Technology of Soft Drinks and Fruit Juices

There are four primary sectors of the global commercial beverage market (Figure 1):

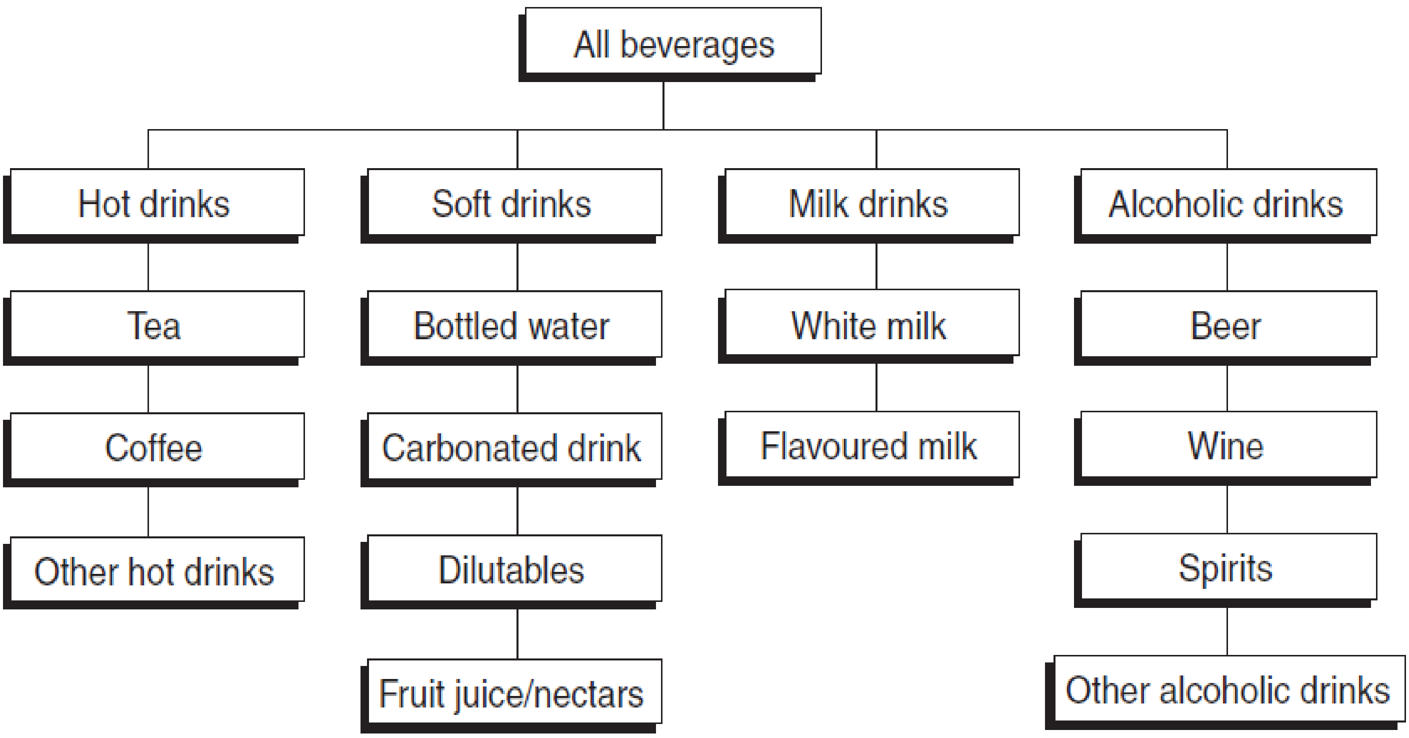
First, Hot drinks, such as tea, coffee and hot malt-based products;

Second, Milk drinks, including white drinking milk and flavored milk products;

Third, Soft drinks, a sector with five main subcategories

1. Bottled water;
2. Carbonated soft drinks;
3. Dilutables, also known as squash and including powders, cordials and syrups;
4. 100% fruit juice, and nectars with 25–99% juice content;
5. Still drinks, including ready-to-drink (RTD) teas, sports drinks and other noncarbonated products with less than 25% fruit juice;

Fourth, Alcoholic drinks, including beer, wine, spirits, cider, sake and flavoured alcoholic beverages –sometimes referred to as pre-mixed spirits.



