10th June, 1897.

THE CARBONIC ANHYDRIDE REFRIGERATING MACHINE.

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The commercial importance of the parts played by refrigerating plants and ice-making machinery in regard to the development of our Export trade can scarcely be overrated at the present time. The more the subject is ventilated and opened up, the better for all concerned; and as inventions and discoveries upon inventions, invariably follow each other in quick succession, it may be as well that in this paper the Author should endeavour to describe the latest improvements in mechanical refrigeration.

It is unnecessary in this paper to go into the history of Mechanical Refrigeration, as the Author should only be treading upon ground which has already been practically exhausted in the many valuable papers contributed from time to time upon the subject by members of this Association.

The Carbonic Anhydride machine, which has only been introduced into the Colonies since 1892, is in its general arrangement similar to other Compression machines except that the submerged Condenser is used. The gas used having no affinity for copper, this metal can be adopted for Condenser coils, where sea-water is used. The parts of the machine being small, steel and brass are exclusively used in its construction, the Compressor Cylinder being generally machined out of the solid forgings.

The joints between the various parts of the machine are made with soft copper rings compressed between faced flanges; the joint when made, being absolutely tight, needs no further attention.

The Compressors are provided with a relief valve which essentially consists of a disc of copper which will give way under a pressure of 1900lbs. Above this disc is a spring loaded valve which is opened after the copper disc has been burst. In the event of a careless attendant starting the machine without opening the stop valve on the delivery side the excessive pressure that would be created in the delivery pipe is relieved as soon as it reaches the bursting pressure of the copper disc.

The Compressor is worked on "The wet" system. A small portion of the liquid CO_2 being carried over to the Compressor from the Refrigerator or Evaporator; thereby taking up the heat of Compression and dispensing with a water jacket on the Compressor.

A good deal has been said and written theoretically about the efficiency of Carbonic Acid gas as a Refrigerating Agent; and to the uninitiated it would appear that this gas was not "in it," against Ammonia or other chemical agents. Professor Linde maintains that "Carbonic Anhydride gas is no more efficient than atmospheric gas after 87deg. Fah. has been reached by the cooling water." In opposition to this theory let me say "If the Theory of the theoretical man is a true Theory, and the Practice of the practical man is a correct Practice, then the Theory and the Practice will fit each other line for line and dot for dot." In this case they do no fit, and some one is wrong; but the Author will leave it to some person with a larger knowledge of Chemistry than himself to explain the chemical change which takes place after the cooling water has reached 87deg., being convinced that there is a change, but what it is he is not prepared to explain. The fact is that the Physical properties of Carbonic acid are not yet known, and Professor Linde confesses that the results in one important particular, at least have shown that the basis upon which he made his calculations are erroneous. However, speaking from the result of practical experience, Carbonic Anhydride gas has been found to stand as one of the best agents of Refrigerating. If it will not liquify at temperatures above 87deg. (its critical point), its possible duty as a Refrigerant in warm climates would be very low. But experience with machines of considerable power using water at 95deg. Fah., has shown the loss of efficiency to be very slight. Now, upwards of 70 Carbonic machines are working satisfactorily (some alongside of Ammonia machines) in the Tropics, and although there is a falling-off of efficiency with water at this temperature (as will be found the case whatever gas is used) it is far less than we have been led to expect.

As all engineers are aware, the weakest part in any Refrigerating machine is the Compressor Piston-Rod gland. More particularly when the Compressor is double acting. This is the chief point that has led many makers to adopt the single acting Compressor in order to avoid the risk of leakage at the gland. In the "Carbonic" machine, the double-acting Compressor is used; the packing for the piston rod consisting of two cupped leathers separated by a gun-metal sleeve. An automatic lubricator keeps the recess in the sleeve filled with glycerine, which acts as a seal between the piston-rod, and the leathers. This arrangement provides a good piston-rod packing, as well as lubrication to the rod and piston, as part of the glycerine is carried into the cylinder, and afterwards separated from the gas before being delivered into the Condenser. The glycerine also fills up all clearances which must increase the efficiency of the Compressor. Glycerine having no affinity for CO_2 it undergoes no change in the machine, and there is therefore no fear of the coils becoming clogged by any small amount of glycerine which might be carried over in spite of the separator. With carefully selected leathers one packing will last from 4 to 6 weeks with constant running. The piston is also provided with leathers, the same as the bucket leathers of a pump. In a 10 tons machine, the whole packing can be renewed in from 20 minutes to half-an-hour.

