# Real refrigeration cycles

The refrigeration cycles in real operation undergo losses in their components due to the inherent irreversibilities of any actual process like friction, mixing and thermal losses. To account for these losses each part in the refrigeration cycle will be assumed to operate in an efficiency less than 100 percent as follows: –

**Compressor**

The compression process in ideal cycles is assumed to be isentropic which is the ideal case. In real compressors certain increase in entropy is inevitable. The isentropic compressor efficiency is defined as ideal work required to operate the compressor to the actual work which is certainly larger than the ideal work: –

$$\eta_c = \frac{Ideal\ \ work}{Actual\ \ work} = \frac{h_{2s} - h_1}{h_2 - h_1} \qquad (1)$$

Where $h_{2s}$ denotes the enthalpy after a hypothetical isentropic compression (Fig. 1). It is also difficult to ensure saturation vapor state at the compressor inlet in real operation. It is even desirable to slightly superheat the working fluid before entering the compressor. Heat transfer from the environment in the pipes connecting the evaporator to compressor further superheats the working fluid and a pressure drop also occurs in these pipes.

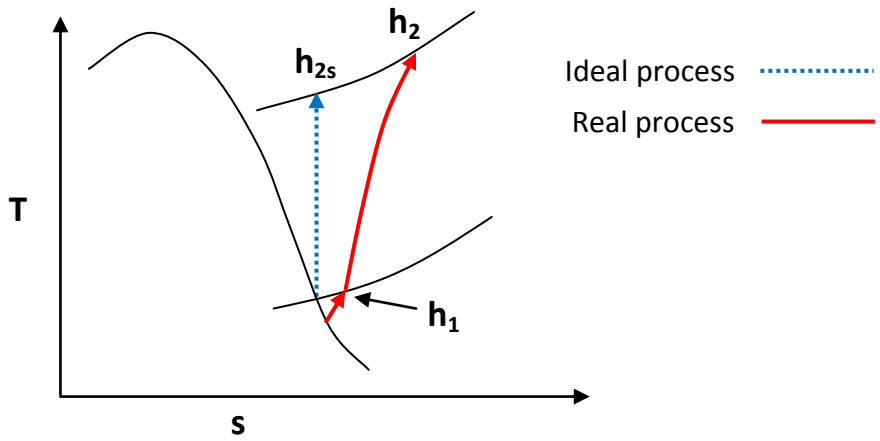


Fig. (1): T–s diagram of a real compression process.

## Condenser

The process in an ideal condenser is assumed to occur at a constant pressure. In real condenser certain pressure drop occurs due to the friction inside condenser pipes in single phase flow and in condensation process. The drop in pressure causes a drop in saturation temperature (Fig. 2) which in turn reduces the amount of heat rejected from the condenser. The state at the condenser exit is difficult to maintain at saturation. So, there is certain subcooling at the condenser exit before the expansion device. This subcooling has a positive effect in cycle operation since the quality at the expansion device exit decreases causing an increase in the evaporator refrigeration capacity.

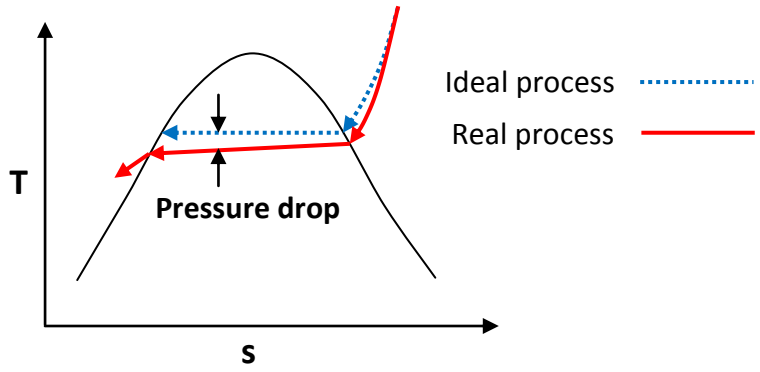


Fig. (2): Ideal vs. real processes in condenser.

## Expansion Device

Throttling process in expansion device is assumed to occur ideally at constant enthalpy. In real expansion processes the associated frictional losses and the turbulent nature of expansion causes a loss in refrigerant energy translated as a drop in enthalpy. However this loss does not always have a negative effect on the cycle since the drop in enthalpy causes a drop in evaporator saturation pressure causing lower refrigeration temperature but the refrigeration capacity is decreased as shown in Fig. 3.