(Figure 1) Beverage sectors and segments.
Source: Zenith International.

Soft drinks and fruit juices are widely consumed in ever-increasing quantities and are very important commodities in the trade of most countries.

Soft drinks and fruit juices are available in bottles, cans, laminated paper packs, pouches, cups and almost every other form of packaging known.

Soft drinks

There is no single definition available but it is generally accepted that they are sweetened water-based beverages, usually with a balancing acidity. They are flavoured , frequently coloured and often contain an amount of fruit juice, fruit pulp or other natural ingredients. The predominant ingredient is water– and it should be remembered that the primary function of soft drinks is hydration. The sweetness and other characteristics are in some respects secondary and yet they do have importance in the provision of energy and some of the minor essential nutrients needed to meet daily requirements.

There are two basic types of soft drinks: the so-called **Ready-To-Drink (RTD)** products that dominate the world market and the **Concentrated or dilute-to-taste** products that are still important in some markets. These include syrups and so called squashes and cordials.

Whether RTD or dilutable, soft drinks characteristically contain water, a sweetener (usually a carbohydrate, although artificial sweeteners are increasingly important), an acid (citric or malic are the most common), flavouring, colouring and preservatives. There is a large range of dditional ingredients that can be used for various effects.

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1. Ready-To-Drink (RTD)

This sector accounts for the largest volume of soft drinks production and is divided into products that are carbonated and Non-carbonated.

Carbonated RTD soft drinks

Carbonated RTD contain ; carbon dioxide, Fruit juices typically have around 10–12% naturally occurring sugars with a pleasant balancing acidity that varies from about 1% down to 0.1%. It is therefore not surprising that soft drinks were typically formulated around 10–11% sugar content with about 0.3–0.5% of added acid (usually citric). The simplest form of beverage contained such a mix of these basic nutritional components in water with flavouring, colouring and chemical preservatives added as appropriate. With the addition of fruit juice to a level of 5–10%, a pleasing effect of both taste and appearance could be achieved.

Non-carbonated RTD

Beverages have shown some considerable growth in recent years mainly because of the availability of aseptic packaging forms. Still drinks that rely on chemical preservation or hot-pack/in-pack pasteurisation suffer from a number of potential problems, including rapid flavour and colour deterioration.

2. Concentrated soft drinks

Concentrated soft drinks became very important during, and in the early years following, the Second World War. Many were based on concentrated orange juice, which was widely available as a nutritional supplement, and were packed in flat-walled medicine bottles.

The main markets for concentrated soft drinks developed in the United Kingdom and its former empire. The products became universally known as ‘squashes’ or ‘cordials’ and became enshrined as such in UK legislation in the 1960s.

