Air enters a 25-cm-diameter 12-m-long duct at 50°C and 1 atm at a mean velocity of 7 m/s. What heat flux from the duct walls to the air would be needed to heat the air to 100°C at the duct's exit? Air properties listed on reverse.

### Given:
- \( T_{mi} \) = initial temperature of air
- \( T_{me} \) = exit temperature of air
- \( D \) = duct diameter
- \( L \) = duct length
- \( \dot{m} \) = mass flow rate of air
- \( c_p \) = specific heat of air
- \( \Delta T \) = temperature difference

### To Find:
- \( \dot{q} \) = heat flux from duct walls to air

### Solution:

1. \[ \dot{m} f_i + \dot{m} A_s = \dot{m} h_e \]
2. \[ \dot{q} A_s = \dot{m} (h_e - f_i) \]
3. \[ \dot{q} = \frac{\dot{m} c_p (T_{me} - T_{mi})}{A_s} \]
4. \[ \dot{q} = \frac{(1.014 \text{ kg/s})(7 \text{ m/s})}{(0.25 \text{ m})^2} \left( \frac{1008 \text{ J/kg.k}}{4} \right) \left( 100 - 50 \right) \text{k} \]
5. \[ \dot{q} = 18.62 \frac{W}{m^2} \]