STEAM JET REFRIGERATION SYSTEM

Introduction

- The steam jet refrigeration system (also known as ejector refrigeration system) is one of the oldest method of producing refrigerating effect.
- This system employs a steam ejector or booster (instead of mechanical compressor) to compress the refrigerant to the required condenser pressure level.
- In this system, water is used as the refrigerant. Since the freezing point of water is 0 °C, therefore, it cannot be used for applications below 0 °C.

Components and Applications

- The basic components of this system are
  - Flash chamber or Evaporator
  - Steam ejector (Compression device)
  - Condenser and
  - Refrigerant control device

- Applications
  - Food processing plants for precooling of vegetables and concentrating fruit juices,
  - gas plants, paper mills, breweries etc.

Principle of steam jet refrigeration system

- The boiling point of a liquid changes with change in external pressure. In normal conditions, pressure exerted on the surface of any liquid is the atmospheric pressure.
- If this atmospheric pressure is reduced on the surface of a liquid, by some means, then the liquid will start boiling at lower temperature, because of reduced pressure.
- This basic principle of boiling of liquid at lower temperature by reducing the pressure on its surface is used in steam jet refrigeration system.
- The boiling point of pure water at standard atmospheric pressure of 760 mm of Hg (1.013 bar) is 100 °C.
- It may be noted that water boils at 12 °C if the pressure on the surface of water is kept at 0.014 bar and at 7 °C if the pressure on the surface of water is 0.01 bar.
- The reduced pressure on the surface of water is maintained by throttling the steam through the jets or nozzles.

Principle of steam jet refrigeration system

Consider that one percent of m kg of water is evaporated by throttling the steam through the nozzle at some reduced pressure (for example 0.085 bar). Thus, the total heat removed by this one per cent of evaporated water

$$= \frac{m}{100} x\, h_{fg}$$

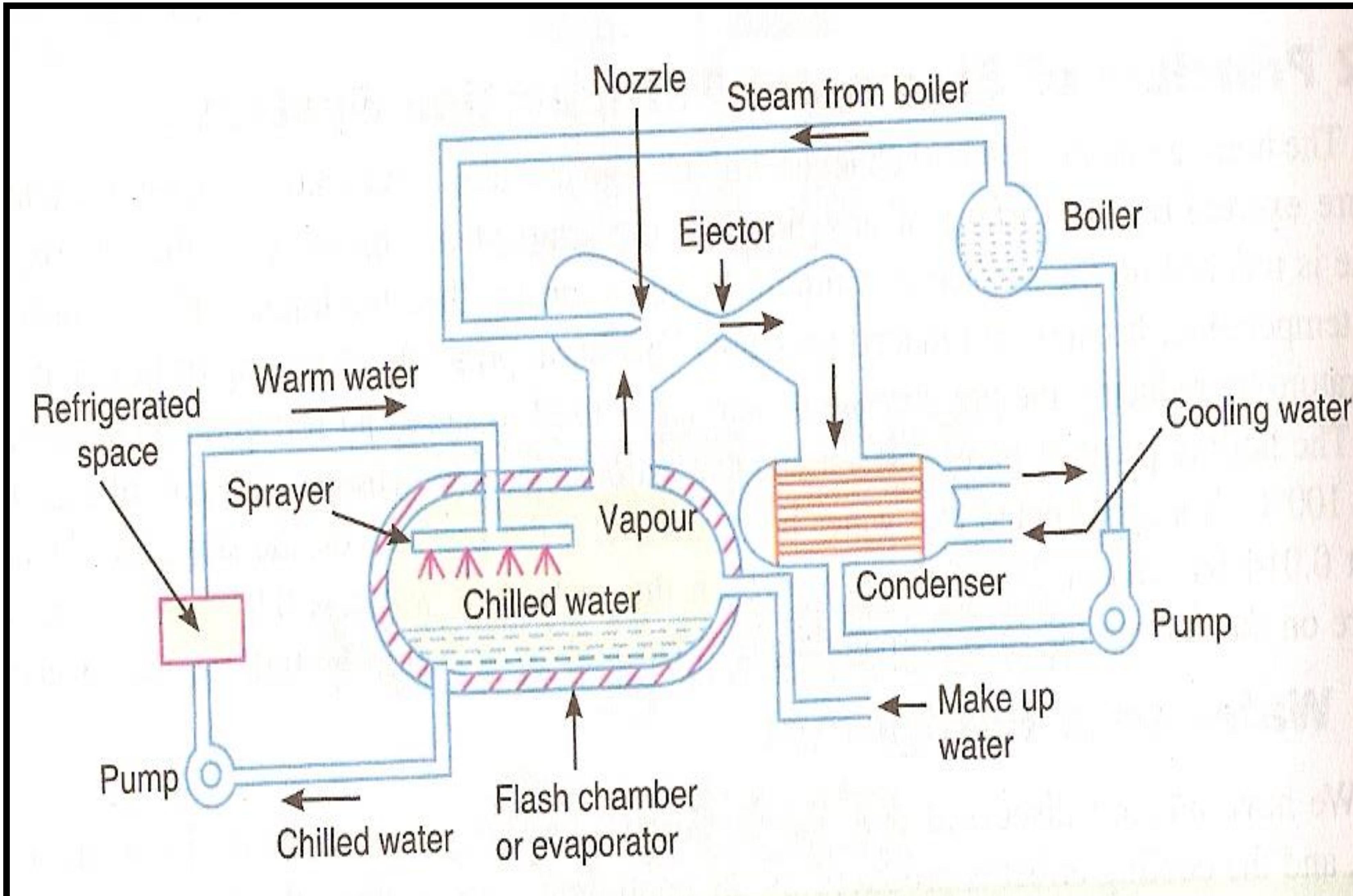
Therefore, fall in temperature of the remainng water will be

$$\Delta T_f = \frac{q_R}{\left(m - \frac{m}{100}\right) s} = \frac{h_{fg}}{\left(m - \frac{m}{100}\right) s}$$

Now for a mass, m = 100 kg and h_{fg} = 2400.5 kJ/kg at some reduced pressure (at a pressure of 0.085 bar, from steam tables),

$$\Delta T_f = \frac{2400.5}{\left(100 - \frac{100}{100}\right) 4.2} = 5.77^{\circ} C$$

Steam Jet Refrigeration System



Advantages

- It is simple in construction and rigidly designed
- It is a vibration free system as pumps are the only moving parts
- It has low maintenance cost, low production cost and high reliability
- It uses water as a refrigerant.
- This system had the ability to adjust quickly to load variations
- The running cost of the system is quite low.

Disadvantages

- The system is not suitable for water temperature below 4 °C
- For proper functioning of the system, maintenance of high vacuum in the evaporator is necessary