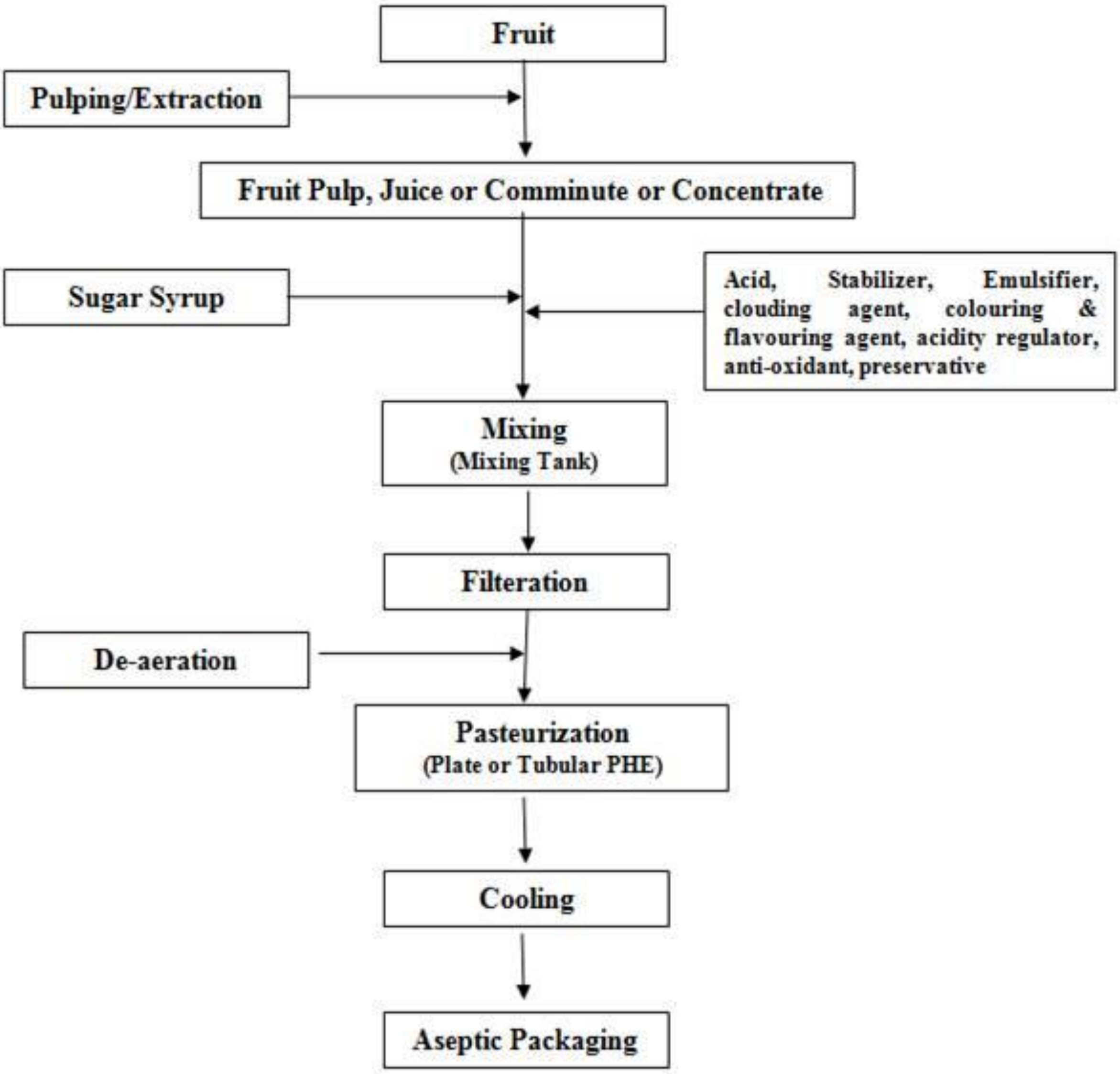


Fig. Process flow diagram for the manufacture of dilutable beverages

There are three main areas of particular nutritional significance for soft drinks;

The First is Energy.

The Second area of Nutritional

Fruit juices/

The fermentable but unfermented product obtained from fruit which is sound and ripe, fresh or preserved by chilling, of one or more kinds mixed together, having the characteristic colour, flavour and taste typical of the juice of the fruit from which it comes.

Concentrated fruit juice/

The product obtained from fruit juice of one or more kinds by the physical removal of a specific proportion of its water content. Where the product is intended for direct consumption the proportion of water content removed must be at least 50%.

Dehydrated or powdered fruit juice/

The product obtained from fruit juice of one or more kinds by the physical removal of virtually most of its water content.

