6.8 Steam Jet Refrigeration System:

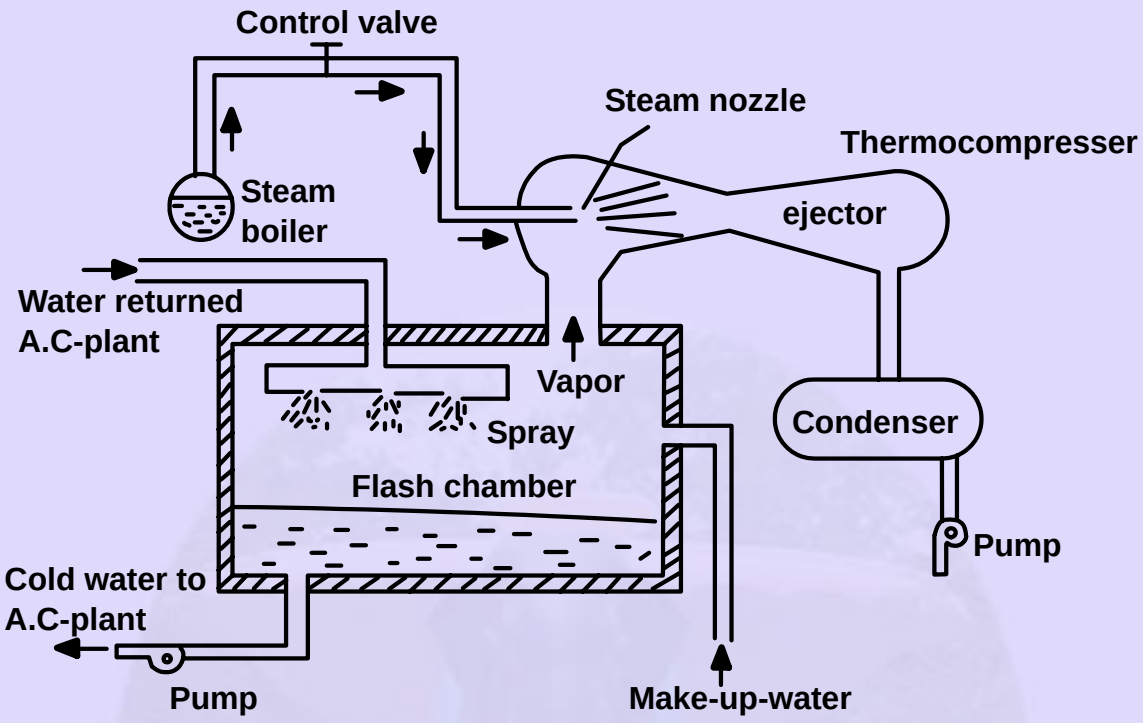

Fig.6.8. Steam jet refrigeration system

This system uses the principle of boiling the water below 100^0C. If the pressure on the surface of the water is reduced below atmospheric pressure, water can be made boil at low temperatures. Water boils at 6^0C, when the pressure on the surface is 5 cm of Hg and at 10^0C, when the pressure is 6.5 cms of Hg. The very low pressure or high vacuum on the surface of the water can be maintained by throttling the steam through jets or nozzles. The general arrangement of the system is shown in the Fig.6.8.

Consider a flash chamber contains 100 kg of water. If suddenly 1 kg of water is removed by boiling, as pressure is reduced due to throttling of steam through nozzles. Approximately 2385 kJ of heat will be removed from the water, which is equivalent to heat of evaporation of water. The fall in temperature of the remaining water will be,

$$Q = m C_p dT$$

$$dT = \frac{2385}{99 * 4.187} = 5.7^0 C$$

Evaporating one more kg of water reduces the remaining water temperature by 5.7^0C further. Thus by continuing this process, the remaining water can be made to freeze. Water is the refrigerant used in the steam jet refrigeration system. As water freezes at 0^0C, then either refrigeration has to be stopped or some device is required to pump the ice.

Operation:

High pressure steam is supplied to the nozzle from the boiler and it is expanded. Here, the water vapor originated from the flash chamber is entrained with the high velocity steam jet and it is further compressed in the thermo compressor. The kinetic energy of the mixture is converted into static pressure and mass is discharged to the condenser. The condensate is usually returned to the boiler. Generally, 1% evaporation of water in the flash chamber is sufficient to decrease the temperature of chilled water to 6^0C. The chilled water in the flash chamber is circulated by a pump to the point of application. The warm water from the load is returned to the flash chamber. The water is sprayed through the nozzles to provide maximum surface area for cooling. The water, which is splashed in the chamber and any loss of cold water at the application, must be replaced by makeup water added to the cold water circulating system.

Advantages:

a) *It is flexible in operation; cooling capacity can be easily and quickly changed.*
b) *It has no moving parts as such it is vibration free.*
c) *It can be installed out of doors.*
d) *The weight of the system per ton of refrigerating capacity is less.*
e) *The system is very reliable and maintenance cost is less.*
f) *The system is particularly adapted to the processing of cold water used in rubber mills,, distilleries, paper mills, food processing plants, etc.*
g) *This system is particularly used in air-conditioning installations, because of the complete safety of water as refrigerant and ability to adjust quickly to load variations and no hazard from the leakage of the refrigerant.*

Disadvantages:

a) *The use of direct evaporation to produce chilled water is usually limited as tremendous volume of vapor is to be handled.*
b) *About twice as much heat must be removed in the condenser of steam jet per ton of refrigeration compared with the vapor compression system.*
c) *The system is useful for comfort air-conditioning, but it is not practically feasible for water temperature below 4^0C.*