resulting from the different speeds of the two compressors. This type can also be reduced by installing mufflers.

When the noise is a result of turbulence and insulating the line is not effective enough, either the use of a supplementary line or the installation of a larger line to reduce the velocity will be helpful.

Code Restrictions

Restrictions imposed by codes, laws and regulations applying at the site of an installation must be known to the designer and obeyed. The *Safety Code for Mechanical Refrigeration* (ASA-B9.1) and the *Code for Pressure Piping* (ASA-B31.1) are primarily drawn up as guides for safe practice, and should be followed whether they have been given the force of law in a particular community or not. Their principal requirements as they apply to refrigeration piping are practically identical. They are the basis of most municipal and state codes, and will become more so as time goes on. However, some ordinances go beyond them in requiring heavier piping and other special features, and it is necessary for the designer to become familiar with the specific requirements applying at the site where the piping is to be installed.

REFERENCES

[1] *Refrigerant Piping Data* (Air-Conditioning and Refrigeration Institute, 1961).
[2] *Piping Application Data* (Carrier Air Conditioning Co., Sections 25B-2, 11-15-51, and 25X-2, 10-15-46).
[3] *Piping Application Data* (Carrier Air Conditioning Co., Section 25B-1, p. 8, 5-1-46. Initially compiled from data of Mueller Brass Co. and Tube-Turns, Inc.).
[4] *Flow of Fluids through Valves, Fittings and Pipe* (Crane Company *Technical Paper* No. 409, May 1942, p. 21).
[5] S. C. Dietrick: Refrigerant piping for air conditioning systems (*Heating and Ventilating*, March 1953, p. 95).
[6] *Equipment Manual*, Section B-10 (York Corp., subsidiary of Borg-Warner Corp., May 1, 1955).
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CHAPTER 70

REFRIGERANT PIPING SYSTEMS FOR REFRIGERANTS 12, 22 AND 500

Basic Principles; Liquid Lines; Suction Lines; Discharge (Hot Gas) Lines: Oil Entrainment, Minimum Gas Velocities; Piping from Condenser to Receiver; Piping at Multiple Compressors; Piping at Various System Components; Refrigeration Accessories; Head Pressure Control for Refrigerant Condensers; Control of Compressor; Manual Compressor Operation; Hot Gas Bypass Arrangements

THE success of a refrigeration system is largely dependent upon proper design of the refrigerant piping and understanding of the system accessories required to perform the necessary operating functions.

This chapter discusses the fundamentals of refrigerant piping and the application of the various accessories that are involved in the satisfactory operation of a complete refrigerant piping system. It deals with systems using Refrigerants 12, 22 and 500. Ammonia piping application is covered in Chapter 71.

Reference should be made to Chapter 69 covering the following general information on refrigerant piping: refrigerant flow data, refrigerant line sizing data, general piping practice and other general references. Piping for multi-stage systems is discussed in Chapter 72.

BASIC PRINCIPLES

Refrigerant piping systems should be designed and operated to generally accomplish the following:

1. Insure proper refrigerant feed to evaporators.
2. Provide practical refrigerant line sizes without excessive pressure drop.
3. Prevent excessive amounts of lubricating oil from being trapped in any part of the system.
4. Protect the compressor from loss of lubricating oil at all times.
5. Prevent liquid refrigerant from entering the compressor, either during operating or idle time.
6. Maintain a clean and dry system.

SYSTEM CAPACITY REDUCTION PROBLEMS

The universal use of automatic capacity control on modern compressors necessitates careful analysis and design of refrigeration systems. The compressor is capable of loading and unloading, as it floats with the system load requirements, through a considerable range of capacity variation. A single machine can unload down to 25 percent of full load capacity, while multiple machines connected in parallel can unload down to a system capacity of 12½ percent and even lower in some cases.

This ability of refrigeration compressors to match widely fluctuating load requirements poses certain problems that must be recognized and properly handled.

Lubricating oil is continually leaving the compressor, in small amounts, with the discharge gas. The complete refrigeration system must be designed to return this oil to the compressor at the same rate that it leaves. Wide variations in system loading require careful system design to return oil at lowest loading and yet not impose excessive pressure drops in the piping and equipment at full load.

Liquid feed devices are designed to operate efficiently down to about 50 percent of full capacity. Below this their performance is not entirely satisfactory. A valve operating at 25 percent capacity is badly oversize and attempts to operate in a nearly closed position. Modulation is practically impossible at this condition and the valve will tend to cycle badly. Liquid distribution to multi-circuit evaporators will depreciate at very low capacity conditions causing uneven air temperatures across the face of a coil. Cycling of the liquid feed device plus poor distribution causes periodic or continual flooding of liquid refrigerant back to the compressor. These and other problems should be analyzed and allowed for in the initial system design stage.

LIQUID LINES

Liquid lines present the fewest problems in design. Refrigeration oil is sufficiently miscible with Refrigerants 12, 22 and 500 in the liquid form to insure adequate mixing and positive oil return. Low liquid velocities and traps in the line do not pose oil return problems.

In designing a liquid line, however, it is desirable to have slightly subcooled liquid reach the liquid feed device, at a sufficiently high pressure for proper operation. This does present two factors which must be considered:

1. The liquid line, and all the valves and accessories in it, must be sized for a practical pressure drop due to friction. (See Chapter 69.)
2. Precautions should be taken to prevent flash gas in the liquid line, or to handle it if prevention is impractical.

Flash Gas in the Liquid Line

Refrigerant remains in liquid form only as long as its temperature is at or below the saturation temperature corresponding to the liquid pressure. If the liquid is only slightly subcooled, either an increase in its temperature or a decrease