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Artificial Refrigeration

Carroll Knowles
University of Rhode Island

ARTIFICIAL REFRIGERATION,

CARROLL KNOWLES,

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In the early barbarous stages of society none of the necessaries of life were laid by for future use; each man obtained only enough food for his immediate needs. But later as civilization advanced, different forms of food were used; and in warm or even in temperate climates, some method of preserving these foods became a necessity.

Ice was one of the earliest and is still one of the most important refrigerating agents. But owing to the uncertainty of the crop, cost of transportation, and danger from the many impurities which it contains, ice is being largely superseded by artificial processes. By these processes dry air is obtained within the storage room, the temperature is under perfect control, while the expense of operating the machines is less than the cost of ice for the same amount of work. When lower temperatures than could be obtained with ice were desired, a mixture of ice or snow with salt or calcium chloride was used. The degree of cold varied directly with the amount of chemical used; that is, before the point of saturation is reached.

It is a familiar principle that bodies are expanded by heat and contracted by cold. If a mass of air is heated, it expands and occupies a larger space. A liquid like alcohol or ammonia expands so much when heated in the air that it assumes a gaseous form. It is well known that when water reaches the temperature of 212° F. it boils and passes off as steam at the same temperature.

Each pound of water at the moment of expanding into steam, takes up 966 units of heat. These 966 heat units are called the latent or hidden heat of steam. It is also true that if alcohol is allowed to expand into the form of vapor, or to evaporate as is commonly said, heat is necessary to permit the expansion. If no artificial heat is supplied, it must be withdrawn from the surrounding atmosphere or from the containing dish.

Liquid ammonia is very much more volatile than alcohol, and because of its lesser cost is well suited to be a refrigerating agent. In the expansion of one pound of ammonia under a pressure of one hundred and ten pounds—about the pressure used in most refrigerating machines—, and at 65°F. one hundred and ten heat units are absorbed. But if the ammonia be cooled to 60°F. it becomes a liquid and when expanded passes into the gaseous form. Then instead of absorbing one hundred and ten heat units, it will through the latent heat of vaporization absorb about six hundred and twenty-five, or a cooling effect is produced equal to the melting of four and one-half pounds of ice.

Artificial refrigeration as applied to the preserving of meats, butter, fruits etc. in warehouses and on board cars and steamers in transit, is accomplished by means of machinery. There are two classes of refrigerating machines named according to the principle upon which they work. These are the compressor and the absorbtion.

In the compressor type the liquid ammonia under a pressure of one hundred pounds and at a temperature of 60°F. is placed in a cylindrical reservoir, and then led through an expansion valve into a coil of pipes surrounded by brine. In passing from a liquid to a gas, heat must be taken up; and as the pipes are surrounded by brine heat will be absorbed from it and its temperature consequently lowered. After passing through the cooler the ammonia, now a gas, is drawn by the suction of a compressor pump into its cylinder, and then forced into a nest of pipes immersed in cold water, where it is liquified under the influence of the cold and pressure. It is then conducted to the reservoir, having completed a cycle of operations, as the working substance returns periodically to its original state.

The cool room or refrigerator should be well insulated from the outside air. Cold brine is pumped from the bottom of the cooler, and circulated through pipes passing around the room, and then led back to the top of the cooler to be used again. The brines ordinarily used are a solution of common salt or calcium chloride and water. For very low temperatures the calcium chloride solution must be used as the salt and water will freeze. A method much less expensive than the use of brine is to expand the ammonia directly into the coil of pipes in the storage rooms. This system is not common as the piping and valves are likely to leak and stored goods to be damaged by escaping gas. Another process

having the same disadvantage is that of forcing a blast of air over the cooler and into the storage room.

Among the more important refrigerating agents which may be used in the compressor machines are sulphuric ether, sulphur dioxide, and carbonic acid. Economically the first two are identical with ammonia, but the compressor cylinder must be respectively seventeen and three times larger. Carbonic acid requires more fuel, but a smaller cylinder may be used, while about the same temperature may be reached as with ammonia. It is not yet common; its great compactness and inoffensive character, however, recommend it where economy of space is required, or stored goods are likely to be reached by escaping gas.

The absorbtion class of refrigerating machines usually consist of six cylindrical vessels, some piping and a pump. The first vessel, a horizontal one called the generator, is filled with ammoniacal liquor, which is then heated by means of steam passing through a coil of pipes within the cylinder, The heat causes the liquor to evaporate, and on rising to pass through the second vessel. This vessel and the remaining four are all vertical The duty of the separator is to separate from the ammonia vapor all water which it contains. From this vessel the gas is led to a coil of pipes in the third cylinder or condenser. It is filled with cold water which is being constantly replenished to keep it at a low temperature. In the condenser the ammonia gas is con-

verted into a liquid by means of the tension of its own vapor and the cooling effect of the surrounding water. After passing through the condenser the ammonia now in the liquid form passes into a second coil of pipes surrounded by brine. Here it is expanded taking heat from the brine, which is consequently lowered in temperature. This brine is then used for refrigerating purposes, in the same manner as in the compressor type. Having accomplished its work, the gas passes into the the absorber, where it meets the original liquid from which it was first distilled in the generator and is absorbed by it. The saturated liquid is then pumped through the last cylinder, or economizer where it meets with the liquor from the generator on the way to the absorber, and finally reaches the generator, to go again through the cycle of operations outlined.

The efficiency of these two classes of machines is nearly the same when the desired temperature is about 20°F. For higher temperatures than this the compressor type is the more economical; for lower, the absorbtion class is the better.

Refrigeration by means of compressed air is rapidly coming into prominence, being especially adapted for use on shipboard. Air compressor machines usually consist of a combination of a steam engine, an air compressor, and an air expansion cylinder. The air after compression is cooled through the agency of water It is then allowed to enter the expansion cylinder and do useful

work against a piston rod, so connected as to relieve the steam engine of part of its work in compressing the fresh charge of air. It is on the absorbtion of heat by the mechanical work done, that the efficiency of the machine depends.

The modern methods of refrigeration have done much towards lowering the price of many perishable forms of food, by making competition possible between different sections of the country, or between different countries, the difficulty and danger of transportation being overcome. They also have a tendency to equalize prices. If the market is glutted with goods, these may now be held for better prices; since as the supply decreases, the price rises. Then if prices are high, goods which have been held will be rushed into the market, the supply increased and the price lowered.

Refrigeration has also extended our foreign trade, making possible the exportation of meats, fruits and vegetables which would otherwise be wasted. In fact it has greatly benefited mankind by practically increasing the food supply, and by raising the standard of living among the poorer classes.