Fruit nectar

Definition, low acid, pulpy or high flavoured fruits with juice unpalatable in the natural taste, fruits with juice palatable in the natural aste and apricots, (individually or mixed together) can be used for the manufacture of nectars without the addition of sugars, honey and /or sweeteners.

apple juice - the juice of apples
cranberry juice - the juice of cranberries (always diluted and sweetened)
grape juice - the juice of grapes
grapefruit juice - the juice of grapefruits
orange juice - bottled or freshly squeezed juice of oranges
pineapple juice - the juice of pineapples (usually bottled or canned)

There is in many countries a growing market for fresh 'single-strength' juice made by squeezing fruit, subjecting it to some processing, packaging it and selling it within a cold chain distribution system. Such juice is usually referred to as 'not from concentrate' and will have a shelf life that varies from 1 or 2 weeks to 2 or 3 months

Fruit and juice processing

The beverage technologist has a wide range of fruit types to choose from, and this chapter will investigate some of the procedures associated with the processing of these to produce fruit juices commercially

Fruit types

Botanical aspects, classification of fruit types

Fruit types for processing

- Pome fruits (such as apple and pear)
- Citrus fruits (Orange, Lemon , Grapefruit, Lime)
- Stone fruits (such as peach, apricot and cherry)

Processing of fruits

In the separation of juice from its fruit, the traditional method has been to apply pressure to the mashed, or pulped, fruit in order to force the liquid portion through a cloth or some form of screen. There are several styles of separator available, for both batch and continuous

production, and a few of these are referred to in the following.

1. Pack press
2 . The horizontal rotary press
3 . The use of centrifuges in processing

Press Line: Clarified type juice (apple, cherry, grape)
Pulper Line: Nectar type juice (peach, apricot, plum)
Citrus Line: Citrus juices (orange, lemon)

Raw Material Quality

Specific cultivars

Free from pesticide residue
Flavor, color, sensory properties
Maturity
Sugar/ Acid ratio= Ripening, Brix

Harvest time

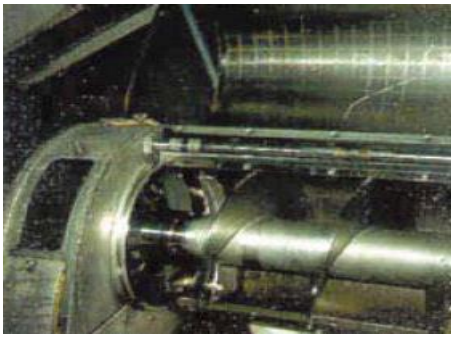
early: inadequate flavor, color, low yield
late: incipient spoilage, low quality

Cleaning, sorting and inspection

- sand, stone, leaf
- unsuitable fruits (visible defects)
- washing and sizing

Crushing/Pulping

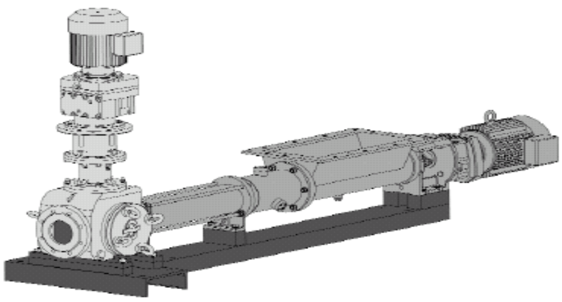
- Mechanical process of destroying cell tissue
- Fruit pulp or macerate
- Rapid heating and cooling prior to juicing
  - inactivates natural enzymes
  - increase yield
  - reduce microbial load
  - rapid cooling prevent NEB



Fruit pulper screw finisher

paddle pulper with brushes for soft

paddle pulper with coarse screen



Positive – displacement screw pump with connected macerator

Enzyme Treatment

- Macerating enzymes improve yield, clarity and stability of the juice.
- extraction of 95% of the soluble solids from the fruit
- addition blends of pectolytic enzymes and holding (powder & liquid) Polygalcturonase (PG), Pectin lyase (PL), Pectin methylesterase (PE), amylases, etc

