Air Source Heat Pump

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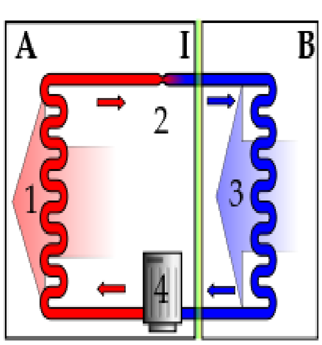
Abstract

This study deals with the performance characteristics of an air conditioning system capable of operating as an air-to-air heat pump using ambient air as a heat source. For this aim, an experimental analysis has been performed on a plant made up of original components from an automobile air conditioning system and some extra equipment employed to operate the system in the reverse direction. It has been observed that the heat pump operation provides adequate heating only in mild weather conditions, and the heating capacity drops sharply with decreasing outdoor temperature. However, compared with the air conditioning operation, the heat pump operation usually yields a higher coefficient of performance and a lower rate of energy destruction per unit capacity. By installing reversing switch, the same device can be used for cooling and heating mode.

1. Introduction

AIR SOURCE HEAT PUMP-

This marvel of modern technology takes heat from the air outside your home and pumps it inside through refrigerant-filled coils, not too different from what's on the back of your fridge. The air source variety is pretty basic, and you'll find two fans, the refrigerator coils, a reversing valve and a compressor inside to make it work.



Components of the air source heat pump:

A: indoor compartment B: outdoor compartment I: insulation.

1: condenser, 2: expansion valve, 3: evaporator, 4: compressor.

Air source heat pumps for cold climates

At least two manufacturers are selling heat pumps that maintain better heating output at lower outside temperatures than conventional air source heat pumps. These low temperature optimized models make air source heat pumps more practical for cold climates because they don't freeze to a stop that quickly. Some models however, defrost their outdoor unit electrically at regular intervals, which increases electricity consumption dramatically during the coldest weeks. In areas where only one fossil fuel is currently available (e.g. heating oil; no natural gas pipes available) these heat pumps could be used as an alternative, supplemental heat source to reduce a building's direct dependence on fossil fuel. Depending on fuel and electricity prices, using the heat pump for heating may be less expensive than fossil fuel. A backup, fossil-fuel heat source may still be required for the coldest days.

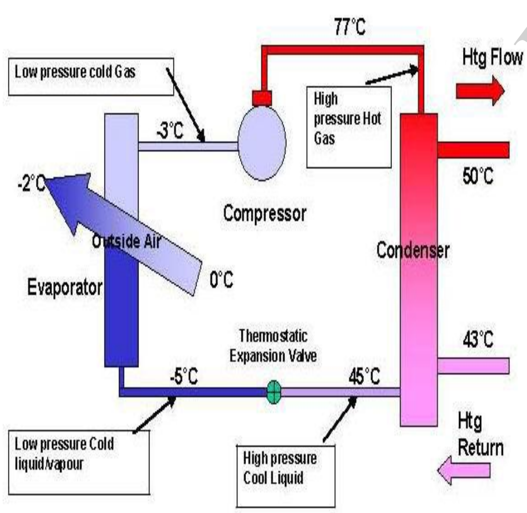
2. Working

A compressor, condenser, expansion valve and evaporator are used to change states of the refrigerant from a liquid to hot gas and from a gas to a cold liquid. Heating and cooling is accomplished by moving a refrigerant through the heat pump's various indoor and outdoor coils and components. An external heat exchanger is used to heat or cool the refrigerant using ambient air. An air source heat pump works on the principles of vapour compression refrigeration.

The heat pump can also operate in a cooling mode where the cold refrigerant is moved through the indoor coils to cool the room air.

