

Planning and Operating a Cream Production Unit: Pasteurization and Cooling of Cream

1. Cream is more viscous and susceptible to mechanical break down. Eg., positive pumps would be preferred to centrifugal pumps.
2. Higher temperature about 80°C is used for pasteurizing cream. >80°C may impair cream quality, possibly through activation of bacterial spores.



Pasteurization of cream: Heating every particle of cream to not less than 70°C for 20 min or 80°C for 25 s.

Objectives of Cream Pasteurization

Destroy the pathogenic organisms

Destroy the undesirable microbes and inactivate the enzymes

Complete the neutralization process in manufacture of butter

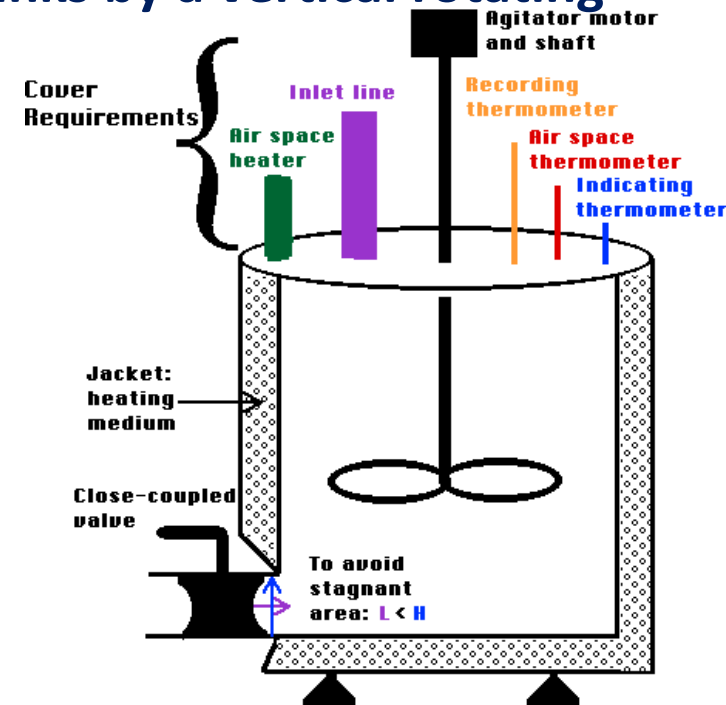
Eliminate some of the gaseous tainting substances

