

Gas properties

Air at 100 kPa and 300 K is compressed steadily by a 20kW compressor to 300 kPa. The air temperature is maintained constant at 300 K due to heat transfer to the surrounding medium at 273K. What is the rate of heat loss of the air?

Answer: -20 kW.

Explanation: Remember that work added to the system is considered negative as is the heat rejected by it. A possible error here is that \dot{Q}_{out} was used instead of \dot{Q}_{net} as specified by the exercise. The variables are not interchangeable. A trick of this question is to notice that you cannot use the equation given in the hint to directly calculate the change of enthalpy with respect to the surroundings.

The conservation of energy equation should be used to calculate the conversion of work into heat.

$$\dot{m}(w + q + k_e + p_e + h)_{in} = \dot{m}(w + q + k_e + p_e + h)_{out}$$

For a compressor, changes in kinetic and potential energy are negligible. Air is kept to the same temperature, so: $dh = c_p dT = 0$ Which gives us:

$$\dot{Q}_{net} = \dot{W}_{net} = \dot{W}_{out} - \dot{W}_{in}$$

A compressor does not deliver any kind of work output, so the final equation is found to be:

$$\dot{Q}_{net} = -\dot{W}_{in} = -20kW$$

Work added to the system is considered negative as is the heat rejected by the system.