Enzymes digest pectin and increase yield, enhance color, flavor of juice

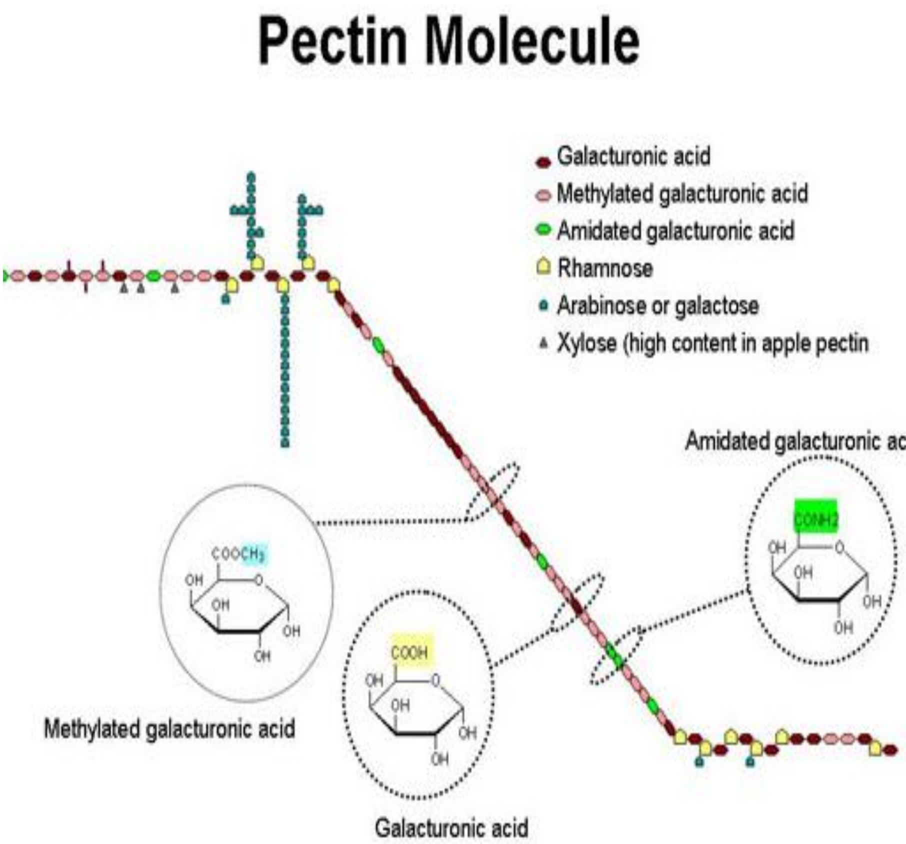
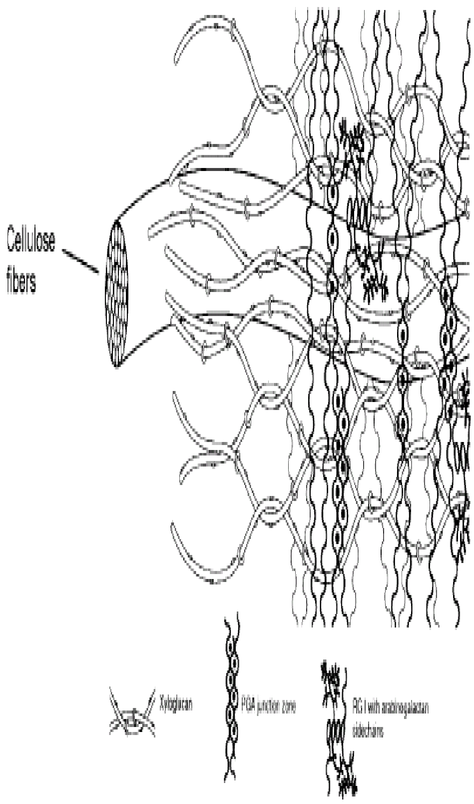


FIGURE 3. Structure of the fruit cell wall



■ **Pectolytic Enzymes**

Pectin enzymes are capable of degrading pectic substances
Commercially important for the treatment of fruit juices/beverages
To aid in filtration/clarification/increasing yields
Pectolytic Enzymes have to be added during production of most fruit juices and veggie soups
Also used for the production of galacturonic acids
Presence of pectic enzymes in fruit/veggies can result in excessive softening
Pectins may also cause "cloud" separation in tomato and fruit juices

■ **Commercial Uses**

Clarification of fruit juices/wines
Aiding the disintegration of fruit pulps
By reducing the large pectin molecules into smaller units, and eventually into galacturonic acid – compound become water soluble – loses their suspending power
Viscosity is reduced
Insoluble pulp particles rapidly settle out

