Small systems can use antiseptic materials such as bleaching powder if proper care is taken. The dosage should be calculated on the basis of applying not over 1 ppm chlorine to the water in the system. By starting with a low dosage and observing the results, the quantity can progressively increase until control is obtained, without damage to the system. Sodium pentachlorophenate is effective in concentrations of about 30 ppm. It is not harmful to the system if used in excess, but it is a pollution hazard in the blowdown.

Most fouling of refrigerating condensers is due to biological growth rather than to scale deposition. An algacide should be applied when an abnormal increase in head pressure is noted. If biological fouling is present, chlorination will give almost immediate results since the organic matter will be destroyed. A more complete discussion of Water Treatment appears in Chapter 15.

WOOD DETERIORATION

Wood is widely used in cooling towers because few materials compare with it in cost or durability. It is less subject to chemical deterioration than most other materials in the system. But it is also attacked by microorganisms causing decay. The incidence of wood deterioration is more prevalent in cooling towers operating with an alkaline water. This observation led to the supposition that the alkali caused a chemical attack similar to the process used in the manufacture of paper pulp.

Later investigations[11,12] have shown that wood-destroying organisms are usually present in the deteriorated wood. Heart redwood contains natural preservatives that are toxic to these organisms. The toxic materials are soluble in water, and the solubility increases under alkaline conditions. This indicates that a high alkalinity will accelerate the leaching and render the wood susceptible to decay rather than cause a purely chemical attack.

This conclusion is supported by the fact that an alkaline water does not lead to deterioration when treated lumber is involved. Preservatives are applied to new lumber by pressure treating processes to assure the required retention and penetration of the preservatives. Most commercial preservatives may also be applied to wet lumber by the diffusion process which results in comparable retentions and penetration. The diffusion treatment provides a means of protecting existing towers built of untreated lumber, and it is being used extensively. The use of pressure treated lumber adds about 10 percent to the cost of a new tower. The cost of a diffusion treatment is usually slightly less.

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CHAPTER 47

FACTORY DEHYDRATING, CHARGING AND TESTING

Dehydration by Heat, Vacuum and Dry Air, Combination Methods, Special Considerations; Moisture Measurement; Charging; Testing of Leaks: Leak Detection Methods, Special Considerations; Performance Testing: Compressor Testing, Testing of Complete Systems, Testing of Components

BECAUSE of the inherent complexities of a refrigeration system the proper processing of components and units is extremely critical. Not only must close tolerances and fits be met, as is normal to many manufacturing cycles, but extreme care must be taken to see that the chemical, electrical and mechanical segments of the system are processed in such a manner that they will remain compatible through an extensive warranty period. Improved designs or clever innovations can be completely nullified by archaic or careless factory procedures. The three processing techniques peculiar to the refrigeration industry, and ones that play a major role in the ultimate success or failure of a unit, are dehydration, charging and testing. Since a complete design must normally specify end results required, such as allowable moisture content, refrigerant quantities, and performance, this chapter will concern itself only with the methods that can be used to secure a specified result rather than how to establish limits.

DEHYDRATION

The danger of excessive moisture in refrigeration systems is well known. In low temperature applications, incomplete dehydration may lead to capillary or expansion valve freeze-up. Other results of incomplete dehydration are the formation of sludge in the system, flapper-valve breakage, and hermetic motor burn-out. Since all these effects, with the exception of freeze-up, cannot ordinarily be detected during a standard factory test, it is extremely important to use a dehydration technique which results in a safe moisture level. In addition to this technique, an accurate method of measuring moisture content in the system must be established. (See Table 1.) The acceptable moisture content depends upon many factors, such as size of the unit, its application, and the type of refrigerant used. Table 1 shows moisture limits specified by several manufacturers for various systems, with the average limit of 15 ppm for Refrigerant 12, and 25 ppm for Refrigerant 22. When the *cold trap* method of moisture determination is used prior to the addition of oil and refrigerant, the moisture limit varies between 0.01 and 1.0 cc.

Dehydration by Heat, Vacuum, and Dry Air

Several satisfactory methods of adequately dehydrating refrigeration systems and components are available, and the final choice of the method used depends on the desired moisture level, size, production quantities, time, and cost.

Heat, vacuum, and dry air are used for moisture removal, either separately or in different combinations. *Heat* is applied by placing the equipment in an oven. The method is primarily used for the dehydration of open parts, such as tubing, driers, and other components. Sufficient time must be allowed to convert all the water present into vapor, and temperatures must be high enough for the removal of water adsorbed on the various surfaces.

Obviously, the relative humidity of the air in the oven must be maintained at low level. Also, the moist air must be exhausted and replaced with dry air, to prevent vapor from being recondensed on the treated parts when they are removed from the oven. As soon as the parts have been removed from the oven, they must be capped or closed, in order to prevent moisture from entering them during cooling. This is not necessary when the parts are directly removed to an area with low humidity.

The dehydrating method using *vacuum* is primarily used for systems or parts which can be closed and made leak-tight. The boiling point of water is lower under vacuum, being only 77 F at 29 in. of mercury, and 59 F at 29.5 in. Therefore the moisture can be converted into vapor and moved to the vacuum pump at reasonably low ambient temperatures.

If *dry air* or *nitrogen* is used for dehydration, the air or nitrogen drawn or blown through the equipment removes moisture by becoming totally or partially saturated.

The three methods described in the foregoing have certain disadvantages which will now be discussed. In the first method (oven heat), time and escape area are critical. If the system or the parts to be dehydrated are large, it may be difficult to heat them to the correct temperature, with the result that either production is limited or a large operating area is needed. Also, since water vapor must escape by its own momentum, a complete system will normally have a small opening for vapor escape as compared to the volume which must move through it. Where spring-mounted compressors are used, the use of oven heat alone may become prohibitive due to the time involved in heating the compressor parts and motor windings by radiation and convection. The necessity of handling the parts soon after they leave the oven presents an additional hazard which must be averted.

The use of vacuum presents a number of problems. In normal shop ambient temperature, the boiling point requires a fairly high vacuum, and the amount of moisture that can be moved per unit time at this point is of course limited by both the size of the pump and the size of the opening and lines through which the vacuum is drawn. The length of piping required may also become a limiting factor.

Dry air or nitrogen sweeping is an effective way of removing moisture, but in systems with several passages or with blind passages, there may not be sufficient flow. As a general rule, the rate of flow should be high enough to avoid complete saturation of the air in order to minimize the danger of deposition of moisture in some cooler portion of the equipment. On the other hand, there is little to be gained by the use of a very high rate of air flow, since the amount of water removed per unit of air will be small. Also, moisture may remain in the pores of the metal due to surface viscosity.[1] This may also happen when the vacuum method is used.

The general responsibility for this chapter is assigned to TC 5.4, Reciprocating and Rotary Compressor Units.