Make possible the removal of some volatile off flavors by vacreation

Methods of Pasteurization

Batch method pasteurization

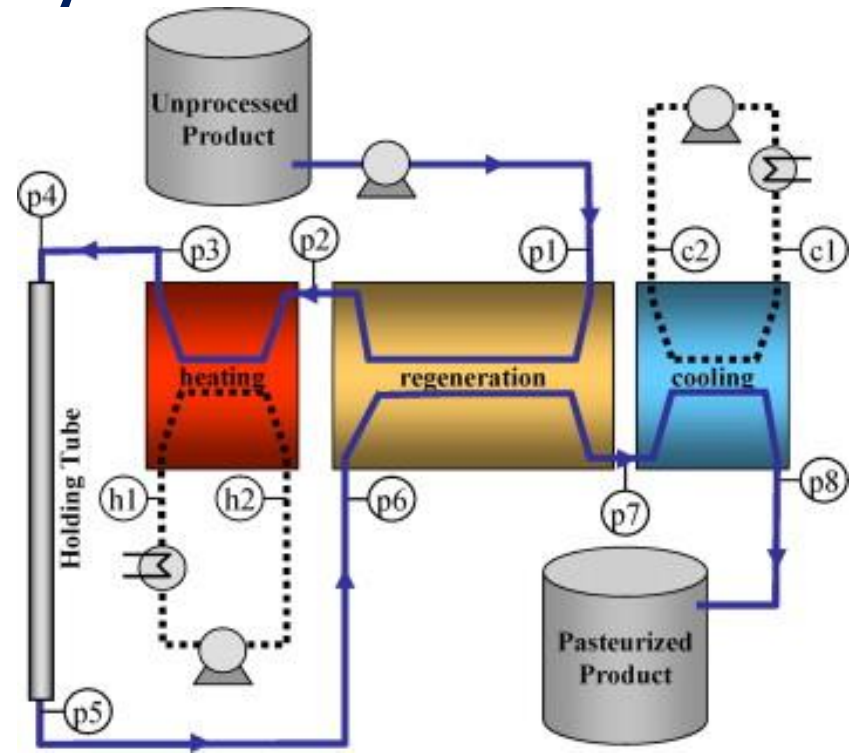
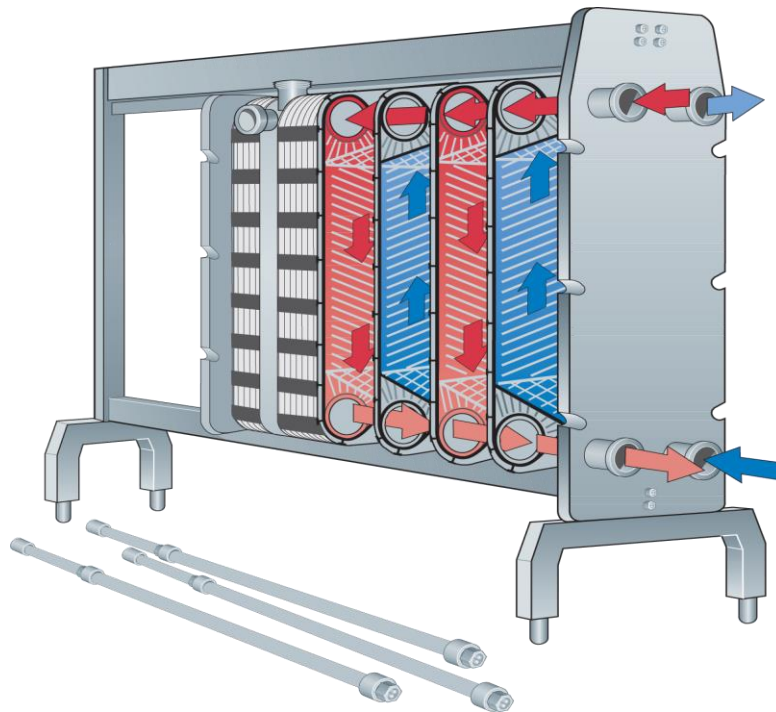
1. Satisfactory, economical for small scale operations.
2. Cream is heated to 70°C for 20 mins and then cooled.
3. Vat pasteurizers commercialized: **Jacketed vats with mechanical agitators and vats without jacket equipped with revolving or oscillating coil.**
4. In jacketed vat, the jacket contains the heating and cooling element. The hot water, cold water, or brine respectively, is sprayed against the jacket side of the heating surface. The cream is agitated by a series of blades moving to and fro length wise or in round tanks by a vertical rotating wing agitator, or by one or more impellers.



