Refrigeration

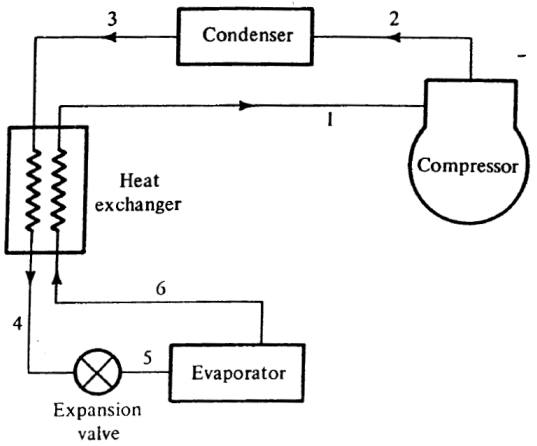
4: Refrigeration Cycles

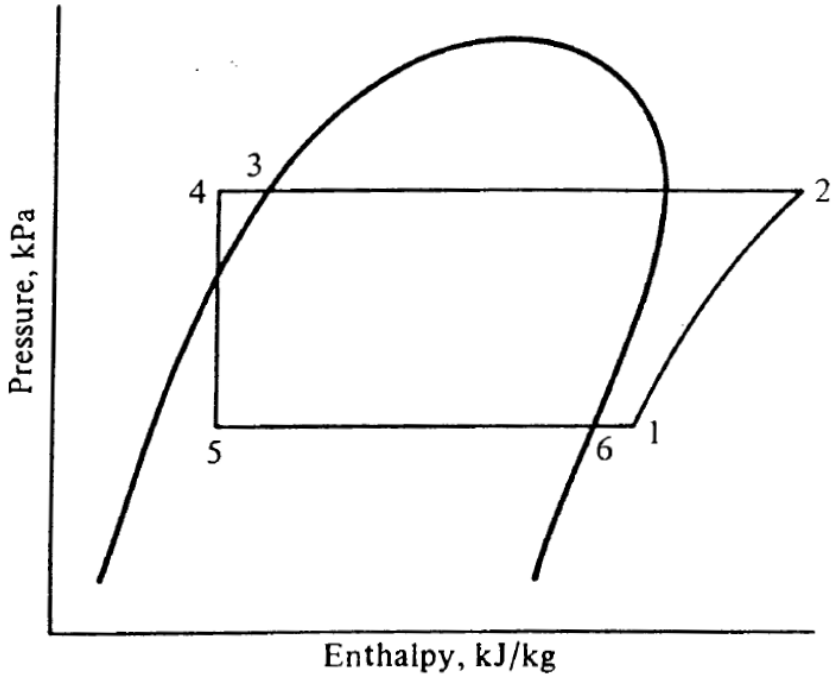
Dr. Wameedh. T.M. Al-Tameemi

COMPRESSION REFRIGERATION CYCLES

Heat Exchangers

Some refrigeration systems use a liquid-to-suction heat exchanger, which subcools the liquid from the condenser with suction vapor coming from the evaporator.





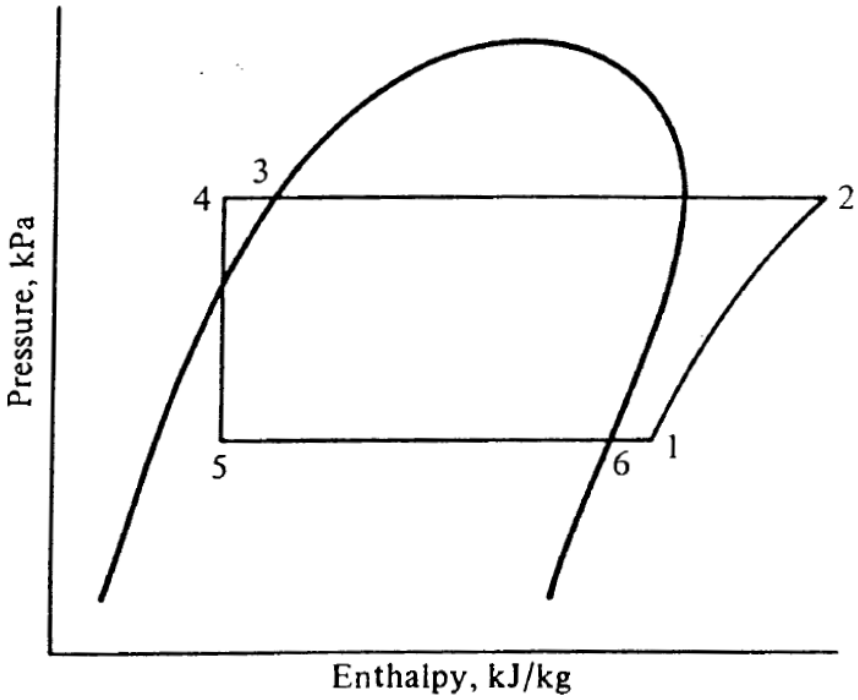
Saturated liquid at point 3 coming from the condenser is cooled to point 4 by means of vapor at point 6 being heated to point 1. From a heat balance, h3 - h4 = h1- h6 . The refrigerating effect is either h6 - h5 or h1 - h 3.

