THE PROCESS REFRIGERATION SYSTEM AT BREWERIES

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1. Introduction

Refrigeration to an ordinary man in the street can simply be defined as the elimination of heat. Refrigeration at the Tanzania Breweries, like any other brewery in the world, is very important. During the crucial period of fermentation much heat is produced. It is therefore necessary to remove this heat thus maintaining a good medium in which yeast continues to act bringing about a proper end of the process. The beer also is required to be kept at low temperatures during the secondary fermentation process and in tanks prior to bottling.

There exists two systems of refrigeration:

(i) Primary refrigeration in which ammonia cools air which is then used for refrigeration purposes.

(ii) The secondary refrigeration system in which ammonia is used to cool alcohol which in turn cools air which again is used for refrigeration purposes.

2. Description of the Refrigeration system

It is the secondary system whcih is used here. The choice of the system is logical. Imagine a leakage in the first system; apart from loss in human lives, such a leak would fill the cold rooms and fermentation with ammonia rendering the beer undrinkable.

To understand the system used here one should refer to Fig. 1 which is a simplified schematic diagram. The system comprises of seven units with plans to add the eigth. A unit here is taken to include a compressor, oil separator, condenser, evaporator and other accessories. A unit is referred in the chart. The action begins with the compressor.

2.1 The Compressor is an eight cylinder useblock using a 250 horsepower electric motor. The compressor draws in anhydrous (dry) ammonia through the suction inlet. The ammonia is then compressed. The delivery valve opens and ammonia is passed into the oil separator through a pipe connected to the delivery manifold. When the compressor is working cylinders get hot. The heat is removed by water passing through jackets in the cylinder heads. The hot water is cooled by letting it drip down in spray from a height while two bigs fans blow air onto it.

2.2 The Oil Separator: Compressed ammonia contains oil vapour from the lubricant of the cylinder walls and pistons. The oil separator is used to remove this oil and return it to the crank-case of the compressor. From the oil separator the now hot ammonia is sent to the condenser.

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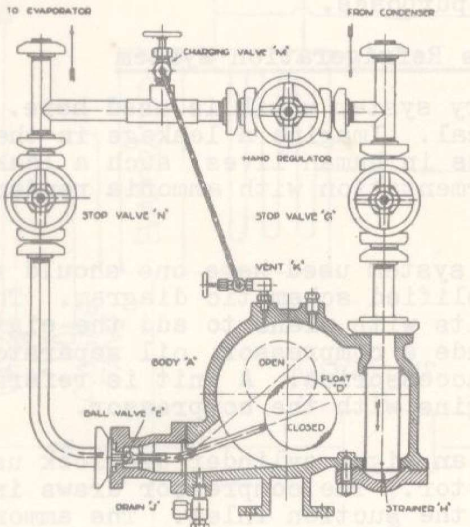
2.3 <u>The Condenser:</u> The condenser is made of a numerous number of steel tubes over which water drips thus cooling the ammonia and turning most of it into liquid. Further cooling is brought about by two fans blowing air upwards through the mass of small tubes. The water drips down into a tray and is pumped upwards by a pump driven by an electric motor. The water level in the tray is maintained constant by a float valve connected to a mains water pipe. From the condenser ammonia goes to the evaporator after passing through the throttling valve here referred to as a high pressure float regulator.

2.4 <u>The Throttling Valve:</u> The throttling valve or high pressure float regulator controls the amount of ammonia which enters the evaporator. This is necessary because if too much ammonia goes into the evaporator some of it may pass into the compressor. This <u>must never</u> be allowed to happen since liquid ammonia frosts the crankcase and could smash pistons, valves and other parts of the compressor. To understand how the regulator functions one has to refer to Fig. 2 below.

H.P. FLOAT REGULATOR



Liquid ammonia passes from the condenser through top valve G and strainer H which removes any solid particle carried over from other parts of the system. As the liquid level in chamber C rises it raises a float D and opens a valve E, allowing liqiid ammonia to pass into the evaporator at a reduced pressure. As the liquid level drops the float drops down thus closing the valve. The procedure thus ensures that only liquid ammonia goes into the evaporator as fast as it is formed. The gaseous ammonia escapes through the constantly open valve K into pipe L and through charging valve M and into the low pressure side of the system. The drain valve J is used to drain away accumulated oil. The regulator can be isolated from the whole plant by opening hand regulator R. A pipe then leads ammonia into the evaporator.

2.5 The Evaporator: The evaporator is a thermally insulated tank containing liquid ammonia. The liquid ammonia surrounds a mass of tubes containing secondary refrigerant - industrial spirit commonly referred to alcohol. As the alcohol passes in these tubes it gives its heat to ammonia which in turn evaporates and is sucked back into the compressor thus completing the ammonia circuit.

