Solutions

2.1

- $x_4 = (s_3 - s_f)/s_{fg} = (5.750 - 0.830)/7.070 = \mathbf{0.6959}$.
- $h_4 = 250.0 + 0.6959 \times 2350.0 = \mathbf{1885.4}$ kJ/kg.

2.2

- $w_t = h_3 - h_4 = 2750.0 - 1885.4 = \mathbf{864.6}$ kJ/kg.
- $w_p = v_f\,\Delta p = 0.001020 \times 7980 = \mathbf{8.1}$ kJ/kg.

2.3

- $h_2 = 250.0 + 8.1 = 258.1$, so $q_{in} = 2750.0 - 258.1 = \mathbf{2491.9}$ kJ/kg.
- $\eta = (864.6 - 8.1)/2491.9 = 856.5/2491.9 = \mathbf{34.4}\%$.

2.4

- Higher boiler pressure raises the average temperature of heat addition, so the second-law ceiling $1 - T_{out}/T_{in,avg}$ rises while the pump cost grows only as $v\,\Delta p$.
- Wet exhaust erodes the last-stage blades: x_4 below roughly 0.88 ruins the machine even when the cycle balances - superheat and reheat exist to keep it dry.