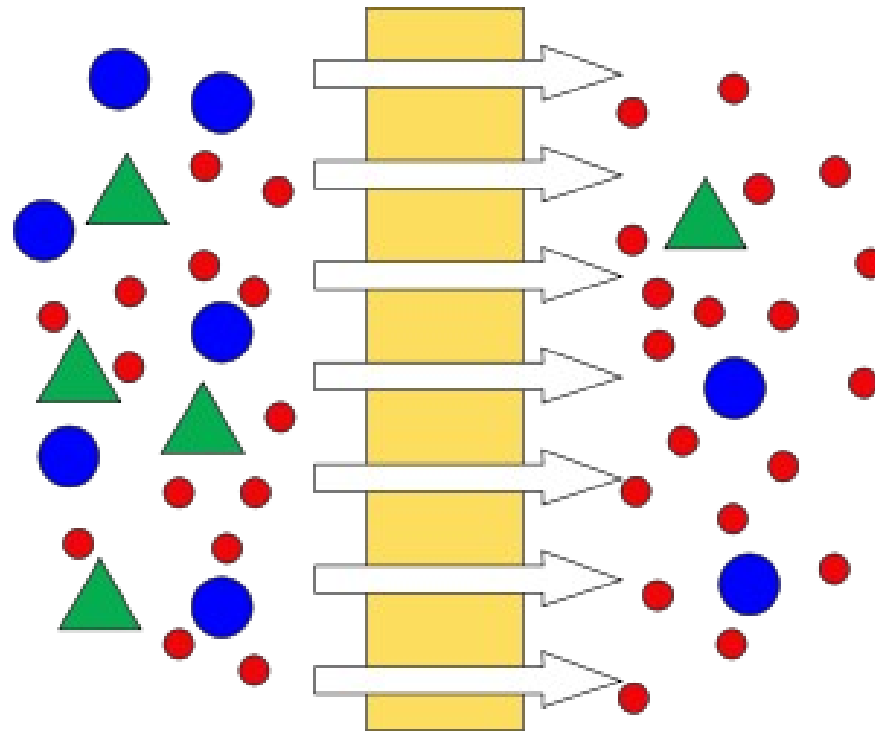


Microbiological Aspects of Microfiltration

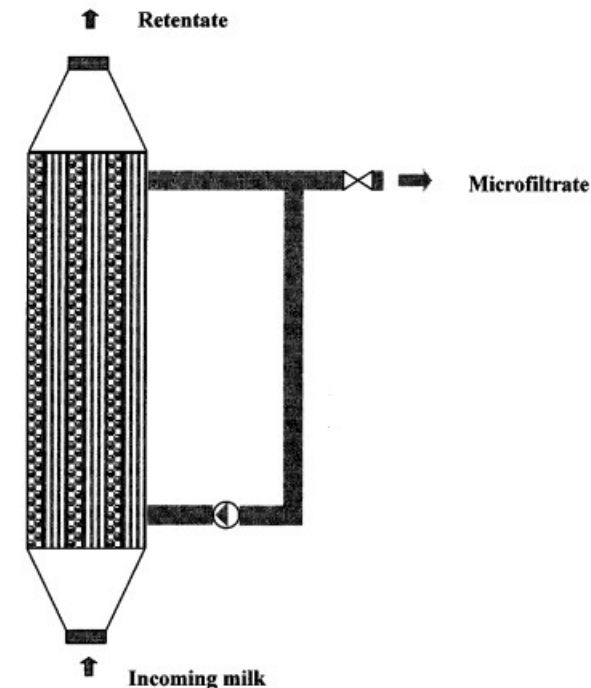


- **Microfiltration is a form of membrane processing that can be used to improve dairy product quality and extend shelf-life with retained nutritional parameters.**
- **This technique allows the differential concentration in the liquid retained by the membrane, named MF retentate, of the components with a size bigger than the average pore diameter of the membrane. The liquid going through the MF membrane is named microfiltrate.**
- **It provides a low-temperature processing alternative to thermal methods (e.g. ultrapasteurization) for reducing the number of bacteria in fluid milk or in whey.**
- **Microfiltration membranes typical range from 0.2-5 μm in pore size and have relatively low operating pressures (0.05–0.2 MPa). It separate biologically derived materials such as colloidal particles, casein micelles, serum protein aggregates and milk fat globules, somatic cells and bacterial cells. Bacteria which generally range from 1-3 μm in size, are retained by the microfilter.**