WORKING

LIQUID REFRIGERATOR(LOW TEMP & PRESSURE)	EVAPORATOR COIL(OUTDOOR UNIT)	VAPOUR (LOW TEMP & LOW PRESSURE)
VAPOUR (LOW TEMP & LOW PRESSURE)	COMPRESSOR	VAPOUR(HIGH TEMP & HIGH PRESSURE)
VAPOUR(HIGH TEMP & HIGH PRESSURE)	CONDENSER (INDOOR UNIT)	LIQUID REFRIGERATOR(HIGH TEMP & HIGH PRESSURE)
LIQUID REFRIGERATOR(HIGH TEMP & HIGH PRESSURE)	EXPANSION VALVE	LIQUID REFRIGERATOR (LOW TEMP & LOW PRESS)



3. Reversing Valve switches

The reversing valve switches the direction of refrigerant through the cycle and therefore the heat pump may deliver either heating or cooling to a building. In the cooler climates the default setting of the reversing valve is heating. The default setting in warmer climates is cooling. Because the two heat exchangers, the condenser and evaporator, must swap functions, they are optimized to perform adequately in both modes.

- In **heating mode** the outdoor coil becomes the evaporator, while the indoor becomes the condenser which absorbs the heat from the refrigerant and dissipates to the air flowing through it. The air outside even at 0 °C (or at any temperature above absolute zero) has heat energy in it. With the refrigerant flowing in the opposite direction the evaporator (outdoor coil) is absorbing the heat from the air and moving it inside. Once it picks up heat it is compressed and then sent to the condenser (indoor coil). The indoor coil then injects the heat into the air handler, which moves the heated air throughout the house.
- In **cooling mode** the outdoor coil is now the condenser. This makes the indoor coil now the evaporator. The indoor coil is now the evaporator in the sense that it is going to be used to absorb the heat from inside the enclosed space. The evaporator absorbs the heat from the inside, and takes it to the condenser where it is rejected into the outside air.

4. Heat Pump Performance

The steady-state performance of an electric compression heat pump at a given set of temperature conditions is referred to as the coefficient of performance (COP).

For a refrigerator, however, the useful quantity is the heat extracted, Q_C , not the heat exhausted. Therefore, the coefficient of performance of a refrigerator is expressed as:

$$CP_{Refrigerator} = \frac{Q_C}{W}$$

The COP or PER of a heat pump is closely related to the temperature lift, i.e. the difference between the temperature of the heat source and the output temperature of the heat pump. The COP of an ideal heat pump is determined solely by the condensation temperature and the temperature lift (condensation - evaporation temperature).

Factors affecting heat pump performance

The performance of heat pumps is affected by a large number of factors. For heat pumps in buildings these include:

- the climate - annual heating and cooling demand and maximum peak loads;
- the temperatures of the heat source and heat distribution system;
- The auxiliary energy consumption (pumps, fans, supplementary heat for bivalent system etc.);
- the technical standard of the heat pump;
- the sizing of the heat pump in relation to the heat demand and the operating characteristics of the heat pump;
- The heat pump control system.

5. Advantages

- Draws approximately 1/3 to 1/4 of the electricity of a standard resistance heater for the same amount of heating, reducing utility bills. This typical efficiency compares to 70-95% for a fossil fuel-powered boiler.
- Few moving parts, reducing maintenance requirements. However, it should be ensured that the outdoor heat exchanger and fan is kept free from leaves and debris.
- As an electric system, no flammable or potentially asphyxiating fuel is used at the point of heating, reducing the potential danger to users, and removing the need to obtain gas or fuel supplies (except for electricity).
- Used to heat air, or water.
- The same system may be used for air conditioning in summer, as well as a heating system in winter.
- Lower running costs, the compressor being the device that uses most power - when in comparison with traditional electrical resistance heaters.

6. Conclusion

Air source heat pumps can provide fairly low cost space heating. A high efficiency heat pump can provide four times the heat compared to an electric heater. Air source heat pumps can heat water up to 70°C without difficulty when the air temperature is 5°C or greater. The overall lifetime costs for using air source heat pumps should be considered carefully as gas (where available) may be cheaper than electricity (although it may produce higher carbon emissions depending upon how electricity is generated in your area).Air source heat pumps should last for over 20 years with low maintenance requirements.

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