COMPRESSION REFRIGERATION CYCLES

In practice, evaporators usually are designed to superheat the refrigerant by a small amount to ensure that no liquid enters the compressor, thereby avoiding possible compressor damage. Similarly, condensers are usually designed to subcool the refrigerant a certain amount to ensure that only liquid enters the throttling device for optimum expansion performance.

Compared with the standard vapor-compression cycle, the system using the heat exchanger may seem to have obvious advantages because of the increased refrigerating effect. Both the capacity and the coefficient of performance may seem to be improved.

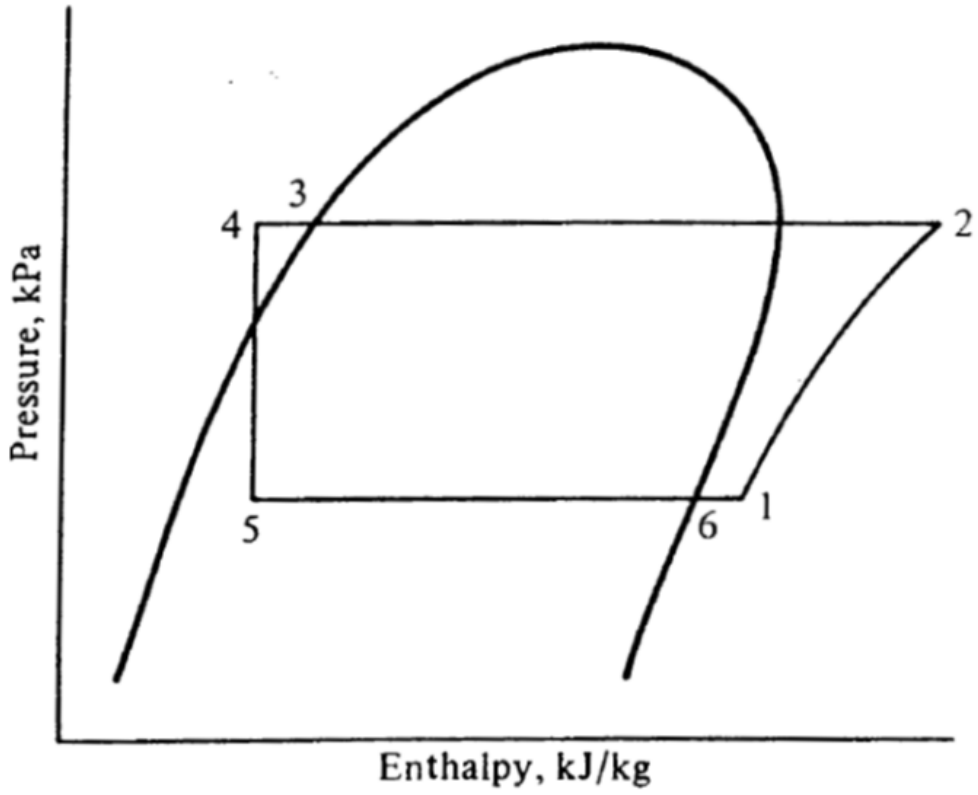
This is not necessarily true, however. Even though the refrigerating effect is increased, the compression is pushed farther out into the superheat region, where the work of compression in kilojoules per kilogram is greater than it is close to the saturated-vapor line.



COMPRESSION REFRIGERATION CYCLES

From the standpoint of capacity, point 1 has a higher specific volume than point 6, so that a compressor which is able to pump a certain volume delivers less mass flow if the intake is at point 1. The potential improvements in performance are thus counterbalanced, and the heat exchanger probably has negligible thermodynamic advantages. The heat exchanger is definitely justified, however, in situations where the vapor entering the compressor must be superheated to ensure that no liquid enters the compressor.

Another practical reason for using the heat exchanger is to subcool the liquid from the condenser to prevent bubbles of vapor from impeding the flow of refrigerant through the expansion valve.