Amount of enzyme required for clarification of juice

- Depends on type of enzyme
- Amount of bentonite/glucose powder
- Bentonite is an activated clay used to form a heavy complex with colloidal material and to remove the presipitate through filtration.
- Type and pH of Juice
- Time and temperature of method used

Pressing

- Rack and cloth, Hydraulic, Continuous screw press
- Pressing aids provide drain channels for juice extraction (perlit, clean rice hull, cellulose fiber)


Rack and cloth press **Hydraulic press**

Bladder press

Juice Clarification & Filtration

To prevent cloudiness (apple, cherry)

- settling with settling agents and cooling (Bentonite, Kieselguhr, Gelatine)
- centrifugation or filtration
- Plate and frame filters

Dearation & Concentration

- Removing air in juice by applying vacuum and saturation with inert gas (N_2 or CO_2)
- Vacuum concentration at low temperature

Final Juice Quality

- Brix: defines juice strength
- Acidity & pH: defines acid balance and change according to type of product
- Ascorbic Acid content
- Formal Index: distinguish natural fruit juices

Filtration

Filtration is a process where by solid particles present in a suspension are separated from the liquid or gas employing a porous medium,which retains the solids but allows the fluid to pass through.

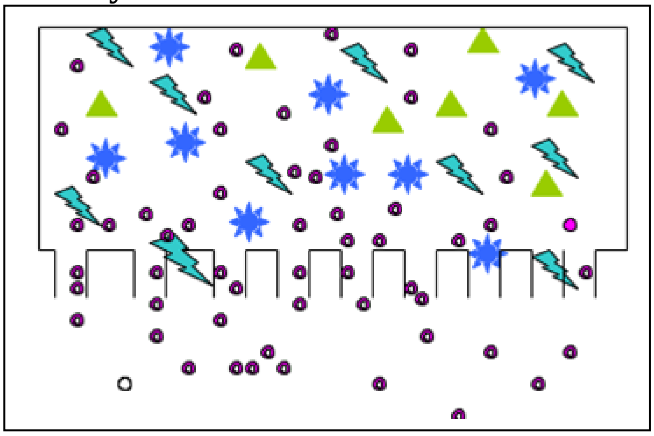
Membrane Filter Technology

A membrane is a thin material that has pores (holes) of a specific size. Membranes trap larger particles that won't fit through the pores of the membrane, letting smaller substances through to the other side.

There are four general categories of membrane filtration systems:

1. Microfiltration
2. Ultrafiltration
3. Nanofiltration
4. Reverse Osmosis

Homopolymer acrylic , Polyimide, Aramid, Polyphenylene sulphide, Polyester, Polypropylene Polyester / Glassm Cellulose



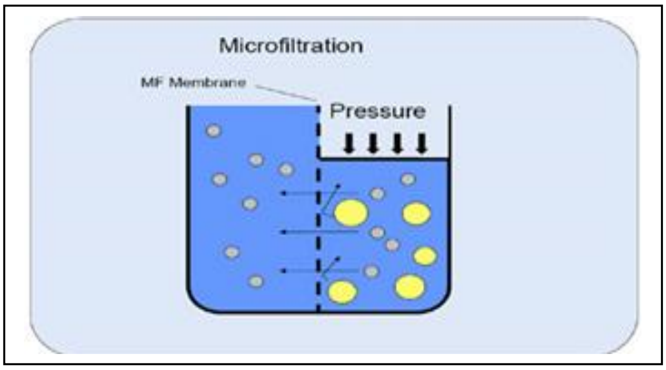
Types of filtration:

1-Microfiltration(MF):

Microfiltration a unique process for filtration and/or separation A fluid suspension, or emulsion under pressure, is forced through the center of a porous tube where a pressure differential is established tube. The difference in pressure forces the liquid to pass through the wall as a very clean fluid, and the suspended material is concentrated in the feed stream. Microfiltration has the largest pore size (0.1- 3 micron).of the wide variety of membrane filtration system. Microfiltration is defined as the filtration of a suspension with colloidal. Typical operating pressure for microfiltration is relatively low, lying between 0.02 MPa and 0.5 MPa