- **It can produce products with flavor characteristics superior to those resulting from high-temperature processing, owing to the absence of cooked flavors and other off flavors.**
- **Fat globules are also concentrated by microfiltration; hence, the process is more suitable for non-fat milk products than for higher-fat products.**
- **The type of microfiltration unit employed, its design and its configuration influence the effectiveness of microbial retention.**

Mechanism of action:

- Membrane filtration employs a specific semi-permeable membrane which allows the passage of selective compounds, known as “permeates”, through it to fractionate a liquid into various constituents.
- The effectiveness of membranes is dependent on the concentration gradient of the liquids and thus formed resultant transmembrane potential across the membrane.



- **New ceramic membranes comprising a multichannel geometry and a highly permeable support which made industrially feasible the revolutionary hydraulic concept proposed by Sandblom: the uniform and low transmembrane pressure (UTP). The UTP concept overcomes most of the heterogeneous fouling of the MF membrane which results from the high cross flow velocities required for obtaining both high permeation fluxes and accurate selectivity. He suggested recirculating the MF permeate, in such flow conditions that the transmembrane pressure is low and uniform all along the membrane.**
- **Cross flow microfiltration (CFMF) has emerged as an industrial separation technology in the dairy industry.**

Applications:

- **Bacterial counts and spore counts in microfiltered milk can be reduced by as much as 99.99% and 99.95%, respectively. Because spores of psychrotrophic strains of *Bacillus* spp. can survive pasteurization, elimination of these spores by microfiltration can reduce spoilage in milk products.**
- **The removal of milk fat by microfiltration poses a disadvantage in the processing of milk for cheese manufacture. However, skim milk produced by microfiltration may be mixed with cream to achieve the desired butterfat content for cheese making.**
- **With the developing technology, the process preserves the sensory and chemical properties of food.**

- Applications of microfiltration used in the dairy industry include the processing of extended shelf-life fluid milk products and the production of milk for cheese manufacture. It eliminates the spores of other spoilage organisms (*Bacillus* spp.) which can deteriorate cheese quality.
- Microfiltration of milk intended for cheese manufacture may prevent the late gas blowing defect by elimination of *Clostridium tyrobutyricum* spores from the cheese milk.
- The utility of microfiltration has been well demonstrated for the separation of fat in whey protein concentrates.
- MF can be profitably incorporated in the upstream and downstream processing of the fermentation broth either in discontinuous operations for separating the biomass from the produced metabolites.

Advantages and disadvantages

- **Simple**
- **Cost effective method**

- **Fouling of membranes which requires timely membrane cleaning. (Membrane fouling is the accumulation of substances on the membrane surface and/or within the membrane pores, which results in deterioration of membrane performance).**

