Chapter – 1 Preface & General

Preface:

This manual is intended for someone who has the prior basic education of refrigeration and has the basic knowledge of mechanical engineering such as thermodynamics, heat transfer and etc.

This manual is mostly dealing with application practices for industrial refrigeration application which is for industrial production and hydrocarbon processing.

What is Engineered Refrigeration System?

“Engineered Refrigeration System” means to design a refrigeration system to meet the requirements of a process or for the need of the production for a specific application with a specific design operation. It is absolutely not accommodating the process to suit any fixed designed of standard or packaged refrigeration product. Engineered system is to compose, to design, to structure, to build and to install the refrigeration system precisely to fulfill the refrigeration need of the process or for the production.

System Concept and System Approach:

It is the objective of this manual to emphasize the meaning of “System” concept and “System” approach.

Each of the components in the “refrigeration system” has its assigned duty under the design operating conditions. The “system” operating conditions and the “system” capacity will change if any one of the components which makes up the refrigeration “system” is changed.

Also, it is important that every step taken and the concept used for the refrigeration “system” design should be explainable by the related applicable theory. Always check with P-H Diagram and the associated engineering formula to see if the flow and thermodynamic properties are fundamentally correct. These rules are applicable to both primary refrigerant circuit and the secondary refrigerant circuit if brine is used for the system. Try to exam the function and the character of each component including each device and valve to see how it is fitted into the structure of the “system”.

Refrigeration Industries and Product Segment Classification:

Various industries and customer users require different types of refrigeration technique, equipment, application and system for its process need and for the making of their product. Therefore, base on the user groups, the refrigeration business can be classified into several major segments as the following:

Industrial Refrigeration – This is an engineered system either field erected or factory specially designed and assembled systems for the industries such as Chemical, Hydrocarbon Processing, Oil, Petrochemical, Natural Gas Processing and other industries that might require industrial grade refrigeration system.

Central Systems for Food and Beverage – This might be a field erected system or factory engineered unit. This application is mainly provided for the installations of cold storage, food processing and freezing.

Walk-in Cold Storage and Freezers – This sector of refrigeration application is for smaller scale of food storage. The refrigeration equipment use for this application is mostly factory packaged.

Transportation Refrigeration – Packaged product, mainly use for food distribution and transportation. This includes container refrigeration.

Display Casings – Packaged refrigeration equipment use for supermarkets.

Packaged Refrigerator and Freezer – Units for home, commercial and restaurant users.

The application for other industrial users such as Pharmaceutical, Environmental Simulation, Electronics and etc. are usually covered by the refrigeration equipment and system suppliers of Industrial Refrigeration and/or Food and Beverage.

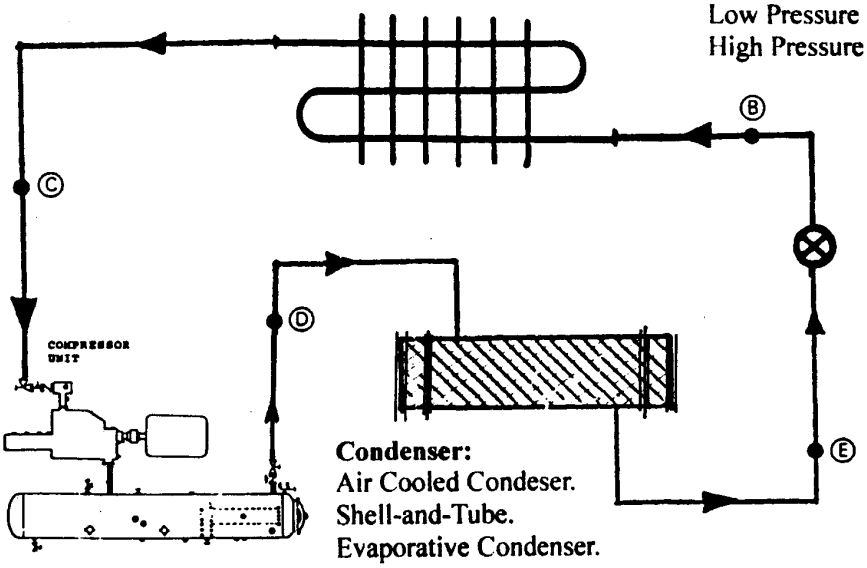
This manual is mainly to be used for the applications for Industrial Refrigeration and for large central commercial refrigeration.