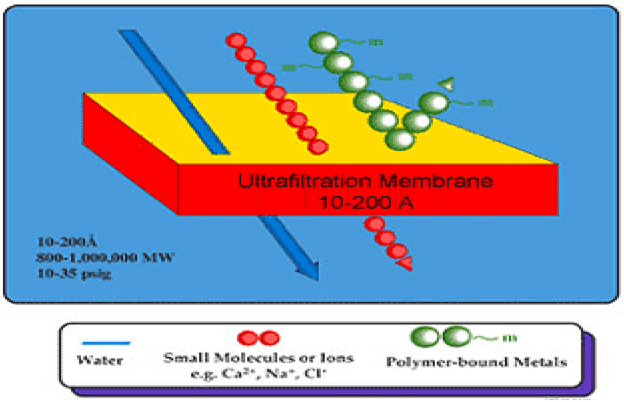
Application of microfiltration*:*

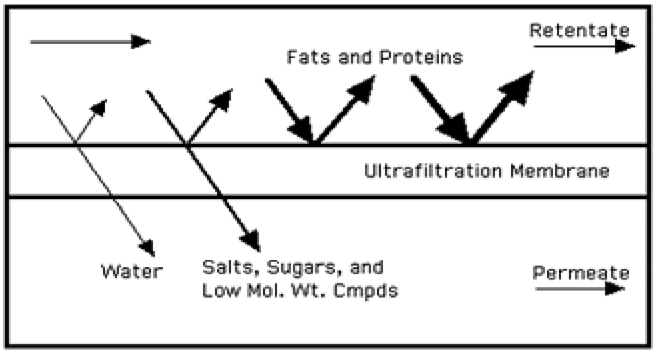
1-Heavy metals removal.
2-Aqueous cleaner recovery.
3-Suspended solids removal.
4-Precious metal recovery.
5-Grinding and tumbling.
6- Vibratory finishing.
7-Emulsion splitting.
8-Catalyst recovery



2-Ultrafiltration (UF):

Ultrafiltration is a method to concentration protein or other macromolecules through a membrane with defined pores. The membranes will have a moleculer weight cut-off (MWCO).An ultrafiltration filter has pore size around 0.01 micron. Ultrafiltration would remove these larger particles, and may remove some viruse. It also retains colloids, microorganisms. However smaller molecules like solvents and ionized contaminants pass into the filtrate.





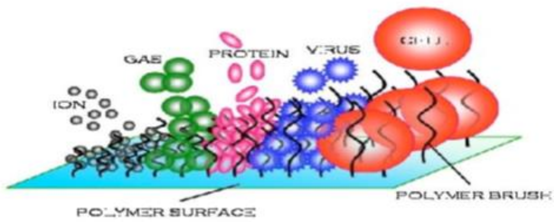
The function that Ultrafiltration processes perform are feed clarification, concentration of rejected solutes and fractionation of solutes. Ultrafiltration (UF) however is not so effective against organic streams

3-Nanofiltration:

Nanofiltration (NF)is one of the four membrane technologies, which utilize pressure to effect separation of contaminants from water stream. A nanofiltration filter has a pore size around 0.001 micron. Nanofiltration removes most organic molecules, nearly all viruses or cells from the filtrate, most of the natural organic matter and a range of salts toxic metal ions, soluble proteins..

Applications of nanofiltration*:*

1-The removal of pesticides from groundwater.
2-the removal of heavy metals from wastewater.
3-wastewater recycling in laundries.

