37.35 A hot water heat exchanger is supplied with $55°C$ LTHW which is used to heat $2\frac{L}{s}$ of domestic water from $20°C$ to $50°C$. The return LTHW temperature is $47°C$. What is the volume flow rate of LTHW required?

A. $0.5\frac{L}{s}$

B. $3.0\frac{L}{s}$

C. $7.5\frac{L}{s}$

D. $11.0\frac{L}{s}$

Assuming 100% efficiency, the heat supplied to the domestic hot water is removed from the low temperature hot water (LTHW). Set these quantities equal and represent each using $Q = \dot{m}c_p\Delta T$.

$$\dot{Q}_{LTHW} = \dot{Q}_{DHW}$$

$$[\dot{m}c_p\Delta T]_{LTHW} = [\dot{m}c_p\Delta T]_{DHW}$$

Substitute the product of density and volume flow rate for the mass flow rate on both sides.

$$\dot{m} = \rho Q$$

$$[\rho Q c_p\Delta T]_{LTHW} = [\rho Q c_p\Delta T]_{DHW}$$

Since both sides of the heat exchanger are using liquid water as a medium, the density and specific heat capacity cancel out.

$$[Q\Delta T]_{LTHW} = [Q\Delta T]_{DHW}$$

Rearrange for the volume flow rate on the LTHW side. Substitute and solve.

$$Q_{LTHW} = Q_{DHW}\left(\frac{\Delta T_{DHW}}{\Delta T_{LTHW}}\right) = \left(2\frac{L}{s}\right)\left(\frac{50°C - 20°C}{55°C - 47°C}\right) = 7.5\frac{L}{s}$$

Answer C