Basic Refrigeration System Review:

A refrigeration system, no matter simple or complex, it is a combination of four principal components, the Compressor, Condenser, Refrigerant Metering Device and the Evaporator as shown in Fig. 1-1. In a central refrigeration system, for various application requirements, each component might have different design as the following:

Evaporator:
Water or Brine
Or Special column
Air – Finned Coil
Shell-and-Tube

Metering Device:
Expansion Valve.
Low Pressure Float.
High Pressure Float.



Condenser:
Air Cooled Condeser.
Shell-and-Tube.
Evaporative Condenser.

Compressor:
Screw Compressor.
Reciprocating Compressor.
Centrifugal Compressor.
Rotary Compressor.

Notes: No Loses.
Cycle is the same for all refrigerants.

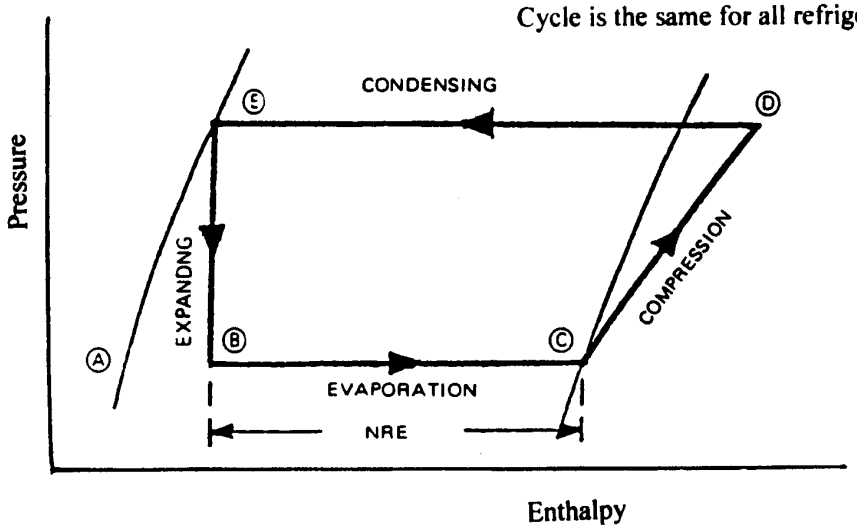


FIG. 1-1 Simple Refrigeration Cycle

Compressor can be either Reciprocating or Centrifugal or Screw.

Condenser can be either water cooled shell-and-tube design or air cooled finned-coil or evaporative wetted pipe or finned-coil.

Flow Metering Device can be either Expansion Valve or High Pressure Float Valve or Low Pressure Float Valve.

Evaporator can be either air finned-coil such as Unit Cooler, Product Cooler or horizontal shell-and-tube heat exchanger or vertical special column.

For some system, it requires other components such as Economizer, Intercooler, Suction Trap, High Pressure Receiver, Low Pressure Receiver, Oil Receiver or Pump Recirculation Receiver. Besides of the components, refrigerant piping, oil system, control system and power system are required for a central system. Defrosting system and other things might also be considered for some application.

Various Refrigeration Systems Description:

Single Stage Refrigeration System:

Reciprocating Compressor.
Screw Compressor.
Single Stage Centrifugal Compressor.

Compound Refrigeration System:

Internally Compound Compressor.
Reciprocating to Reciprocating Compressor.
Rotary to Reciprocating Compressor.
Screw to Reciprocating Compressor.
Single Stage Centrifugal to Reciprocating Compressor.
Screw to Screw Compressor.
Single Stage Centrifugal to Screw Compressor.
Single Stage to Multistage Centrifugal Compressor.
Screw to Multistage Compressor.
Multistage Centrifugal to Multistage Centrifugal Compressor.

Cascade Refrigeration System:

Reciprocating to Reciprocating Compressor.
Screw to Reciprocating Compressor.
Screw to Screw Compressor.
Multistage Centrifugal to Screw Compressor.
Multistage Centrifugal to Multistage Centrifugal Compressor.

System description also defines refrigerant feed and the type of Evaporator and the arrangement as the following:

Open System – Refrigerant flow is never returned back to the system.
Closed System – Refrigerant flow is continuously recirculated,
Direct Expansion System.
Flooded System.
Liquid Recirculation System.
Brine or Water Chilling System.
Thermosyphone Evaporator System.

System description is also can be identified by the method of heat rejection:

Air Cooled System.
Water Cooled System.
Evaporative Condensing System.

A refrigeration system can easily be described by high lighting the type of system, type of evaporator, refrigerant feed and method of heat rejection. For example: the system is “screw to screw compound brine chilling system with water cooled condenser”.