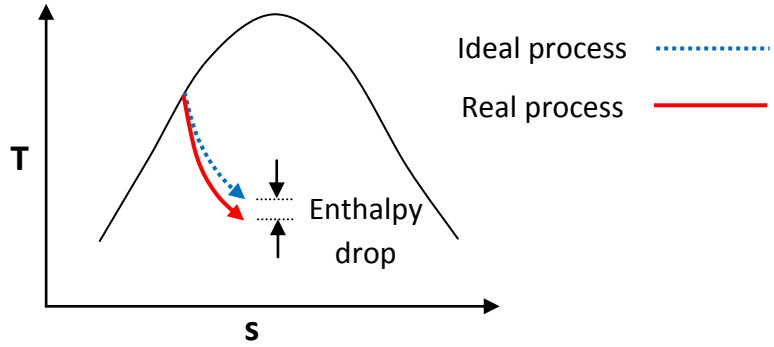


Fig. (3): Ideal vs. real processes in expansion device.

## Evaporator

The process in an ideal evaporator is assumed to occur at constant pressure. The refrigerant in real evaporators undergoes drop in pressure due to friction and change of phase (Fig. 4). A drop in saturation temperature follows the drop in pressure.

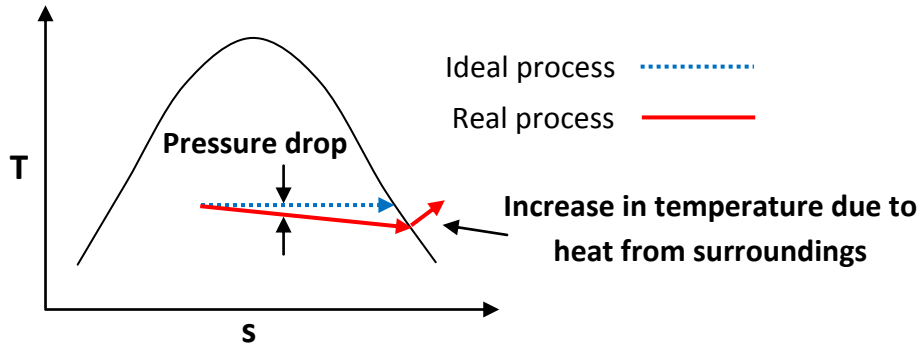


Fig. (4): Ideal vs. real processes in evaporator.

The whole real refrigeration cycle is shown in Fig. (5).

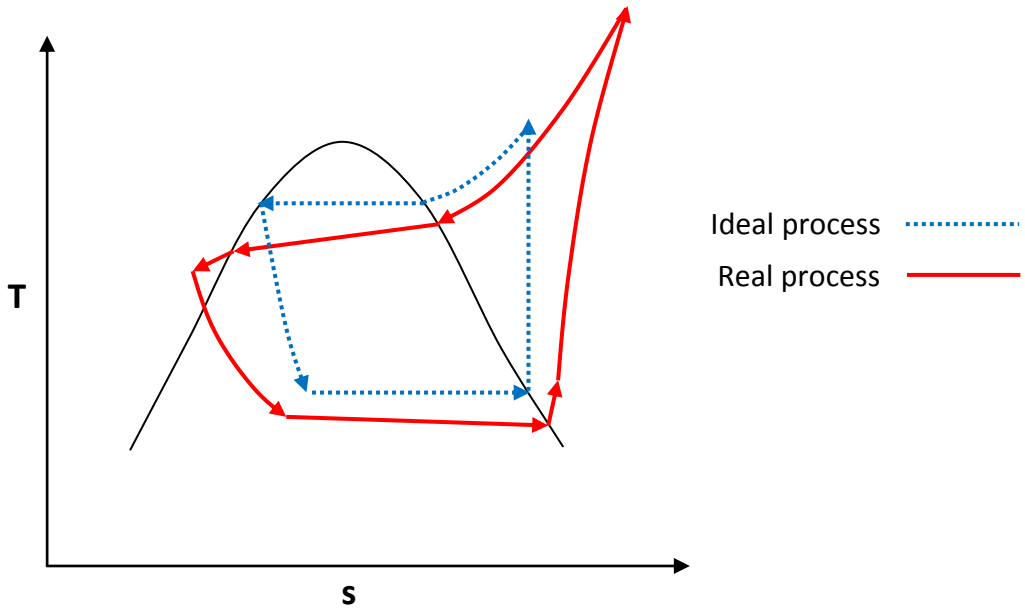


Fig. (5): Real refrigeration cycle.