New technologies in dairy industry

INTRODUCTION

Preservation of dairy products is a method of maintaining dairy product at a desired level of properties for their maximum benefits to the consumers. In general, each step of handling, processing, storage, and distribution affects the characteristics and quality of dairy product.

A number of new preservation techniques are being developed to satisfy current demands of economic preservation as well as consumer satisfaction in nutritional and sensory aspects, convenience, absence of preservatives and environmental safety.

New and alternative dairy processing methods and novel combinations of existing methods are continually being sought by industry for producing better quality dairy products more economically.

Over the years, many traditional technologies have been optimized for quality dairy products with the use of membrane processing, microwave and high-pressure processing and electrical pulse processing.

NEW TECHNOLOGIES IN DAIRY INDUSTRY MEMBRANE PROCESSING

The main membrane systems used in dairy technology reverse osmosis, nano filtration, ultrafiltration and microfiltration. The membrane filtration is divided: microfiltration, ultrafiltration, nanofiltration, and RO.

Principles of Membrane Separation Membrane processes include a wide range of unit operations from sieving to reverse osmosis (RO). Membrane processes have been investigated in dairy food industry for concentration of fluid milk and whey

Filtration of coarse particles, i.e., in the micron range, is carried out by conventional dead-end filtration where particles are retained by the filter that later form a cake layer resulting in increased resistance to filtration.

This requires frequent cleaning and replacement of filters. The most common membrane configuration used in the industrial setup is cross flow membrane filtration.

It is continuous type and used to separate particles, which are about 10 µm to solute molecules that are a few Angstroms. In cross flow membrane separation, the bulk phase is forced to flow along the membrane surface using external pressure.

The size of particles retained in these processes ranges from 0.1 to 10 µm (microfiltration), 1000–500,000 molecular weight cut-off (ultrafiltration). Flow of the liquid through the membrane is driven by hydraulic pressure gradient, while flow of the solute through the membrane is diffusion driven and by concentration gradient.

Ultrafiltration

Ultrafiltration is a sieving process that employs a membrane with definite pores that are large enough to permit the passage of water and small molecules. Ultrafiltration is a medium pressure-driven membrane filtration process. Ultrafiltration is based on a membrane with a medium open structure allowing most dissolved components and some non-dissolved components to pass, while larger components are rejected by the membrane. Ultrafiltration membranes allows separation of smaller molecular weight substances ranging from 10,000 – 75,000 daltons with operating pressure ranging between 10 – 200 psig. When pressure is applied to a fluid, the semipermeable membrane allows small species to pass through as permeate and larger species are retained and concentrated as retentate. Ultrafiltration has a wide range of applications in the dairy industry.

In the dairy industry, ultrafiltration is used for a wide range of applications such as protein standardization of cheese milk, powders, fresh cheese production, protein concentration and decalcification of permeates as well as lactose reduction of milk.

In ultrafiltration of milk, non protein nitrogen and soluble components such as lactose, salts, and some vitamins pass through the membrane, whereas milk fat, protein, and insoluble salts are retained by the membrane

Ultrafiltration produces from milk a permeate containing water, lactose, soluble minerals, non-protein nitrogen and water-soluble content increase in proportion to the amount of permeate removed.

The ultrafiltration process has been used for milk protein standardization, deproteinization of whey, preparation of biological peptides, fractionation of proteins, manufacture of rasogolla mix powder, low lactose powder, preparation of protein rich milk, manufacture of milk protein concentrates, manufacture of whey protein concentrates, etc.

*****Ultrafiltration followed by a traditional cheese production process can be used for pre-concentration of cheese milk.

*Ultrafiltration is commonly used in the production of Milk Protein Concentrate (MPC) where it can lead to an increase of the protein content in the total solids

*Whey Protein Concentrate (WPC) is obtained using ultrafiltration.

*Ultrafiltration is widely used in the production of white cheese where the whole milk is concentrated to 34-40% total solids.

*Ultrafiltration process has also been used for the manufacture of several fermented dairy products like yoghurt, shrikhand and various types of soft and semi soft varieties of cheeses.

*In the production of lactose-free milk, ultrafiltration plays an important role in attaining a sensory experience similar to that of fresh milk.

*Ultrafiltration can be used to standardize and increase the protein content of milk without the use or in absence of additives such as milk powder.

*Ultrafiltration can be used for the decalcification of RO or preferably NF pre-concentrated permeates for lactose production.

Reverse Osmosis.

Reverse Osmosis is a high pressure-driven membrane filtration process which is based on a very dense membrane The word osmosis is derived from the Greek osmosis meaning push. The reverse osmosis membrane is permeable to solvents but not to the larger molecules in solution.

The reverse osmosis membranes are characterized by a molecular weight cut off of nearly 100 daltons and pressure involved are 5 – 10 times greater than those used in ultrafiltration.

In principle, only water passes through the membrane layer. In the dairy industry, reverse osmosis is normally used for concentration or volume reduction of milk and whey, milk solids recovery and water reclamation.

The osmotic pressure of the solution is directly proportional to the concentration of solute and temperature, and inversely proportional to the molecular weight of the solute. Because the osmotic pressure is inversely proportional to the molecular weight of the solute, small molecular components make a greater contribution to osmotic pressure than large ones. Hence, in milk the osmotic pressure results from salts and lactose rather than proteins.

The potential applications of reverse osmosis technology are: bulk transportation of reverse osmosis concentrated milks, pre-concentration of milk for khoa making and spray drying, utilization of pasteurized reverse osmosis concentrate in place of market milk, partial concentration of whey, partial concentrate of milk and buttermilk.

*Reverse osmosis is a very efficient way of removing water from the milk or whey prior to the evaporation stage

*Reverse osmosis can be applied as a supplement to evaporation. If a new evaporation line is required or an existing line is to be extended, huge savings can be obtained by joining the two technologies.

*Reverse osmosis can be used to concentrate skim milk or whole milk in order to increase the total solids content.

*Reverse osmosis can be applied to reduce the volume of milk or whey - e.g. for saving transportation costs**.**

Microfiltration

Microfiltration is essentially used as a clarifying process to remove macro materials and suspended solids, milk fat globules, bacteria and colloidal particles. In microfiltration, membranes with pore size ranging from 0.1 – 10 micron and the operating pressure in the range of 1 – 25 psig are used. The most significant application of microfiltration is for selective separation of bacteria from milk.

*****Milk Microfiltration is today widely used in the production of high quality market milk and ESL milk.

*****Improvement of cheese milk can be achieved using microfiltration. The natural content of anaerobic spores in milk - such as clostridia - which can survive normal pasteurization and cause undesired gas formation in the cheese, can be reduced by means of microfiltration.

*****Microfiltration can improve the quality of milk and whey powder considerably through a reduction of bacteria and spores. As a consequence, heat treatment can be kept at an absolute minimum which - among other things - contributes to a preservation of the functional properties of the whey proteins in the powder.

*****The chemical and microbiological quality of the cheese brine used for salting cheese products is critical for the final quality of the cheese. As brine may contain undesired microorganisms, cheese brine has traditionally been subjected to different types of treatment such as heat treatment, kieselguhr filtration, UV treatment or even addition of preservatives.

*****Microfiltration can fractionate milk proteins into casein and whey proteins. The fractionated casein can be used in the production of high-quality casein and caseinate or in the production of special casein-rich milk products.

*****The milk fat is concentrated to a very high level, and in order to achieve the final protein concentration, removal of the milk fat is required. Microfiltration is the obvious solution for performing this fat removal.