



A REVIEW ON SUGAR REFINERY PROCESS

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Raw Sugar Melting

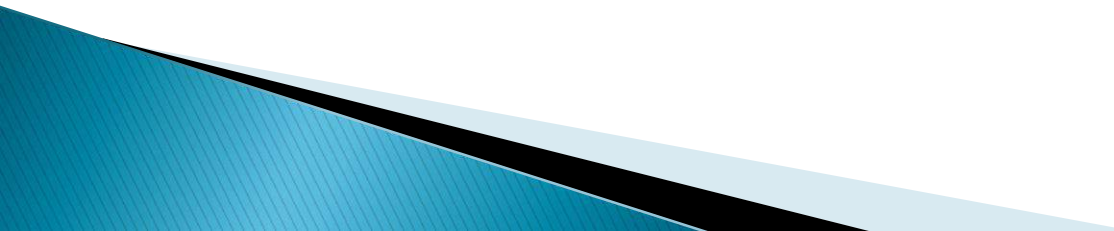
What is refined sugar:

- ▶ Refined Sugar is produced by sugar cane or beet via raw sugar. (i.e. From sugar cane or beet, first produced raw sugar by ordinary process known as Defecation process. Then raw Sugar is following further process like melting, clarification and decolourization to produced refined sugar.

Refined sugar Vs White sugar:

- ▶ Refined sugar is better than plantation white sugar because it contain less impurities, less colour value of ICUMSA. As well as it is suitable for long time storage.
- ▶ alone refinery.

Types of Refined Sugar manufacture:

- ▶ There are two types of sugar refineries.
 - ❖ Refineries operating in *conjunction with raw sugar factory*.
 - ❖ Independent refineries which purchase raw sugar from raw sugar factories. Independent refinery called stand
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Basic Steps in Refined Sugar Making Process:

1. Affination:

It is a process for higher colour Raw Sugar. For good quality raw sugar there is no need to doing this process. The main aim of affination process is to obtain affinated sugar over 99 purity & containing minimum colour and ash. In this process above 60% colour is removed mechanically depending on input colour of raw sugar.

2. Melting:

Raw sugar (low colour & good quality) or Affinated raw sugar is melted to 60 to 65o Bx in a special melter.

3. Clarification:

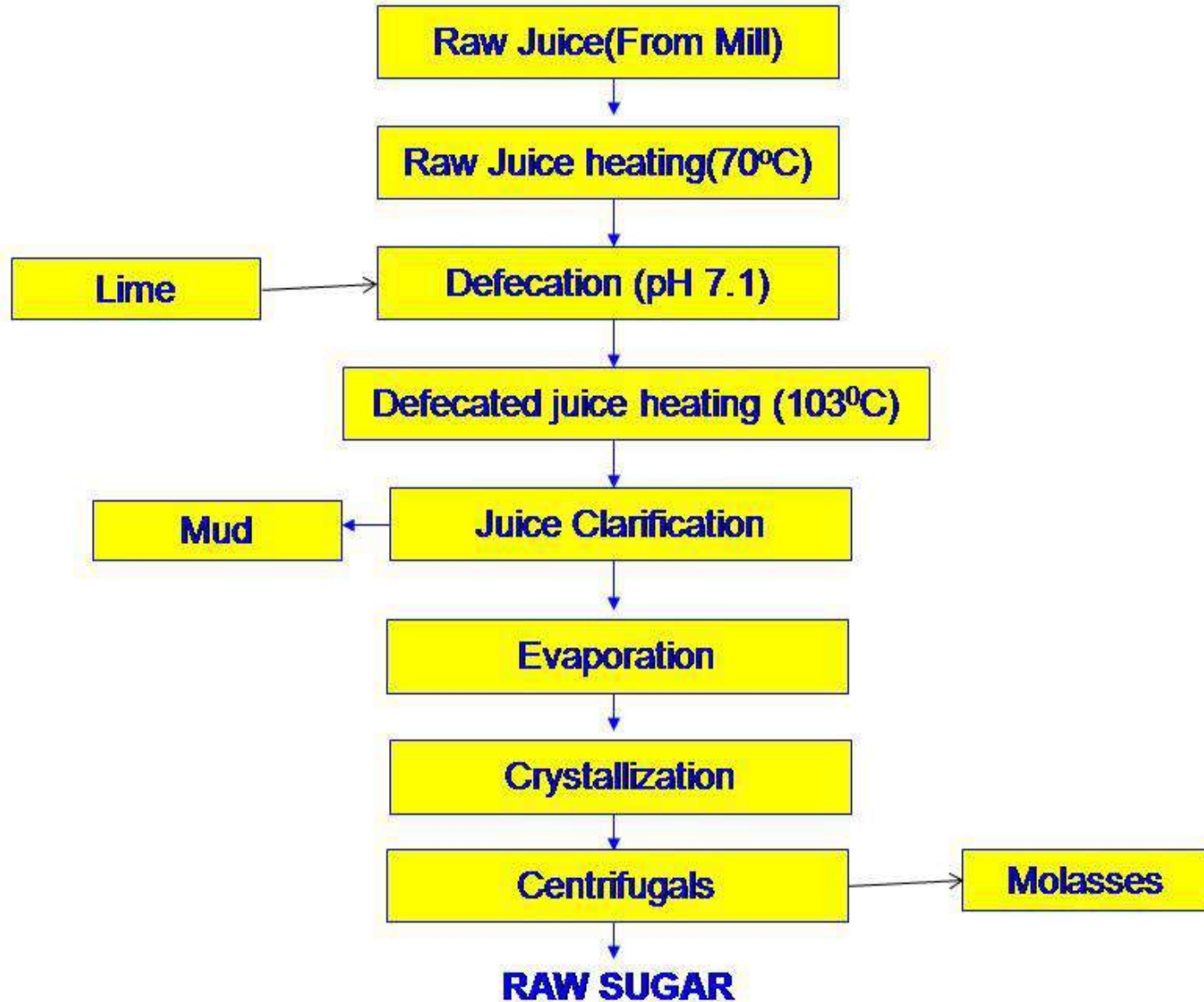
Clarification process helps to removing impurities and eliminates maximum colour of melt. Generally refineries are following two types of clarification processes. They are

