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Improve the cop of Vapor compression cycle with change in Evaporator and Condenser pressure

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Abstract: aim is to improve the coefficient of performance of system which is based on vapor compression cycle. To improve the coefficient of performance, its requires that the compressor work should decrease and refrigeration effect should increase. It means that decrease in condenser pressure and temperature so the refrigeration effect will increase and compressor input work due to this cop will increase. And also increase in pressure and temperature of evaporator the work input will decrease and refrigeration effect will increase due to this cop will increase for a vapor-compression refrigeration system in 1834. Perkins built a prototype system and it actually worked. According to the drawing in Perkins patent liquid ether ($C_4H_{10}O$) was contained in an "evaporator vessel" where it was vaporized under a partial vacuum maintained by the suction of a crude hand-operated compressor. The evaporator vessel was submerged in a liquid from which the heat required to vaporize the ether was extracted, thereby cooling the liquid.

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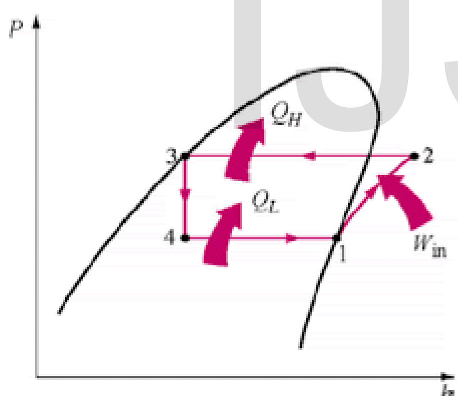
Introduction: Vapor compression refrigeration system is based on vapor compression cycle. Vapor compression refrigeration system is widely used method for air-conditioning of buildings and automobiles. It is also used in domestic and commercial refrigerators, large-scale warehouses for chilled or frozen storage of foods and meats, refrigerated trucks and railroad cars, and a host of other commercial and industrial services. Oil refineries, petrochemical and chemical processing plants, and natural gas processing plants are among the many types of industrial plants that often utilize large vapor-compression refrigeration systems. So improvement of performance of system is too important for higher refrigerating effect or reduced power consumption for same refrigerating effect. Many efforts have to be done to improve the performance of VC refrigeration system.

In 1805, American inventor Oliver Evans described in detail, but never built, a refrigeration system based on the vapor-compression refrigeration cycle. An American living in Great Britain, Jacob Perkins, improved upon the design proposed by Oliver Evans and obtained the first patent In 1842, an American physician, John Gorrie, designed the first system for refrigerating water to produce ice. He also conceived the idea of using his refrigeration system to cool the air in the rooms of a Florida hospital used for treating yellow-fever and malaria patients. His system compressed air, then partially cooled the hot compressed air with water before allowing it to isentropically expand while doing part of the work required to drive the air compressor. Alexander, a professor of engineering, mathematics and astronomy at Middlebury College in Connecticut, began experimenting with vapor-compression refrigeration in 1848 and obtained British and American patents in 1850 and 1853 for a vapor-compression system capable of using either carbon dioxide (CO_2), ammonia (NH_3) or ether. He is credited by many with having initiated commercial refrigeration in the United States by building an ice plant in 1855 at Cleveland, Ohio that produced about 2000 pounds (900 kilograms) of ice per 24 hours.

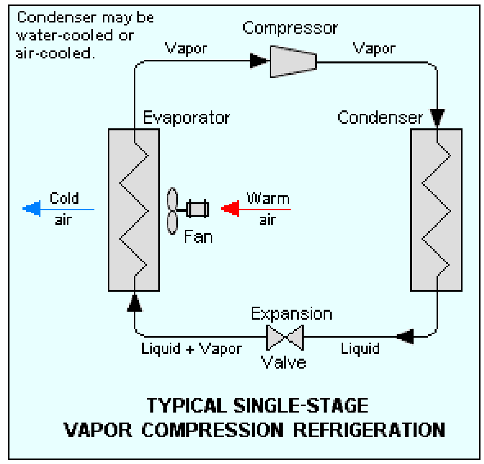
Theoretical analysis

Simple vapor compression cycle: Dry saturated vapor coming from evaporator is compressed in compressor so pressure is increases superheated vapor is passed through condenser where vapor is condensed by flowing the cooling water in condenser. Dry saturated liquid is passed through expansion valve where expansion takes place so pressure is decrease by expansion after expansion liquid is passed in evaporator where it absorb the heat of storage



1-2 compression process ,2-3 condensing process ,3-4 throttling process ,4-1evaporating process .Q_H is heat rejection, Q_L is heat absorbtion, W_{in} is work input to thecompressor.