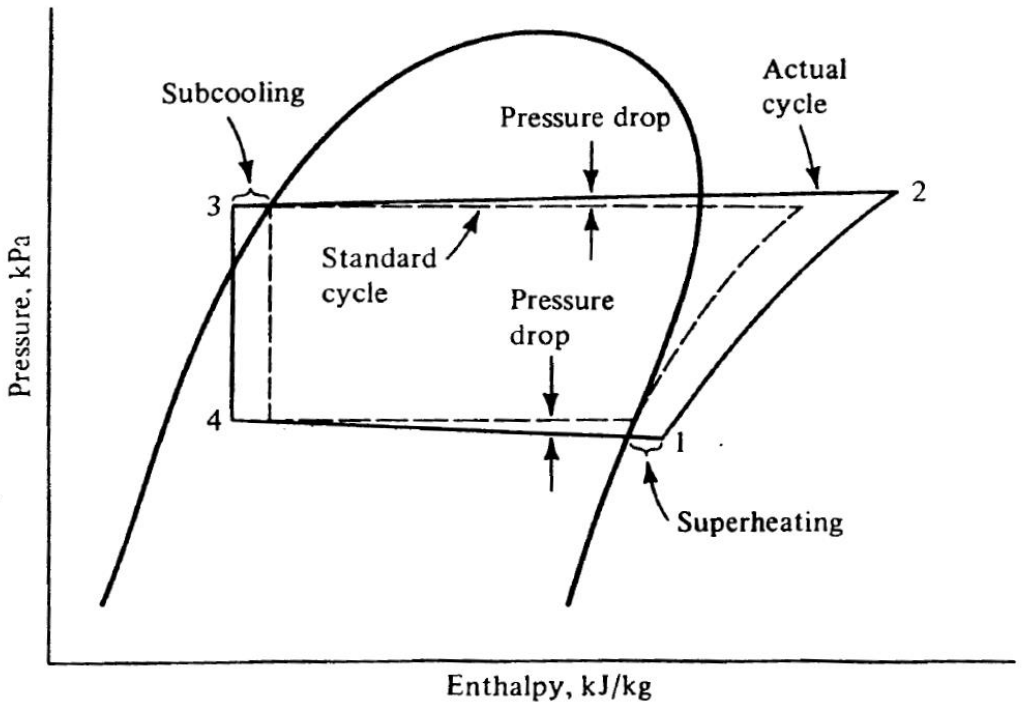


COMPRESSION REFRIGERATION CYCLES

Actual vapor-compression cycle

The actual vapor-compression cycle suffers from inefficiencies compared with the standard cycle. There are also other changes from the standard cycle, which may be intentional or unavoidable. Some comparisons can be drawn by superimposing the actual cycle on the pressure-enthalpy diagram of the standard cycle.

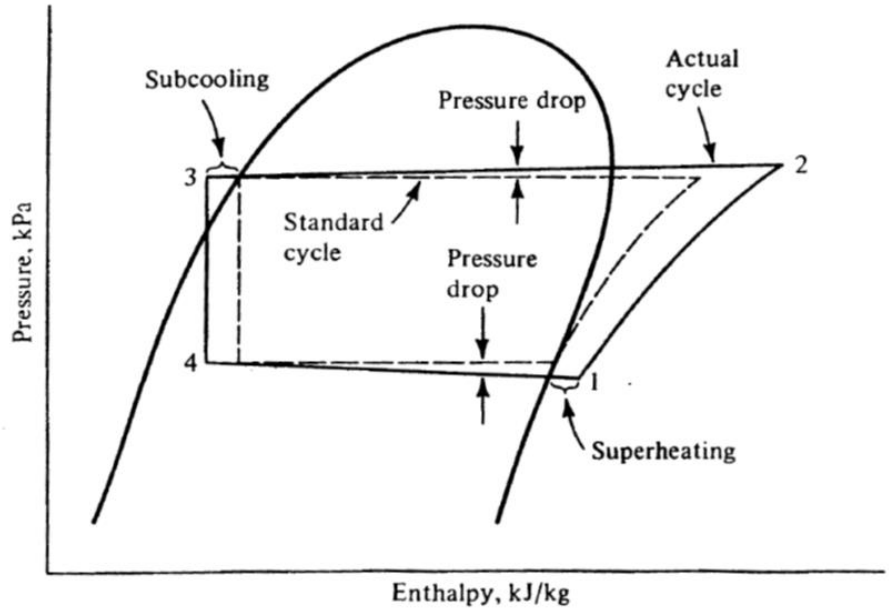
The essential differences between the actual and the standard cycle appear in the pressure drops in the condenser and evaporator, in the subcooling of the liquid leaving the condenser,. and in the superheating of the vapor leaving the evaporator. The standard cycle assumes no drop in pressure in the condenser and evaporator.



COMPRESSION REFRIGERATION CYCLES

Actual vapor-compression cycle

Because of friction, however, the pressure of the refrigerant drops in the actual cycle. The result of these drops in pressure is that the compression process between 1 and 2 requires more work than in the standard cycle. Subcooling of the liquid in the condenser is a normal occurrence and serves the desirable function of ensuring that 100 percent liquid will enter the expansion device. Superheating of the vapor usually occurs in the evaporator and is recommended as a precaution against droplets of liquid being carried over into the compressor. The final difference in the actual cycle is that the compression is no longer isentropic and there are inefficiencies due to friction and other losses.



Next: Refrigeration Processes and cycles II

References:

-2021 ASHRAE Handbook -- Fundamentals (SI)
- REFRIGERATION & AIR CONDITIONING BY W.F. STOECKER & J.W JHONES

Thank you