High Temperature Short Time pasteurization

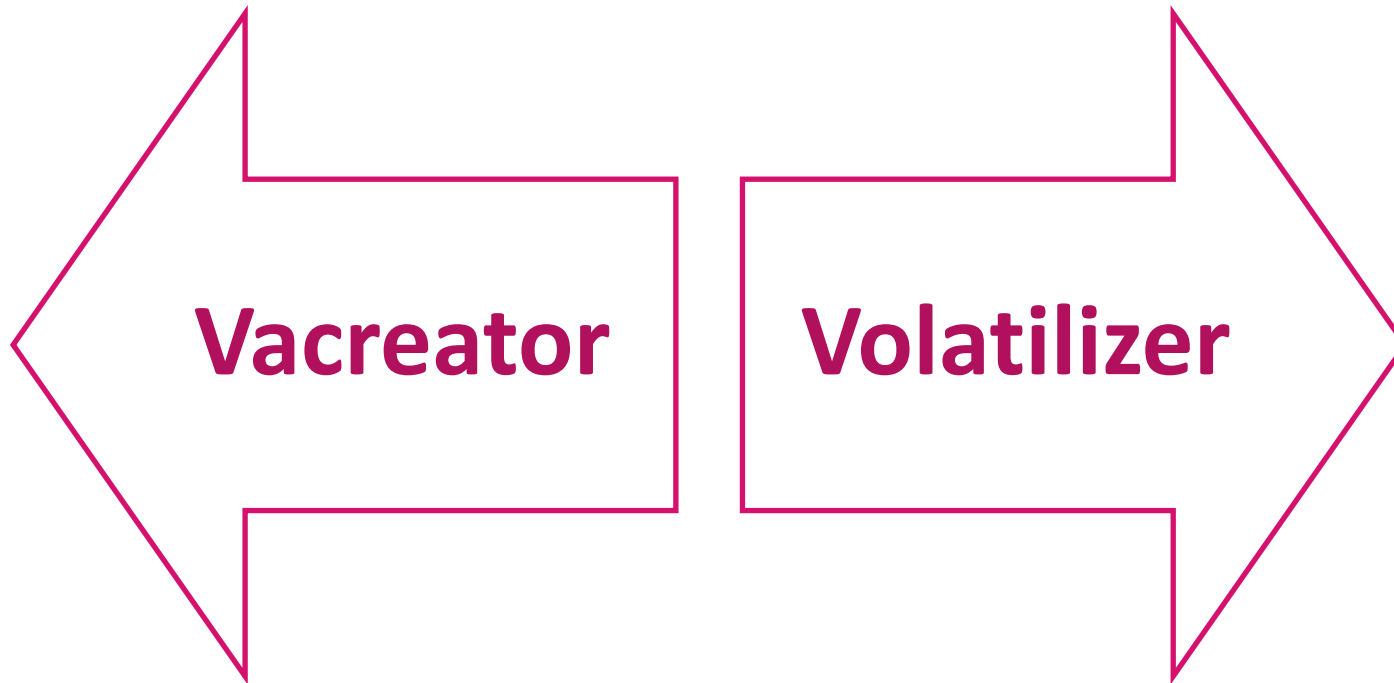
- 1. HTST: Plate heat exchangers (PHE)**
- 2. PHE is made up of a series of thin metal plates that are held tightly together in a press. The plates are grooved either on one side or on both sides. The grooves serve as canals through which the cream flows.**
- 3. This pasteurizer is built for high temperature flash heating or holding pasteurization, with regenerative and cooling units.**
- 4. The heating medium and the cold water and brine travel in counter current to the flow of cream. The depth of the grooves in the plates determines the thickness of the layer of cream between the plates. The grooves are shallow and even deep. They therefore, ensure a uniformly thin layer of cream.**

5. Thinness of metal plates and high velocity of the heating medium ensures rapid and uniform heat exchange with use of hot water at a temperature few degrees higher than desired pasteurizing temperature of cream.
6. Eliminates tendency of scorching and cooked flavor.
7. Continuous and suitable for large scale operation.
8. Acidic/neutralized cream forms burnt-on-films easily on the plate while suitable for freshly separated sweet cream.
9. Maximum heating temperature may be **95-100 °C for 15 secs.**