COP (Coefficient of Performance): it is a performance parameter of simple VC Cycle. If refrigerating effect is increases or work input is decreases than performance of simple VC Compression cycle are increases



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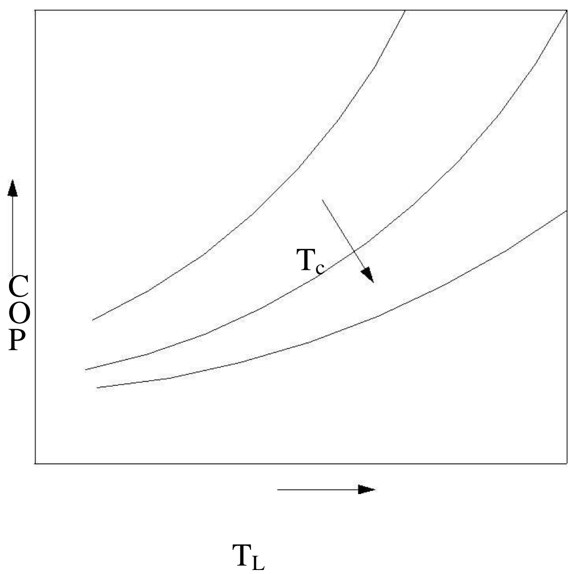
Vapor compression cycle with increase in pressure and temperature of evaporator and decrease in condenser pressure and temperature

The performance of a standard Vapor compression can be obtained by varying evaporator and condensing pressure and temperatures over the required range. Figure shows the effects of evaporator and condensing temperatures refrigeration effects of a standard Vapor compression cycle. As shown in the figure, for a given condenser temperature and pressure as evaporator temperature and pressure increases the specific refrigeration effect increases marginally. It can be seen that for a given evaporator temperature and pressure, the refrigeration effect decreases as condenser temperature increases. These trends can be explained easily with the help of the P-h diagram. It can also be observed that the volumetric refrigeration effect increases rapidly with evaporator temperature due to the increase in specific refrigeration effect and decrease in specific volume of refrigerant vapor at the inlet to the compressor. Volumetric refrigeration effect increases marginally as condenser temperature decreases.



It shows that the specific work of compression decreases rapidly as the evaporator temperature increases and condenser temperature and pressure decreases. Once again these effects can be explained using a T s or P h diagram. For a given condenser temperature, the work of compression increases initially, reaches a peak, then starts decreasing. This is due to the fact that as evaporator temperature increases the specific work of compression decreases and the specific volume at the inlet to the compressor also decreases. As a result, an optimum evaporator temperature and pressure exists at which the work of compression reaches a maximum. Physically, the work of compression is analogous to mean effective pressure of the compressor, as multiplying this with the volumetric flow rate gives the power input to the compressor. For a given power input, a high work of compression implies smaller volumetric flow rates and hence a smaller compressor.

shows the effect of evaporator and condenser temperatures on COP of the VC cycle. As expected, for a given condenser temperature and pressure the COP increases rapidly with evaporator temperature, particularly at low condensing temperatures. For a given evaporator temperature, the COP decreases as condenser temperature increases. However, the effect of condenser temperature becomes marginal at low evaporator temperatures.

The above results show that at very low evaporator temperatures, the COP becomes very low and also the size of the compressor becomes large (due to small refrigeration effect). It can also be shown that the compressor discharge temperatures also increase as the evaporator temperature decreases. Hence, single stage vapor compression refrigeration systems are not viable for very low evaporator temperatures. One has to use multistage or cascade systems for these applications. These systems will be discussed in the next lecture. One can also observe the similarities in performance trends between VCC cycle and Carnot cycle.

Conclusion

It means that decrease in condenser pressure and temperature so the refrigeration effect will increase and compressor input work due to this cop will increase. And also increase in pressure and temperature of evaporator the work input will decrease and refrigeration effect will increase due to this cop will increase for a vapor-compression refrigeration .

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