Department of Mechanical Engineering MEC1405

COEFFICIENT OF PERFERMANCE TESTS ON A HEAT PUMP/REFRIGERATION MACHINE

Objective

To determine the coefficient of performance of a heat pump/refrigeration machine.

Apparatus

Hilton mechanical heat pump, see attached schematic diagram.

Theory

The performance of a machine operating on a thermodynamic cycle is determine by the ratio OUTPUT/INPUT. In a heat engine that converts heat into work, the output is the work done and the input is the heat input and the ratio is termed the efficiency of the engine. In a heat pump or refrigeration machine, the output refers to the heat transferred and the input to the work done on the cycle, and the ratio is called the COEFFICIENT OF PERFORMANCE (*COP*).

In a heat pump and refrigeration cycle, work (W) is done on a fluid to circulate it in a cycle where it absorbs heat (Q_L) at a low temperature and rejects heat (Q_H) at a high temperature.

Hence when we use the machine to absorb heat, we call it a refrigerator and the COP is defined as:

$$COP = \frac{Q_L}{W}$$

When we use the machine to reject heat, we call it a heat pump, and the *COP* is defined as:

$$COP = \frac{Q_H}{W}$$

Where,

Q_H = heat rejected per unit time by the condenser = $m_c \times s \times (T_c - T_i)$

and m_c = water flow rate in condenser tank (red)

s = specific heat of water

T_c = high temperature reached in condenser tank

T_i = inlet temperature of water

Q_L = heat absorbed per unit time by the evaporator = $m_e \times s \times (T_i - T_e)$

and m_e = water flow rate in evaporator tank (blue)

s = specific heat of water
T_e = low temperature reached in evaporator tank
T_i = inlet temperature of water

W = work done by compressor in unit time = E/t
and E = electricity consumed by compressor motor in time t,
t = time to consume E units of electricity

Procedure

Switch on the water supply and leave to settle. Then switch on the heat pump and leave it working for about 15 minutes until conditions are steady. It is very important that steady conditions are attained for this exercise to be valid. Take the following readings:

m_c = water flow rate in condenser tank (red)
m_e = water flow rate in evaporator tank (blue)

T_c = high temperature reached in condenser tank
T_e = low temperature reached in evaporator tank
T_i = inlet temperature of water

E = electricity consumed by compressor motor in time t,
t = time to consume E units of electricity

This same procedure is repeated three times for different water rates.

Analysis

From the readings taken during the tests, calculate the *COP* of the machine when used as a heat pump and when used as a refrigerator for three different flow rates.

Conclusion

Comment on the results achieved.

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