Vacreator

Pasture feeding of animals can produce flavour taints through herbage derived substances dissolved in the fat. As most of the tainting substances are relatively volatile, a process was devised in New Zealand both to pasteurise the cream and to remove the volatiles through what is essentially a steam distillation process. The piece of equipment is known as a Vacreator, which was the trade name adopted for the Murray Vacuum Pasteuriser (present manufacturers and agents NDA Engineering Group, Auckland, New Zealand). The process is known as vacreation. Vacreation has been used in a number of countries, and not only it improves the flavour of creamery butter, but also extends the shelf-life significantly when compared with butter derived from plate-pasteurised cream. In the Vacreator, steam is intimately mixed with cream and the condensed vapour plus volatiles are removed by flash evaporation under vacuum.

The typical pressure and temperature conditions pertaining to each vessel are shown on the diagram. 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. 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.

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 purely 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. The somewhat complicated system is called 'weaving flow', and is essentially counter-current with the cleanest cream meeting the cleanest steam.

The somewhat complex nature of flows has been found to be necessary because of the tendency of cream to foam under vacuum, so that the separation of the liquid and vapours becomes difficult. The liquid and 'vapours are separated via a cyclonic centrifugal action with the cream being fed tangentially into each vacuum vessel at a slight down-wards 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. The flow of steam

assists in providing the cream with sufficient kinetic energy to flow through the system, but loss of energy occurs in the separation process which necessitates the use of the internal cream pump to push the cream to the final two stages. The flow from vessel to vessel is also controlled through the pressure differential between the vessels, but the high operating temperatures (and thus low vacuums) mean that transfer of cream by pressure differences is limited to two vessels in series. The vacuum levels, temperatures and flows of cream and steam thus 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.

The amount of taint removed is proportional to the quantity of steam used. In the spring or during prolonged periods of wet weather, feed growth and the proportion of green feed in the diet results in 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. Taints resulting from poor quality cream may also be removed by vacreation, but high steam flows are required.

The 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. Some heat is recovered through the preheater. Also available are thermorecompressors, which will generate low pressure steam from waste heat recovered from the vapours. The low pressure steam can be fed to the raw steam entering the Vacreator, but the cost of thermorecompressors warrants their use only with large, high-throughput units. The high energy usage of the Vacreator has led to some companies investigating flash-pasteurisation which incorporates a limited vacuum treatment. Such a process is acceptable for treating cream with a low taint level, but is generally unsuitable for cream with a high taint level if the cream is to be used for producing butter. Further experimental work in New Zealand has indicated that steam: cream ratios can be reduced if the proportion of steam entering vessels 1 and 2 is more carefully controlled. Control is by a valve that limits the quantity of steam passing to vessel 2, which is at lower pressure. With such control, the differential pressure between the two vessels can be maintained, and flooding of vessel 1 is eliminated even at steam flows as low as 0.09 kg steam/ kg cream

Steam quality is of utmost importance in Vacreator treatment. It must be of culinary standard and filtered because of the intimate contact

with the cream. This limits the use of certain chemicals for the treatment of boiler feed water.

Steam is injected into cream during vacreation at a velocity of approximately 140 m s-1(500 km h-1), and this violent treatment causes disruption of fat globules with an increase in the proportion of fat present as small globules (<2 μm). Vacreation will also increase the number of large fat globules (> 10 μm) due to agglomeration resulting from foaming or flash-boiling. The increase in the number of small fat globules can lead to higher losses of fat in buttermilk. The introduction of low velocity steam diffusers alleviates this, and is possible when the steam split into vessels 1 and 2 is carefully controlled.

Certain models of Vacreator have the water ejector condenser replaced by a plate heat exchanger surface condenser and liquid-ring mechanical vacuum pump. Cream throughput of these models has been increased from maximum of 10,000 kg h-1 to 18,000 kg h-1. The four primary vacuum vessels lie in a line with the pre-heater lying horizontally just underneath and to the rear of these. The flash vacuum vessel and condenser are situated behind the pre-heater