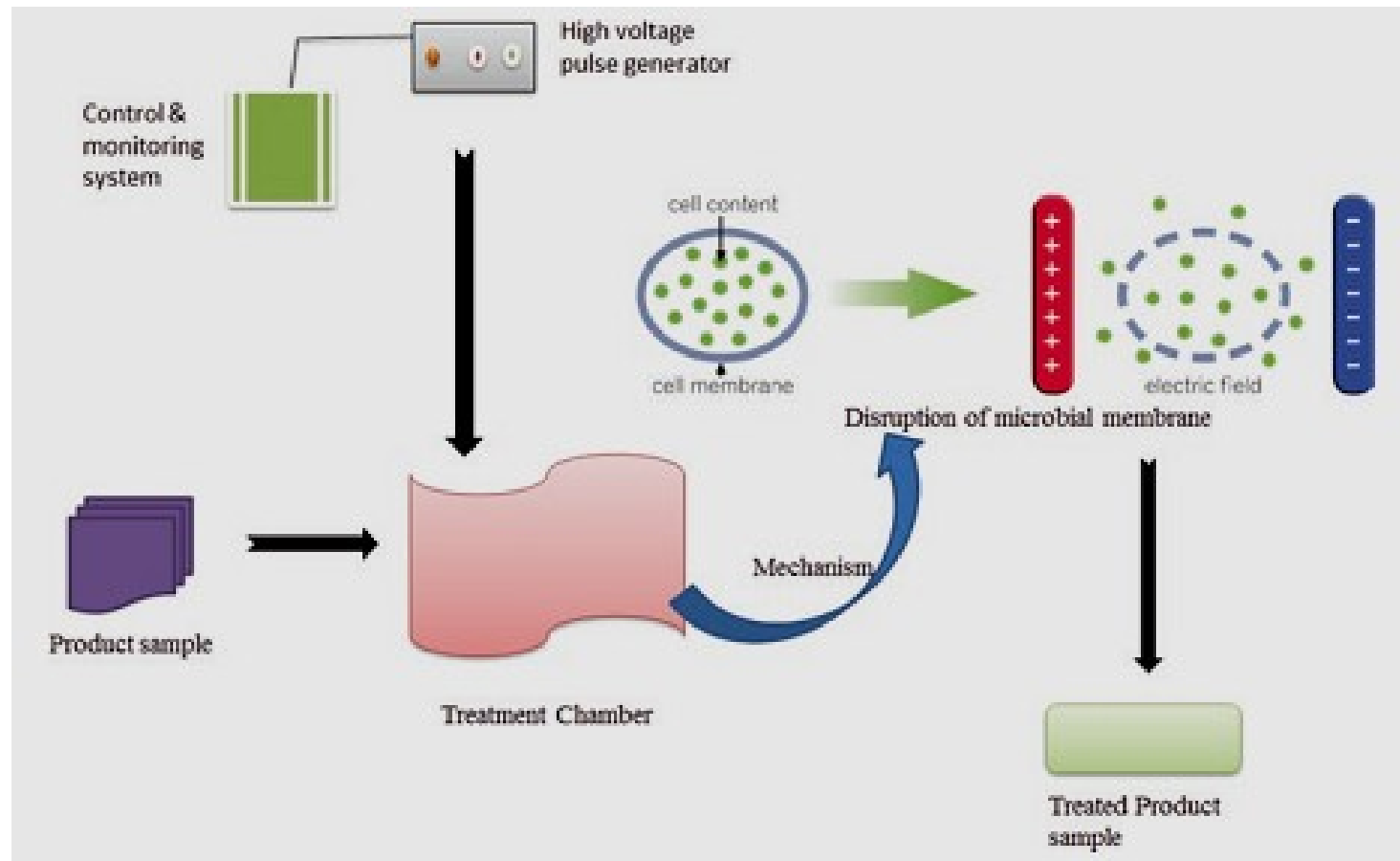
Microbiological Aspects of Pulsed Electric Field (PEF)

Mechanism of action

- The pulsed electric field (PEF) technology is considered to be one of the efficient techniques for microbial and enzymatic inactivation at mild temperatures.**
- PEF in combination with sub-pasteurization temperatures can attain the potential levels of microbial inactivation in milk at par to conventional thermal pasteurization.**
- Pulsed electric field (PEF) technology involves small bursts of high intensity electric fields (10–80 kV/cm) applied for microseconds to liquid food positioned between two electrodes.**
- The electrical current is transmitted to each point in the liquid due to the presence of the charged molecules present it.**

- **There are two widely accepted theories of microbial inactivation through PEF: electrical breakdown and loss of cell membrane functionality. The former hypothesizes the microbial cell to be a membrane bound dielectric cytoplasm matrix as capacitor and the surrounding food system as medium with differing electrostatic setting: thus creating a difference in electrical conductivity on either side of microbial cell membrane thereby generating transmembrane potential. In the instance of an external electric field, the ions in the two medium moves, where ions with opposing charge are attracted towards each other causing reduction in membrane thickness and eventually pore formation and membrane breakdown.**

- The latter hypothesis suggests that due to application of PEF, the integrity and arrangement of membrane biomolecules, like proteins and phospholipid, is disordered, causing the prolonged opening of ion/protein channels thereby forming irreversible pores and disruption of microbial cell.



Application

- PEF-applied milks can be stored under refrigerator conditions for more than two weeks without altering their physical, chemical, and sensory properties. Effective against *E. coli*, *S. aureus*, *Bacillus subtilis*, *B. cereus* and *L. monocytogenes*.
- PEF application on ultra-high temperature treated skim milk inoculated with *Pseudomonas* spp., significantly inactivated microbial population at 31 kVcm⁻¹, 55 C thereby extending the shelf life of the treated milk up to 8 days at 4 °C.
- One study demonstrated the effect of PEF in raw milk against Alkaline Phosphatase enzyme. The treatment at 38 kVcm⁻¹, 44 C resulted in 10% inactivation of enzyme.
- PEF process keep the protein structures and fat globules within the processed milk unchanged, although it did not prove to be a better option than the HTST process.