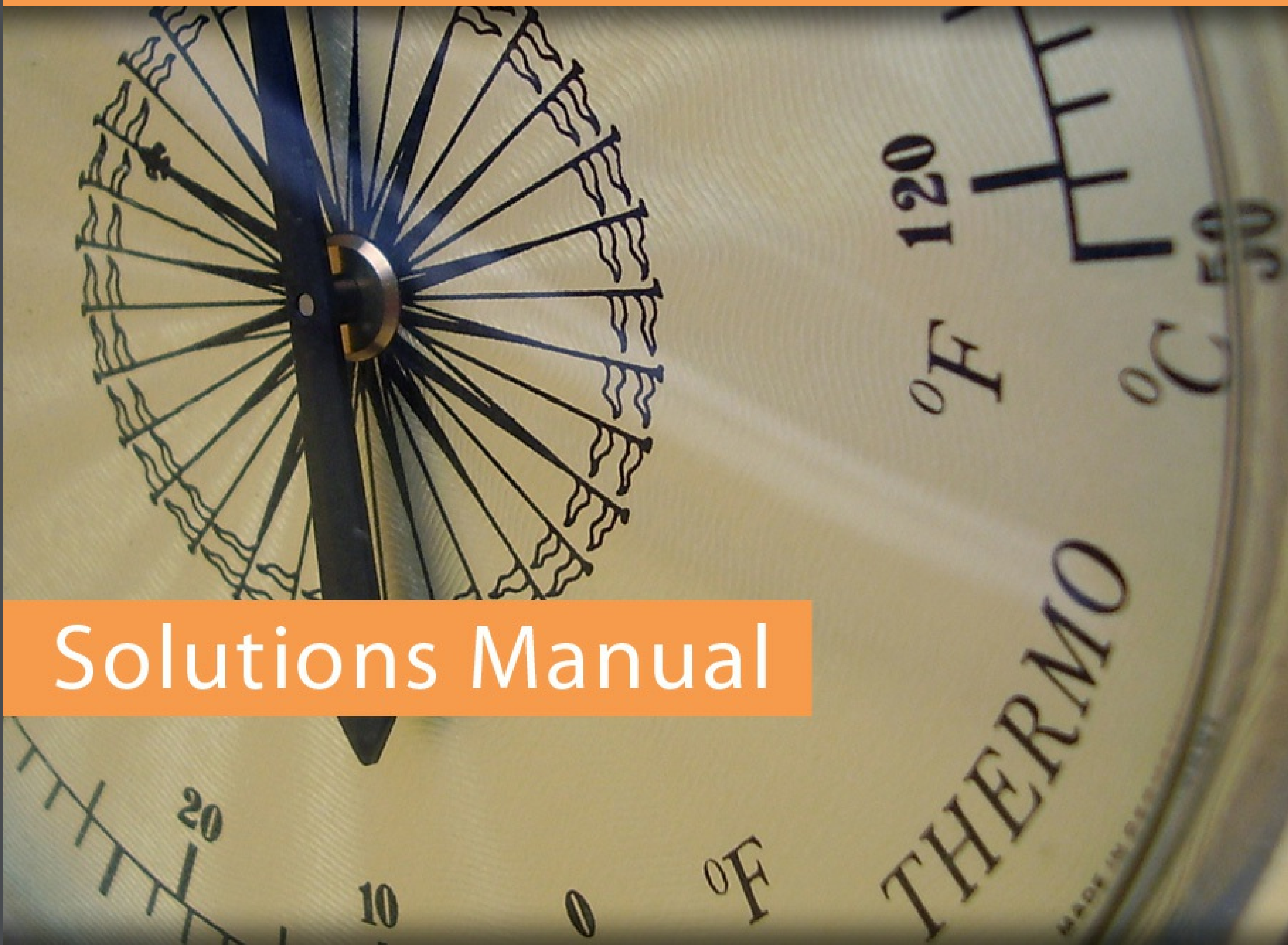
Engineering Thermodynamics Solutions Manual

Prof. T.T. Al-Shemmeri



Solutions Manual

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4.2 First Law of Thermodynamics S.F.E.E Applications

1. A boiler is designed to work at 14 bar and evaporate 8 kg/s of water. The inlet water to the boiler has a temperature of 40 deg C and at exit the steam is 0.95 dry. The flow velocity at inlet is 10 m/s and at exit 5 m/s and the exit is 5 m above the elevation at entrance. Determine the quantity of heat required. What is the significance of changes in kinetic and potential energy on the result?

[Ans: 20.186 MW]

Solution:

1. SFEE : $Q - W = m[(h_2 - h_1) + \frac{V_2^2 - V_1^2}{2} + g(z_2 - z_1)]$

W =0 (since constant pressure process),

ignoring Δke and ΔPe: the SFEE reduces to

$Qs = m_s (h_2 - h_1)$

State 1- h_1 is hf at T=40C, closest to this is Ts=45, h1=191.83 kJ/kg

State 2, $h=h_f+0.95h_{fg}$ at 14 bar.

h_2=830.30+0.95x1959.7 = 2692 kJ/kg

hence

$Qs= m_s (h_2 - h_1)$= 8 x(2692 – 191.83) = 2000136 kW= 20 MW

2. Taking into account changes in KE and PE

The KE and PE contribution is calculated

$$X = m[\frac{V_2^2 - V_1^2}{2}] + g(Z_2 - Z_1)]$$

$$= 8x[\frac{5^2 - 10^2}{2000} + 9.81x(\frac{5}{1000})]$$
$$= -0.3 + 0.049$$
$$= -0.251\, kW$$

This is tiny (0.001%) in comparison to 20 MW.