When the evaporative temperature is lower in a single compression refrigeration system, the NRE is smaller, the system efficiency is getting to be less desirable; the power consumption is higher and the compressor size might be also larger. The way to improve the refrigeration cycle efficiency is to use an intercooler or a liquid subcooler to increase the value of NRE and to use a desuperheater to reduce the discharge temperature and to help the compression head of the compressor.

Increasing the NRE means reduces the refrigerant amount flow to the evaporator to produce the required tons of refrigeration; this results in smaller compressor motor and may be even smaller compressor. Because of the smaller amount of refrigerant is circulated, smaller refrigerant piping, valves, fittings and insulation are to be used for the refrigeration system.

Intercooler, liquid subcooler or desuperheater is basically to be used with a refrigeration system that is having multistage compression with exception of the screw compressor because screw compressor has a special feature would allow a side connection to the compressor casing even it is used for single compression. The intercooler used for screw compressor is called economizer; more details are outlined in Chapter 5.

The component of various intercooler, liquid subcooler and desuperheater for the refrigeration cycle efficiency improvement are illustrated as the following:

**Flash Intercooler:**

The FIG. 3-1 is the Flash Intercooler. From the diagram [1] of FIG. 3-1, the liquid either high side or from higher stage at point “A” is throttling through an expansion device of High Pressure Float Valve or Liquid Level Control Valve. The pressure is dropped down to a lower temperature level of “B” Flash gas and the liquid are disengaged inside the intercooler. The flash gas returns to the high stage compressor suction “D”. The refrigerant liquid is supplied to the evaporator at point “C”.

The equipment and the component for this flash intercooler arrangement is shown in Diagram [2] of FIG. 3-1. The equipment is a combination Intercooler and Receiver with a high pressure float valve. The H.P. Float in this arrangement only provides throttling function to dump all the liquid from high side to the Intercooler/Receiver; it has no liquid level control capability for the Intercooler/Receiver.

Diagram [3] of FIG. 3-1 is a vertical type Flash Intercooler with a liquid level control.
valve. The valve is with liquid level controller to control the refrigerant liquid level inside of the intercooler. The result of this arrangement on the P-H diagram is the same as the equipment listed under [2].

FIG. 3-1   Flash Intercooler
Diagram [4] shows a horizontal intercooler. It has the same functions as of the vertical arrangement as shown in Diagram [3].

The desuperheating capability of these flash intercoolers is limited. The suction gas temperature to the high stage compressor is the mixture of the discharge superheated gas from low stage compressor and the saturated flash gas from the intercooler at the intermediate temperature level.

**Liquid Subcooler:**

FIG. 3-2 illustrates two different types of liquid subcooler. The refrigerant liquid is from either high side or from higher stage at point “A”. A portion of the liquid expands through an expansion device such as DX valve or liquid level control valve. The liquid is throttling down to an intermediate temperature of B-D; this is to subcool the main stream refrigeration from “A” to “C”. The evaporated gas at the intermediate temperature is leaving the intercooler, mixes with the discharge gas from the low stage compressor, then return to the suction of the high stage compressor.

Diagram [2] of FIG. 3-2 is the arrangement of using a DX type shell-and-tube liquid subcooler with a DX valve and Diagram [3] is a flooded type subcooler with liquid level control valve.

**Desuperheater:**

Desuperheater is sometimes being used for special application to quench the high suction superheated gas even for single stage compression application. FIG. 3-3 shows the desuperheater that only provides the desuperheating function without intercooling. Therefore, it does not help to improve the NRE in a multistage system in this case.

The desuperheater shown is a vertical design. It can be horizontal construction. Portion of the liquid from condenser or from high pressure receiver at point “A” expands through a liquid level control valve down to an intermediate temperature of B-D to desuperheat the low stage discharge gas from “E” to “D”. The mixture of the discharge gas from low stage compressor and the desuperheating gas goes to the suction of the high stage compressor.

Desuperheating function can also be accomplished by using DX valve or even less expensive arrangement of liquid injection.
[1] Compound System or Multistage Liquid Subcooling

[2] DX Type Liquid Subcooler

FIG. 3-2 Liquid Subcooler
FIG. 3-3  Desuperheater
**Flash Intercooler & Desuperheater:**

The intercoolers shown in FIG. 3-4 are with advantages of both flash intercooling and desuperheating. Liquid either from high side or from higher stage at point “A” is throttling through the Low Pressure Float Valve (or Liquid Level Control Valve), the pressure is dropped down to the lower level of “B”, flash gas and the liquid are disengaged inside the intercooler. The refrigerant liquid is supplied to the evaporator at point “C”. Portion of the liquid in the intercooler is to cool the discharge gas from low stage compressor from “E” to “D”. The mixture of flash gas and the desuperheating gas returns to the high stage compressor suction at point as shown.

Diagram [2] is a vertical design and Diagram [3] is the horizontal arrangement. The functions of the both intercooler are the same.

**Liquid Subcooler & Desuperheater:**

The intercooler shown in FIG. 3-5 is similar to the vertical intercooler as shown in the diagram [2] of FIG. 3-4 except this intercooler is with a coil type heat exchanger inside of the intercooler to provide subcooled liquid at point “C” for the evaporator.

Actually, the liquid flow A-B and B-D in the P-H Diagram has two streams of refrigerant flow; one represents the refrigerant need to cool the refrigerant flow from “A” to “C” and another one represents the refrigerant flow need to desuperheat the discharge gas from low stage compressor from point “E” to “D”.

FIG. 3-4  Flash Intercooler & Desuperheater
[1] COMBINATION LIQUID SUBCOOLING AND DESUPERHEATING INTERCOOLER.

[2] COMPOUND SYSTEM, LIQUID SUBCOOLING AND INTERSTAGE INTERCOOLING

FIG. 3-5  Liquid Subcooler & Desuperheater