Vacuum pasteurization

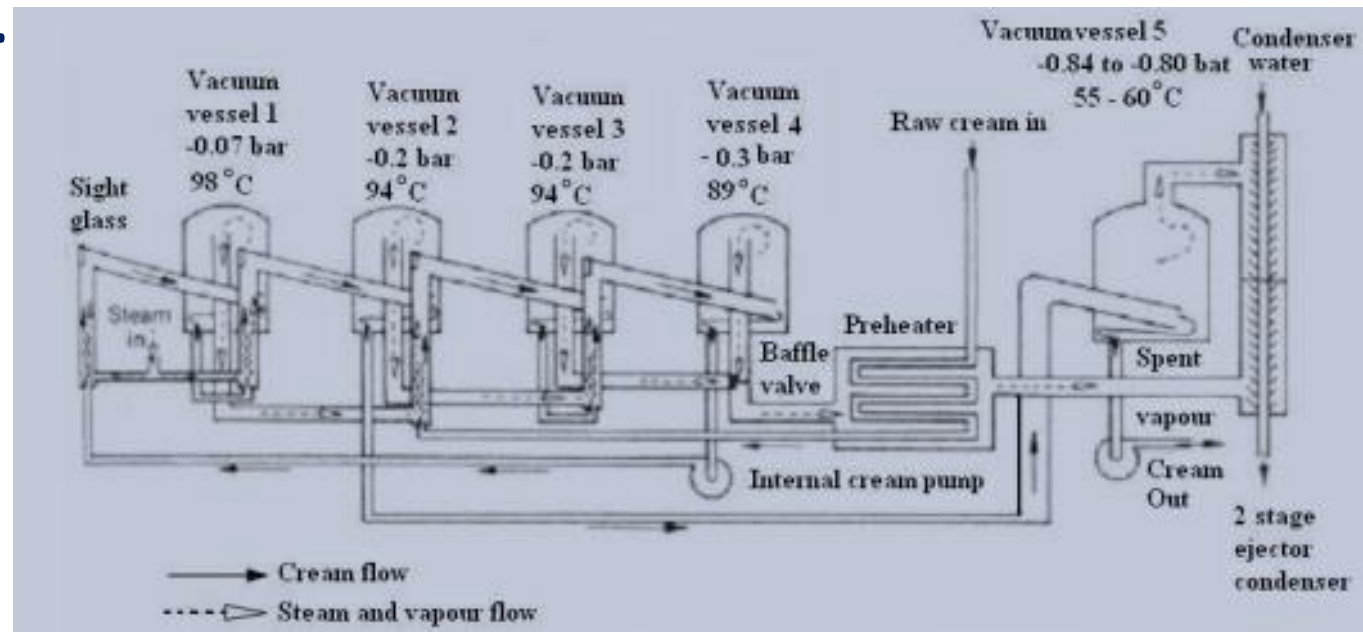
Recent technology of cream pasteurization using principle of reduced atmospheric pressure



Vacreator

1. Vaccination process was devised in New Zealand both to pasteurise the cream and to remove the volatiles (flavour taints through herbage derived substances dissolved in the fat) through steam distillation process. The piece of equipment is known as Vacreator.
2. This process improves the flavour of creamery butter, extends the shelf-life significantly when compared with butter derived from plate-pasteurised cream.
3. In the Vacreator, steam is intimately mixed with cream and the condensed vapour plus volatiles are removed by flash evaporation under vacuum.

5 vessels



- 4. Raw cream is preheated in a tubular heat exchanger by vapours exiting from vacuum vessels 3 and 4. The cream is mixed with steam and vapours. It exits from vessel 1 and passes into vessel 3, where the pressure is reduced slightly and the cream and vapours are separated. The cream is then mixed with steam and vapour, exits from vessel 2 and the mix is passed into vessel 4 for separation. The vapours from vessels 3 and 4 are combined and passed through the preheater, before passing to a water jet condenser which provides vacuum and condenses the remaining condensable vapours.**
- 5. A spring-loaded baffle valve applies a back pressure to vapours from vessel 3, so that the pressure difference required to transfer cream between vessels is maintained.**

- 6. The cream from vacuum vessel 4 passes into an internal cream pump and is pumped to vessel 1, where it meets fresh incoming steam. The cream separated in vessel 1 is mixed with fresh steam again before passing into vessel 2. The cream exiting from vessel 2 passes into vessel 5 which acts as a flash cooler, with the vacuum removing water vapour and the associated latent heat. The cream exits at approximately 55-60 °C, and the vapours are removed in the condenser.**
- 7. Liquid and vapours are separated via a cyclonic centrifugal action with the cream being fed tangentially into each vacuum vessel at a slight downwards angle. The vapours are removed through a centrally mounted pipe. If foaming is severe, liquid gets carried over with the vapour stream resulting in product loss.**
- 8. Vacuum levels, temperatures, flows of cream and steam require very careful control to ensure that excessive product loss through foaming or flooding does not occur. The modern Vacreator is now equipped with microprocessor control to assist in achieving optimum temperature conditions during operation.**