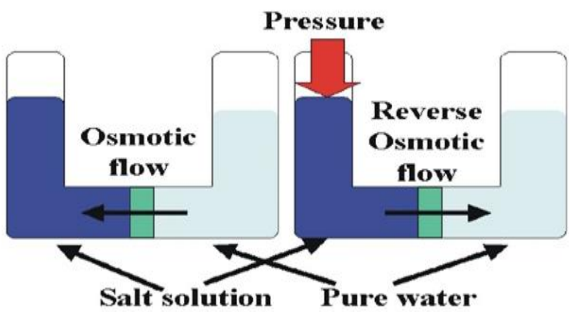


3-Reverse osmosis(RS):

Is based upon the fundamental pursuit for balance.Two fluids containing different concentration of dissolved solids that come in contact with each other will mix until the concentration is uniform.when these two fluids are separated by a semi permeable membrane(which lets the fluid flow through,while dissolved solids stay behind),a fluid containing a lower concentration will move through the membrane into the fluids containing a higher concentration of dissolved solids.Reverse osmosis filters have a pore size around 0.0001 micron.After water
Passes through a reverse osmosis filter,it is essentially pure water.In addition to removing all organic molecules and viruses,reverse osmosis also removes most minerals that are present in the water.Reverse osmosis removes monovalent ions,which means that it desalinates the water.

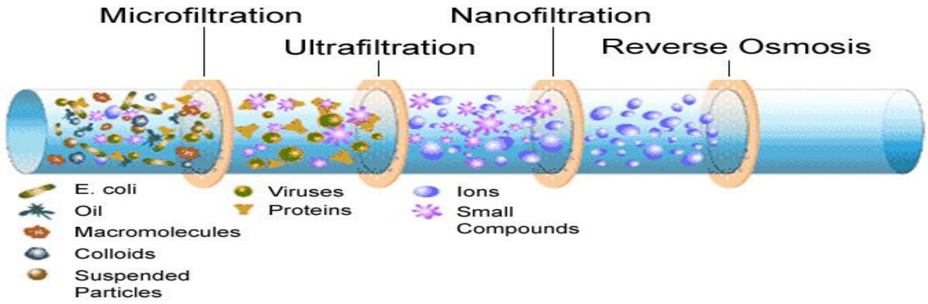
Applications of Reverse osmosis:

1-water softening.
2-Drinking water production.
3-process water production.
4-Ultra pure water production (electronic industries).
5-concentration of molecular solvents for food and dairy industries.



A Series of Filtrations Increases Efficiency

Filters can be sequenced from large to small pore size to decrease fouling**.** They must still be cleaned regularly to remain usable



***Advantages of using ultrafiltration, nanofiltration or reverse osmosis to treat water**

All three of these membrane filtration processes are effective methods of treating water that cannot be treated using conventional treatment methods.Reverse osmosis,in particular,has been responsible for ending several nearly decade long Boil water Advisories.For example,in 2003,a reverse osmosis system,together with biological treatment process,was set up to successfully treat drinking water for the Yello Quill First Nation,which had been on a Boil water Advisory since 1995.The water in the First Nations which is located in Saskatchewan,contained high levels of organic matter,iron,manganese,ammonium andarsenic,to name a few.

***Disadvantages of using ultrafiltration, nanofiltration or reverse osmosis to treat water**

Compared with the benefits of using membrane filtration to treat water,there are very few disadvantages.If conventional water treatment processes caneffectively treat the water,then constructing a reverse osmosis water treatment facility would be an unnecessary cost.But for the First Nations communities that have been on Boil Water Advisories for many years, a reverse osmosis treatment system can be a valuable investment that can provide safe drinking water for the residents.Reverse osmosis removes a number of healthy minerals from water,in addition to the harmful minerals and particles.The removalof these minerals,including calcium and magnesium,can actually make water unhealthy,especially for people with inadequate diets and people who live hot climates,as water can provide these necessary minerals.The addition of calcium and magnesium,as described above,can resolve these concerns.10

Filter type	Sym-bol	Pore Size, µm	Operating Pressure,psi	Types of Materials Removed
Microfilter	MF	1.0-0.01	<30	Clay, bacteria, large viruses, suspended solids
Ultrafilter	UF	0.01-0.001	20-100	Viruses, proteins, starches, colloids, silica, organics, dye, fat
Nanofilter	NF	0.001-0.0001	50-300	Sugar, pesticides, herbicides, divalent anions
Reverse Osmosis	RO	< 0.0001	225-1,000	Monovalent salts