2.6 Alcohol Circuit: After cooling, alcohol from the evaporators goes into two storage tanks maintained at -12°C and -7.5°C. The temperature in these tanks is maintained by thermostats Fig. 3, which start and stop the ammonia compressors in sequence according to the alcohol temperature. Pumps circulates alcohol from the storage tank to the evaporators and back from the storage tanks alcohol is used for a variety of jobs:-

2.6.1 **Cooling of Air**

The several rooms in which beer is fermented and stored prior to bottling are required to be at low temperatures. Similarly the yeast room and the hop store are cooled. The temperature of these rooms should never rise above a certain predetermined value. The service corridors to such rooms are served with cold air.

The process of cooling air:

Cold alcohol from the storage tanks is pumped to the cooling units by the service pumps. Each unit consists of a fan driven by an electric motor. The fan blows air over a mass of coiled tubes containing cold alcohol. The air gives its heat to the cold surfaces of the tubes. The now cold air is conducted in big rectangular galvanised iron sheets known as cawls into the various rooms and corridors. For maximum efficiency the same air is returned to the cooling units via another cawl thus forming a closed circuit for air. The rooms which need this air are the cold rooms, fermentation rooms, filter rooms, yeast room and the hop store and of course the service corridors. To ensure that temperature is strictly maintained on some entrances to the cold rooms, a fan is installed which blows cold air immediately after opening the door. This prevents warm air from entering the cold room. Another precaution taken in maintaining room temperature constant is the use of lagged doors.

2.6.2 **Cooling of alcohol for use in the jackets**

There are now two fermenting rooms at the Breweries appropriately labelled here as "new" and "old". It will be remembered that the fermentation involves production of big quantities of heat which must be removed maintaining the beer at 7°C. This is done using alcohol which passes through the jackets of the fermentation vessels. In the "new" system alcohol from the "-7.5°C"storage tank is used and pumped directly into the vessel jackets thus forming a closed circuit. But in the old system the case is very much different. Alcohol from "-7.5°C" is pumped into the heat exchanger near the lower attamperating tank. The alcohol in the lower attemperating is maintained at 7°C - 14°C by means of the above mentioned alcohol in the heat exchanger. From the lower attemperating tank alcohol is pumped into the upper attemperating tank, way up on the roof of the "windlawlers" building. From here alcohol goes into the jackets by means of gravity. The cooling in the "new" system is better and can be controlled at will though more expensive. Cold alcohol is also used for cooling the yeast vessels where yeast is propagated.

2.6.3 Use in heat exchanger

The heat exchanger was mentioned in the above section. The heat exchangers used at the TBL are imported from Sweden. These consists of an assembly rectangular stainless steel plates corrugated on each side. These are assembled on a shaft with a rubber gasket in between two consecutive plates to prevent leakages. Cold alcohol passing on one side of the plate absorbs heat of another liquid on the other side of the plate. Two other heat exchangers apart from that mentioned in (2) are:

(i) The Wort cooling Heat Exchanger

After filtering the wort (beer before it is fermented) is cooled from 100°C to 6.5°C. The cooling is done in two stages in the same heat exchanger. First the wort is cooled from 100°C to 35°C using water in one part of the exchanger and it is then passed into the second part where further cooling is carried on from 35°C to 6.5°C before being sent to the fermentation vessels. The water from heat exchanger is used for brewing,reducing the amount of heat used to boil the water.

(ii) The Transfer Heat Exchanger

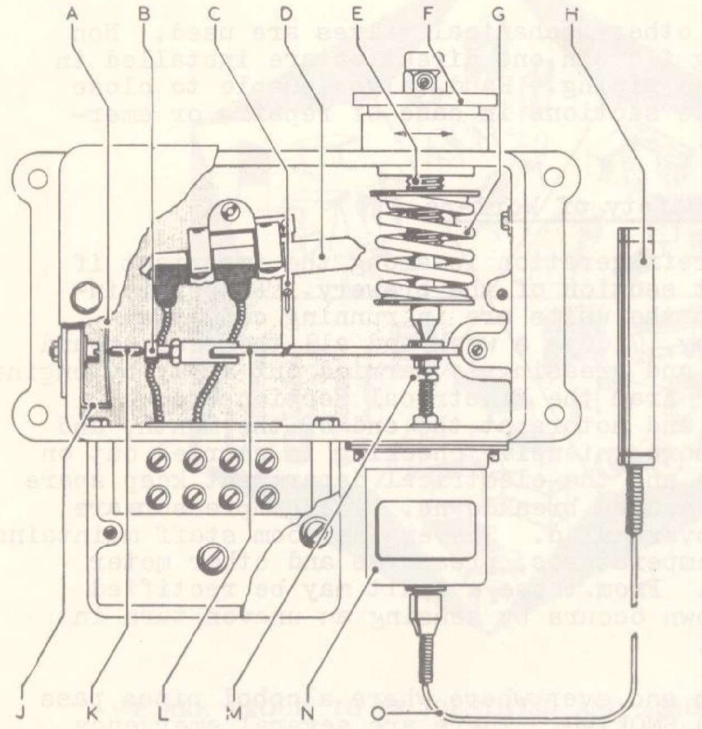
After fermentation the beer is cooled from 7°C to 0°C by this heat exchanger. It is then pumped into storage vessels.

