evaporator, amounting to approximately 11 lb per hour per ton of refrigeration developed. The remainder of the water at the desired low temperature, is pumped out of the evaporator and used at the point where it is required.

The ejector compresses the vapor which has been flashed into the evaporator, plus any entrained air taken out of the water circulated, to a somewhat higher absolute pressure, and this mixes with the impelling steam on the discharge side of the jet. The total mixture of entrained air, evaporated water and impelling steam is discharged into a surface condenser at a pressure which permits the available condensing medium to condense it. The resulting condensate is removed from the condenser by a small pump, where it can be discharged to the sewer or returned to the system in the form of makeup water, or part of it may be returned to the boiler feed pump.

As the normal temperature of water required for air conditioning purposes is between 40 F and 50 F, with an average temperature of approximately 45 F, this type of water cooling is particularly desirable, as the efficiencies and operating costs compare very favorably with other types of refrigerating equipment, especially in view of the fact that the cooling apparatus is, as a general rule, less expensive to install.

Approximately three times as much condenser water is required for the steam jet cooling system as would be necessary with other types of mechanical refrigeration, but as the system can be designed with a large number of jets, each of which can be cut off as the load falls below maximum, constant refrigerating efficiency is maintained and frictional losses, volumetric inefficiencies, etc., are kept at a minimum.

The slight amount of air which may be entrained in the cooled water, is removed by a small secondary ejector which raises the pressure sufficiently so that the air can be discharged to the atmosphere. A small secondary condenser, of course, is necessary to condense the steam used in the secondary jet.

Steam jet refrigeration has an advantage, where cooling towers are used for supplying the condensing liquid, as there is a great saving in the amount of steam used per ton of refrigeration. As the outdoor weather conditions vary, and of course the load on the cooling system with it, the compression ratio between the condenser and evaporator can be reduced and less propelling steam used per ton of refrigeration developed. Roughly, in air conditioning work, mechanical compressors show a falling off of 30 to 40 per cent in the power input when using the most economical arrangement of compressors, as the load varies from 100 per cent to 25 per cent of the rated capacity; whereas with steam jet cooling equipment, the amount of steam required for producing the necessary refrigerating effect falls off in direct proportion to the load on the system or with cooling towers, the amount required falls off even more rapidly.

Compressors and Refrigerants

There are many different types of compressors, a number of refrigerants, different types of evaporators, condensers and arrangements of the cycle; each of which has its particular place and usage. There are four (4) different types of compressors, and in general, six (6) different refrigerants normally used for air conditioning purposes. The generally used compressors are of the following types:

1. Reciprocating compressors.
2. Centrifugal compressors.
3. Rotary compressors.
4. Steam Jet compressors.

The refrigerants in most general use are:

1. Ammonia.
2. Carbon Dioxide.
3. Dichlorodifluoromethane.
4. Dichloromethane.
5. Methyl-chloride.
6. Water Vapor.

The following is a brief discussion of the various types of compressors and their relationship to the refrigerants:

Reciprocating compressors can be used for any of the refrigerants listed, except water vapor and dichloromethane.

Centrifugal compressors can be used for dichloromethane or water vapor, and theoretically, for any of the other refrigerants, but the resulting loss in efficiency, with the higher pressure gases, limits the centrifugal compressor to the two refrigerants named.

The rotary compressors are generally used for methyl-chloride and dichlorodifluoromethane, because of their relatively low pressure and compression ratios.

The steam jet compressor is used only when water vapor is the refrigerant.

Reciprocating compressors are a thoroughly familiar piece of equipment and have been developed to a point where their efficiency is high and their operation very satisfactory. They generally operate at low speeds, and in large installations this fact makes them desirable for general use. They are of two types, the vertical and the horizontal type, either single or double acting. Reciprocating compressors are widely used in ordinary refrigeration work and they can be used with more refrigerants than other types of compression units. For instance, when carbon dioxide is used as the refrigerant, the reciprocating compressor is used because of the extremely high pressures and relatively high ratio of compression.

Centrifugal compressors are usually built in two or more stages where the compression ratio is high and their design follows closely that of any other centrifugal equipment, such as general service pumps and fans.

Rotary compressors may be used for medium or low pressure refrigerants, with small compression ratios.

Steam jet compressors which have recently entered the field, cannot be used economically for water temperatures much below 40 F. They are simple and compact, have no moving parts and produce practically no vibration. Further, water is a cheap and inexhaustible refrigerant and does not need to be used in an enclosed system in the same way as other gases.

The source of condensing water to some extent governs the type of refrigerant used. If condensing water is available at temperatures of not more than 70 to 75 F any of the refrigerants mentioned can be used economically, but if the available condensing water temperature is above 80 deg, carbon dioxide becomes uneconomical as its critical temperature is approximately 88 F. A condensing water temperature over 80 deg makes the power required for compression high. All refrigerants have critical temperatures and pressures sufficiently high so that their efficiency is not materially affected by the condensing water temperatures, except in so far as this temperature affects the compression ratio.

Steam jet cooling systems can use water up to 85 F, or even slightly higher.

The applicability of the various refrigerants is interesting. Carbon dioxide is limited by the condensing water temperature, the power consumption is slightly higher than other refrigerants, and the pressures are three to four times that of ammonia.