6 Microfiltration

The term 'microfiltration' originates from the initial use of finely porous membranes for filtering microbes and bacteria from water and air. Microfiltration (MF) is by far the most widely used membrane process with total sales greater than the combined sales of all other membrane processes. Microfiltration has numerous small applications. It is most widely used for separation of suspended particulate matters, bacteria, fragmented cells or large colloids from solution.

6.1 BASIC PRINCIPLE OF MICROFILTRATION

Microfiltration is a low pressure cross flow membrane process for separating colloidal and suspended particles in the range of 0.05 to 10 microns. It closely resembles conventional coarse filtration or sieving. It is essentially a sterile filtration with pores (0.1 to 10.0 microns), so small that micro-organisms cannot pass through them. A microfiltration membrane is generally porous enough to pass molecules of true solutions, even if they are large. Microfilters can also be used to sterilize solutions, as they are prepared with pores smaller than 0.3 microns, the diameter of the smallest bacterium, *Pseudomonas diminuta*.

During World War II, many of the German water supply system were destroyed in air raids. They were forced to check the bacteriological contamination of water at frequent intervals. The conventional standard methods of bacteriological studies were usually time consuming, taking 96 hours. On the other hand, if membrane filter techniques were applied, the study could be accomplished within 24 hours. The scheme is as follows:

500 ml sample of water could be filtered through the membrane trapping the entire bacterial flora on the surface. Membrane subsequently is placed in the nutrient media, to allow the growth of micro-organisms. Visible colonies could be observed within 12 to 24 hours.

6.1.1 Cross Flow Microfiltration

In cross flow microfiltration (CFMF), the suspension is pumped tangentially over the filtration medium (see Figure 6.1). Clear liquid permeates the filtration medium and is recovered as the permeate, while the solids accumulate at the filtration barrier to form a fouling layer or cake. The cake, constituting an increase in hydraulic resistance, decreases the permeate flux. However, the tangential suspension flow tends to limit the growth of the cake. Thus, after an initial rapid increase in cake thickness, cake growth ceases, and the cake thickness becomes limited to some steady-state value. Correspondingly, after an initial rapid decrease, the permeate flux levels off, and it either attains a steady-state, or exhibits a slow, long-term decline with time.

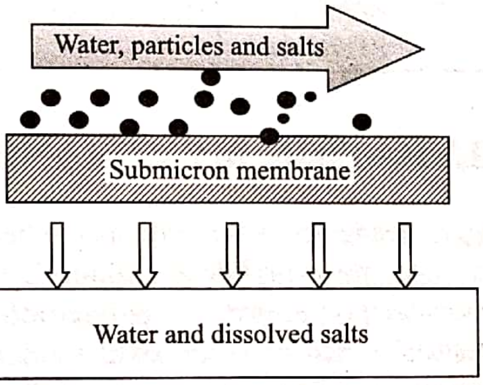

Figure 6.1 Schematic representation of cross flow microfiltration.

6.1.2 Dead-end Microfiltration

The dead-end mode is analogous to conventional sand filter operation, where intermittent stoppage for backwashing the filter media is required. In the dead end filtration arrangement, the feed flow is normal to the membrane surface. The retained particles or the solute remain on the membrane forming a cake or a gel layer. This is described in Figure 6.2. Particle accumulation on the membrane increases the filtration resistance. The applied pressure may be gradually increased to overcome the resistance and to maintain the flow.

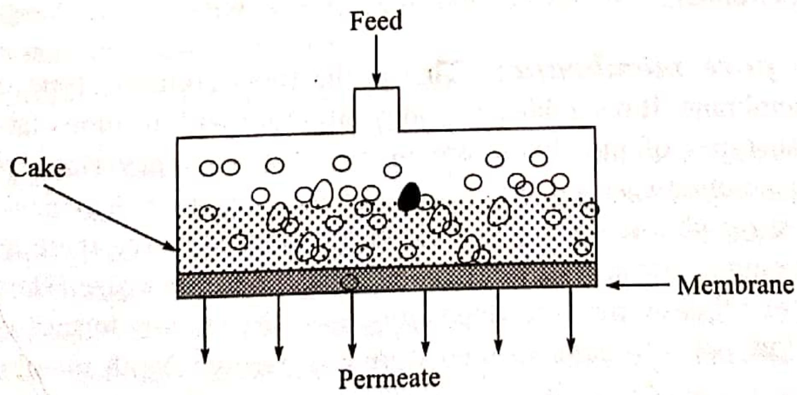

Figure 6.2 Schematic representation of dead-end microfiltration.

Microfiltration is operated at 0.2 to 3.5 bar pressure and typical value of flux is above 200 $l/m^2/h$. Some basic information about microfiltration and membrane materials is given in Table 6.1.

Table 6.1 Some basic information on microfiltration

Membrane type	Porous, mostly symmetric; asymmetric membranes are used in some cases
Thickness and pore size	10–150 μm; pore size: 0.1 – 10 μm
Pressure differential	Less than 2 bar
Mechanism of separation	Sieving or size exclusion
Membrane materials	Hydrophilic and partially hydrophilic polymers—cellulose acetate, polycarbonate, polysulfone, (and polyether sulfone), polyimide and polyetherimide), polypropylene, PTFE, etc.

6.2 MICROFILTRATION MEMBRANES

The MF membranes are made from natural or synthetic polymers such as cellulose nitrate or acetate, polyvinylidene difluoride (PVDF), polyamides, polysulfone, polycarbonate, polypropylene, polytetrafluoroethylene (PTFE), etc. The inorganic materials such as metal oxides (alumina), glass, zirconia coated carbon, etc. are also used for manufacturing the MF membranes. The properties of membrane materials are directly reflected in their end applications. Some criteria for their selection are mechanical strength, temperature resistance, chemical compatibility, hydrophobicity, hydrophilicity, permeability permselectivity and the cost of membrane material as well as manufacturing process.