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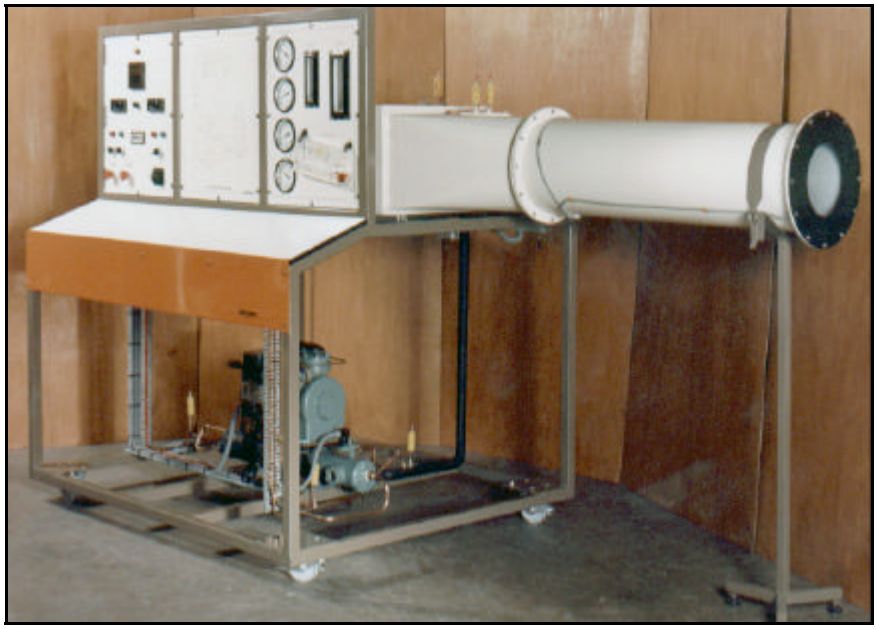
TECHNOLOGY



P5670

AIR TO WATER HEAT PUMP

INTRODUCTION

Cussons P5670 Air to Water Heat Pump demonstrates how conventional refrigeration equipment may be used in the form of a heat pump to convert low grade heat, in a stream of ducted air, to higher grade heat for increasing the temperature of a water flow stream utilizing a vapour compression cycle. The instrumentation allows accurate setting of the operating parameters and provides the student with necessary information to establish an energy balance.

DESCRIPTION

The complete system comprising refrigeration unit and air handling ductwork is packaged onto a bench-mounted steel trolley which also functions as the control and instrumentation desk. The refrigeration assembly is a simple vapour compression system consisting of hermetic compressor, concentric-tube, water-cooled condenser, thermostatic and hand expansion valves and a suction/liquid heater exchanger to provide liquid sub-cooling and suction vapour superheating. The air handling ductwork comprises an intake flow measuring section, flow control device, temperature measuring section, filter, evaporator coil, an exit temperature measuring section, and a 3 speed fan.

Instrumentation is mounted on the front panel for measurement of refrigerant flow rate, water flow rate, refrigerant liquid pressure, refrigerant temperature at 8 points, water temperature (2 points), air dry bulb (2 points) and wet bulb temperature (2 points). While an inclined manometer is provided for measuring the pressure drop across the air inlet flow measuring device.

Thermostats, pressurestats, relays and contactors associated with the refrigeration unit and the air fan are housed within the control and instrumentation desk.

OPERATION

GENERAL

Figure 1 illustrates the operating principle employed in the heat pump. The variable speed fan in the air handling unit draws ambient air in through an orifice plate and filter unit to the evaporator, where heat is extracted to evaporate the working fluid. From here the air is ducted via a silencing section back to the surroundings. Air flow is measured by a manometer across the inlet orifice. Both wet and dry bulb air temperatures are measured before and after the evaporator section to enable an assessment of the rate of heat extraction from the air to be made. The air flow rate is controlled by the three speed fan.

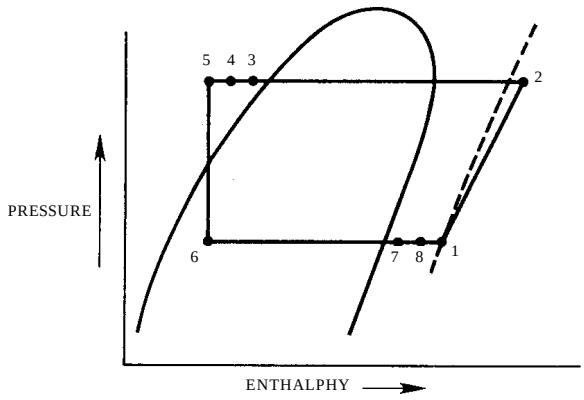


FIG. 1 Pressure - Enthalpy Diagram

DETAILED

The unit works on the vapour compression cycle, using Tetrafluoroethane, R134a, as the working fluid. The Pressure - Enthalpy diagram for the cycle is shown above.

The compressor raises the pressure of the working fluid in its gaseous phase along the line 1 - 2 as shown above. This process is thermodynamically irreversible, as can be seen from the increase in entropy. The fluid is then condensed at constant pressure in the water cooled condenser (2 - 3 above). The heat rejected to the water at this stage forms the useful work output of the heat pump. The liquid R134a then passes through the heat exchanger (3 - 4) where it is sub-cooled. Further sub-cooling occurs (4 - 5) due to heat losses from the R134a flow meter, and associated pipework.

The pressure of the R134a is then reduced adiabatically by the use of a thermostatic expansion valve, (5 - 6) prior to being evaporated at constant pressure in the evaporator section of the air handling unit (6 - 7). This evaporation extracts heat from the air passing through the air handling unit.

In order to ensure that no liquid is present in the fluid entering the compressor, the R134a is passed through a heat exchanger to superheat it (7 - 8). Further superheating occurs in the pipework between the heat exchanger and the compressor inlet (8 - 1) due to the R134a being at a lower temperature than the ambient air.

The useful output of a heat pump is the heating of the water passing through the condenser. The source of this heat is the ambient air. The work input to the cycle is the power input to the compressor. The "Coefficient of Performance" (C.O.P.) of a heat pump is defined as useful work output divided by work input which in this case is the heating of the water divided by the compressor input power.

TENDER SPECIFICATION

Apparatus mounted on castors, comprises semi-hermetic, twin-cylinder, air-cooled, reciprocating compressor with 48 mm bore, 30 mm stroke and capacity of 9.46 m^3/hr at 1450 rev/min; a shell and tube type condenser with water on tube side; an air handling unit with 3 speed fan providing 2.37 m^3 air/sec with measurement points for wet and dry bulb temperatures at inlet and outlet, fitted with air flow measurement orifice 0.2m diameter on a removable inlet duct; exhaust duct fitted with silencer and unit housing direct expansion evaporator for working fluid. Instrumentation consists of digital indication of working fluid temperature at eight points around the circuit, cooling water temperature into and out of condenser, and wet and dry bulb air temperature at inlet and outlet of air handling unit, analogue indication of working fluid pressure at four points around circuit by Bourdon Tube gauge, indication of water and working fluid mass flow rate by tapered tube variable area flowmeters, measurement of air orifice depression by inclined manometer and digital indication with analogue trend of compressor electrical power input.

SERVICES

Electrical supply:- 415 V, 3 Phase, 50 Hz supply
Maximum consumption 2.5 kW

Water Supply:- 18 litres/min maximum at 20°C maximum

PHYSICAL DETAILS

	Nett Weight		Length		Width		Height	
	kg	lb	m	in	m	in	m	in
P5670	250	550	2.9	114	1.3	51	1.7	67

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