The system used in transmitting the cold to the Chambers in the "Carbonic" machine is usually by Brine circulation, but Direct Expansion or Air Circulation have been used, where it has been preferred. Where Brine circulation is used instead of the pipe coils in the Rooms, Steel walls are substituted through which the Refrigerated Brine is circulated. It is claimed for these walls that the first cost is less than pipes; also, less space is occupied by the walls than with pipes. The reserve of cold in the tanks is much greater than pipes (taking space for space) which adds to a greater Refrigerating effect being produced after the machine has stopped; and also allows a more gradual rise in temperature, whereby the goods stored are turned out brighter and drier than is usually the case with direct Expansion or Air Circulation.

The Brine walls also form a false ceiling and sides to the Chambers, and this induces an air current in the same way as the arrangement in the "Auldjo" system which has been explained in a previous paper.

As Meat, Fish, and Dairy Produce are the principal commodities treated in cold storage, and as the Freezing of goods will in the future be supplanted by chilling only to 34deg. or thereabouts, the question of the most suitable means to transfer the cooling effect of the machine to the goods stored is worthy of discussion.

With Air Circulation (by mechanical means) the extreme low temperature of the air coming in contact with the goods is not desirable in chilling, as it is absolutely necessary that meat especially should be saturated with an even temperature not lower than 32deg. This result is not obtained uniformally with Mechanical Air Circulation. Direct Expansion has the disadvantage of leaks in the room coils causing loss of goods, in the case where Ammonia is used—also the absence of any refrigerating effect after the machine has been stopped.

All those points are provided for in the Brine Circulation. Of course, on the other hand it is claimed that the same efficiency is not obtained with Brine Circulation, but if proper insulation of pipes and brine tanks is provided for, there is small loss. Taking the question of first cost, the difference in cost of piping a room for Brine and Direct Expansion is about 15 per cent.

WATER TOWERS.

In many places, scarcity of water has prevented the adoption of the Refrigerating Machine. This has been overcome by the addition of a water cooling tower, whereby the water from the Condensers of the Machine, and if necessary the injection from the Steam Condenser of the Engine, can be cooled and returned to a tank to be used again. The Author has seen several Water Towers with Louvered sides, and provided with dash plates or baffles over which the water falls in spray, reducing it about 10deg. Fah. in its course from top to bottom. In a tower of this description the cooling effiect is only in ratio to the humidity of the atmosphere. If the percentage of moisture is high, the cooling effect is small.

A type of Water Tower coming greatly into use in America, has been erected under the Author's supervision for the Queensland Railways at Brisbane. This Tower is 40ft. high, is close boarded and lined with iron, forming a large air trunk. In this are fitted two sets of slats or partitions, each set 15 in number, composed of 1 inch hard-wood boards, the bottom set being placed at right angles to the top, and by means of distributing troughs the water is directed in a thin film over these slats. The heat is extracted from the water during its progress by means of a column of air delivered between the slats, by an air propeller which is placed above the tank into which the cooled water falls. The air is thus broken up into small particles by the falling spray which causes it to be evenly distributed between each slat. The result produced is that each portion of the cooling surface is doing equal work.

In this tower it is possible to cool water to 10deg. Fah. below the atmospheric temperature irrespective of the humidity of the air, as the speed of the fans can be regulated to suit the amount of air necessary to produce the result.

The machine was 12 tons capacity—Ice-making—and indicated about 40 H.P. Jet condensing. The water, after passing through the Gas Condenser, supplied the injection for the Jet Condenser, the air pump discharging it to an underground tank from which the water was pumped to the top of the Tower, to be re-cooled.

Although 4,000 gallons per hour was the maximum required by the Machine, the Tower was capable of cooling 8,000 gallons, or handling 4,000 gallons twice, in hot weather before it is used in the machine. It was found in a five weeks' run, the loss by evaporation averaged 5,000 gallons per 24 hours.

The efficiency of the water cooling Tower will have to be calculated with the efficiency of the whole plant (where the tower is used) therefore improvements in its construction will be of as vital importance as the Freezing Machine itself, for there is if anything more scope for the introduction of Mechanical Refrigeration in places where water is scarce, or in using artesian water than where it is abundant, especially in the inland parts of this Colony.