3. Safety, Control and Maintainance

The whole refrigeration plant is under automatic control. Each unit has its own control panel. As an indication of the automation. If by any means the compressor starts or stops the following will follow suit: (1) condenser fans, (2) condenser pumps, (3) evaporator pump, (4) and accompanying alcohol service pumps. Each control panel for a unit has an isolator switch which cuts power to all components. The switches are clearly marked for such positions as "OFF","ON", "HAND" or "AUTOMATIC. Automatic switches responding to various changing conditions such as temperature and pressure and are used to start and stop the units whenever necessary. Here follows a description of some of the safety controls.

3.1 The Thermostatic Switch

The thermostatic switch is kept anywhere where temperature surveillance is to be kept. Such places are the alcohol tanks, certain alcohol pipe section, cold air cauls, cold rooms and are also used to maintain proper temperature in the cylinder head of compressors. Fig. 3 is referred to in explaining action of the switch.



A—Leaf Spring.
B—Adjusting Screw.
C—Connecting Link.
D—Mercury Tube.
E—Adjusting Spindle.
F—Adjusting Head.
G—Spring.
H—Thermostat Bulb (when fitted).
J—Leaf Spring Holder.
K—Pintle.
L—Lever.
M—Spindle Nose.
N—Thermal Bellows (inside housing).
O—Capillary Tube.

As temperature rises, the gas in the thermostat bulb expands raising bellows N thus overcoming spring G and lifts lever L tilting the mercury in tube D. As the lifting continues finally mercury will fill the space across the two contacts thus starting the compressor and accessories. For falling temperatures the gas contracts hence spring now pushes down on the lever tilting mercury to one side and breaking contact thus switching off the unit. The leaf spring A amplifies the small movements of lever L hence quickening the tilting of mercury in the tube.

3.2 Low Pressures & High Pressure Cut-outs

The low pressure cut-out is installed on the suction side of the compressor. It cuts out power to the compressor when suction pressure is very low. The high pressure cut-out is installed on the delivery side of the compressor to cut-out power when pressure of compressed ammonia rises above a certain fixed value.

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3.3 Selenoid Valves

They operate mainly in conjunction with thermostats. At times the falling of temperature in a certain single room does not warrant the switching of the whole unit. T e thermostat in that room electrically activates the selenoid valve which in turn cuts off alcohol to a corresponding cooling unit thus stopping further cooling of that particular room only.

3.4 Other Devices

Hand operated and other mechanical valves are used. Non return valves allowing flow in one direction are installed in various sections of the piping. Hand valves enable to close off completely any pipe sections in case of repairs or emergency.

4. Maintainance and Safety of Workers

As mentioned the refrigeration is among the important if not the most important section of the brewery. Proper maintenance to ensure that the units are in running condition twenty-four hours a day, 7 days a week and all the year around is necessary. Oiling and greasing is carried out daily by engine room hands. A "fundi" from the Electrical Section checks alcohol service pumps and motors at the end of the month, and every three months a more intensive checking is carried out on the motors. The store and the electrical department keep spare motors to fill in for sudden breakdowns. The compressors are checked annually and overhauled. The engine room staff maintains a log-book in which temperatures, pressures and other meter readings are recorded. From these a fault may be rectified before a major breakdown occurs by sensing an uneven turn in the recorded readings.

In the engine room and everywhere where alcohol pipes pass are hung NOTICES OF NO SMOKING. There are several emergency fire fighting equipment such a buckets of sand and fire extinguishers; most of the engine room staff know how to operate these. The company issues clothing and footwear to permanently employed workers to ensure individual safety. Those working in the cold rooms are given thick pullovers to contain the cold. These people also get what is known as cold allowance for working in such extreme conditions. It should also be stressed that all workers are insured against accidents.

5. Conclusion

Refrigeration is a very interesting and an important subject in tropical countries especially in Tanzania where new operations such as those of "CHAKULA BARAFU" and several SUPERMARKETS selling frozen foods are slowly gaining importance and attention. One cannot fail to see how much Tanzania stands to gain by proper use of this important technology nor can one fail to see the bright future of a Tanzanian refrigeration engineer who must keep the equipment in operation.

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