9. The amount of taint removed is proportional to the quantity of steam used. In spring or wet weather, there is increased levels of taints, and consequently high steam flows during vacreation are required, typically **0.25-0.3 kg steam/kg cream**. During drier parts of the season, less green feeds are consumed so that less steam is required, typically **0.18 kg steam/kg cream** to remove the lower levels of taint.
10. Major disadvantage of vacreation is its energy usage through the relatively large quantities of steam required, as the design of the Vacreator is such that vessel flooding will prevent operation at steam flows less than 0.15 kg steam/kg cream.
11. Steam quality is of utmost importance in Vacreator treatment.
12. Steam is injected into cream at a velocity of approx. 140 ms^{-1} (500 km h^{-1}) leading to disruption of fat globules with an increase in the proportion of fat present as small globules ($<2 \mu\text{m}$). Vacreation also increase the number of large fat globules ($>10 \mu\text{m}$) due to agglomeration resulting from foaming. Increase in number of small fat globules can lead to higher losses of fat in buttermilk.

Volatilizer:

- 1. Consists of a steam injection flash pasteurizer and high vacuum retort (vacuum pan).**
- 2. Steam enters the pasteurizer (Stainless steel) at the top through direct steam jets. Cream is uniformly heated here to 85°C by direct steam. This heated cream is discharged from the pasteurizer through float controlled valve to a high vacuum chamber (which is made of glass-coated steel) at the top by vacuum discharge tubes. Its release into high vacuum pan causes it to form a fine mist which impinges against the sides of the pan and flows down over the glass coated surface in a thin film.**
- 3. Escaping water vapours and volatilized products are voided through the condenser, and high vacuum (27-20 inches) lowers the temperature of the cream to about 38°C. The treated cream discharges from the vacuum pan at the bottom.**

Objectives of Cooling of Cream

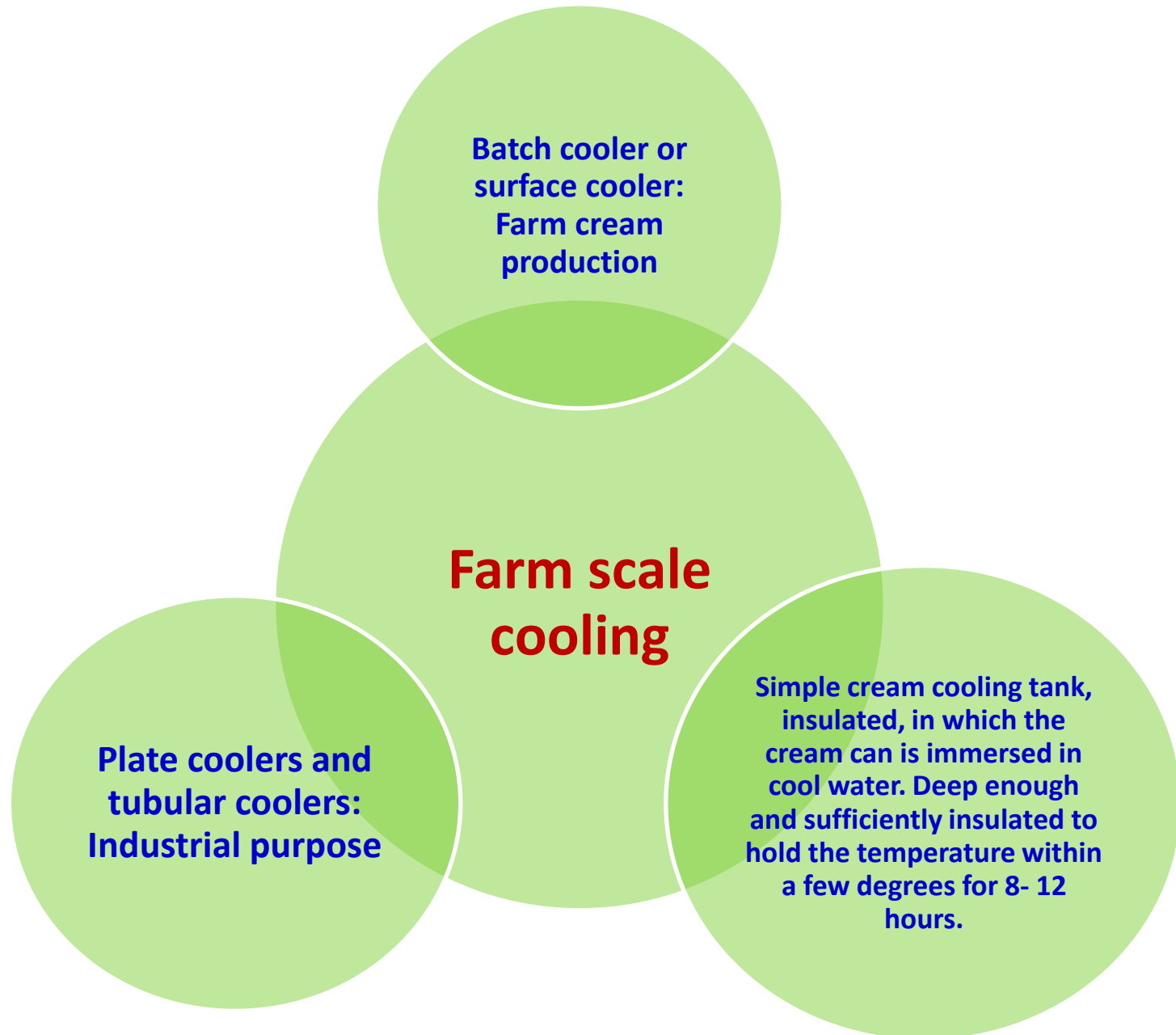
1.

- **Minimize the growth of microorganisms**

2.

- **Bring about the desired fat crystallization required in butter making**

Methods of Cooling Pasteurized Cream



Regenerative Heater Coolers:

- 1. As part of HTST pasteurization process, regenerative cooling of cream is followed by final cooling by means of chilled water.**
- 2. Regenerative heater coolers is based on reciprocating heat exchanges between the hot outgoing and the cold incoming cream.**
- 3. When using a combination of intra-tube heater and surface cooler, hot cream flows up through the inside of the pipe unit and the cold cream flows down over the outside of the pipe unit. The incoming cold cream is thus heated by the hot cream coming from the pasteurizer, and out flowing hot cream is cooled by the cold, raw cream flowing to the pasteurizer.**
- 4. Under average conditions, the temperature of the cold cream is thus raised by about 12-15 C by hot cream and temperature of hot cream is lowered approximately 12-15 C by the cold cream, thus accomplishing a considerable saving of heat energy.**

Surface Cooler:

- 1. Highly suitable for the cooling of flash-pasteurized cream.**
- 2. Surface cooler comprises two corrugated/undulated SS plates providing horizontal passages for cooling water or liquid refrigerant between the plates. The cream allowed to flow from top reservoir over the outside of the plates gets cooled. The surface cooler is usually confined to two sections, each arranged with independent in-take and out-flow for the refrigerant. The upper section is cooled with water and lower section with brine/ direct expansion ammonia.**
- 3. Advantage: Aeration of the cream.**
- 4. Drawback: Surface cooler breaks the closed system of cream flow.**

Internal Tube Cooler:

- 1. It consists of the two-tube principles, one inside of the other.**
- 2. The cream flows through the inner tube, while the refrigerant flows in counter current between the inner and outer tubes.**
- 3. The usual unit consists of one or two sections for water and one section for brine or direct expansion ammonia.**
- 4. Advantage: Preserving the unbroken, closed system of cream flow, discharging the cream into the vats and up to any reasonable elevation without the need of a pump at the discharge end of the cooler.**
- 5. The internal tube cooler does not subject the cream to aeration. If aeration is desired it should be provided before the cream reaches this cooler.**