- a) Melt Phosfloatation
- b) Melt Carbonation

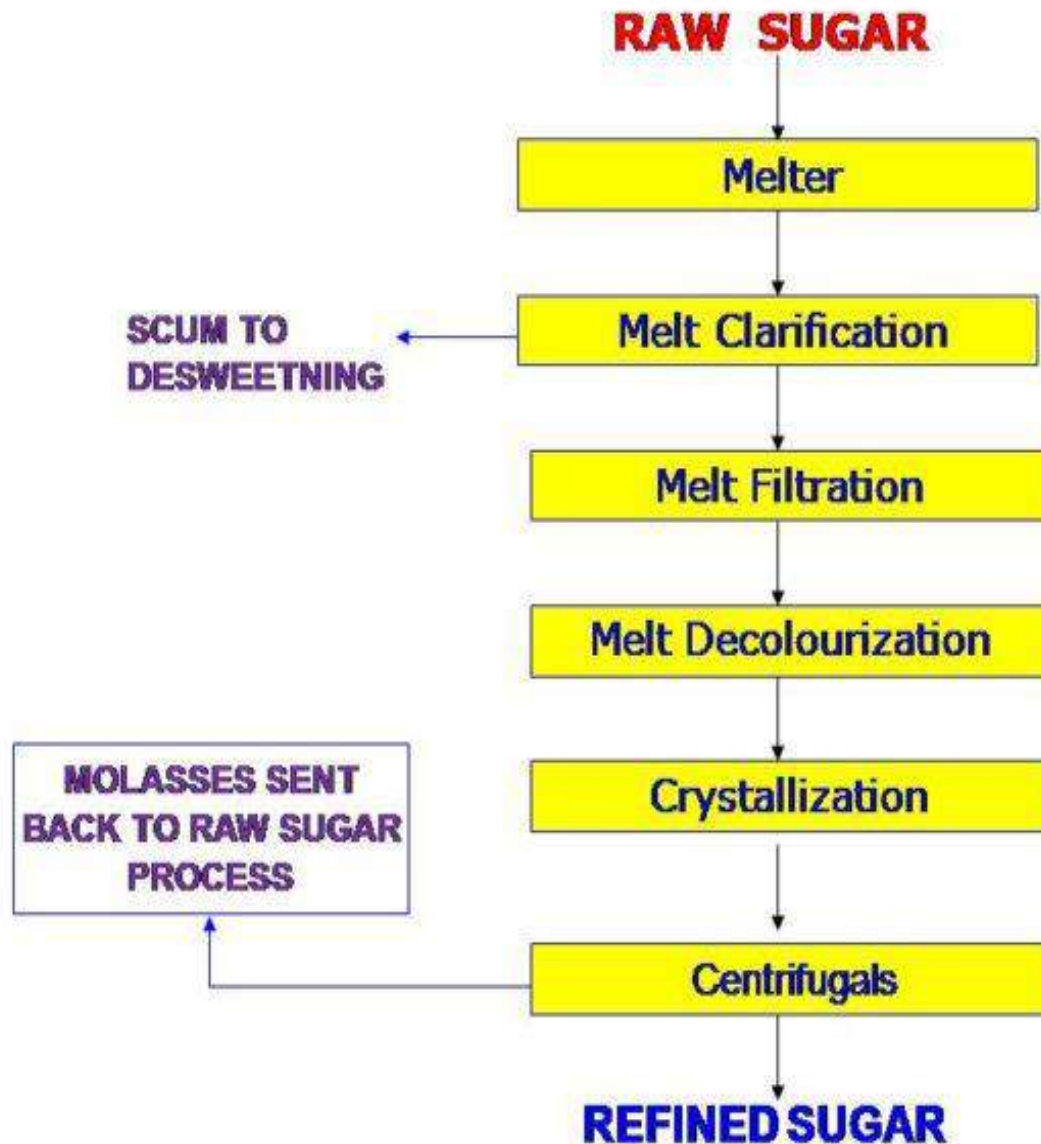
Defecation Process:

- ▶ This is the oldest & cheapest method of juice clarification
- ▶ In this process lime & heat are two basic agents.
- ▶ The lime and heat treatment forms a heavy precipitate of complex composition.
- ▶ Contains in soluble lime salts, coagulated albumin, and varying proportion of the fats, waxes and gums.
- ▶ Phosphoric acid is added to increase P_2O_5 content of juice to 300 ppm.
- ▶ Then lime added to neutralize organic acids,
- ▶ Besides insoluble tricalcium phosphate $[Ca_3 (PO_4)_2]$ is also formed which occludes colloids & suspended impurities.

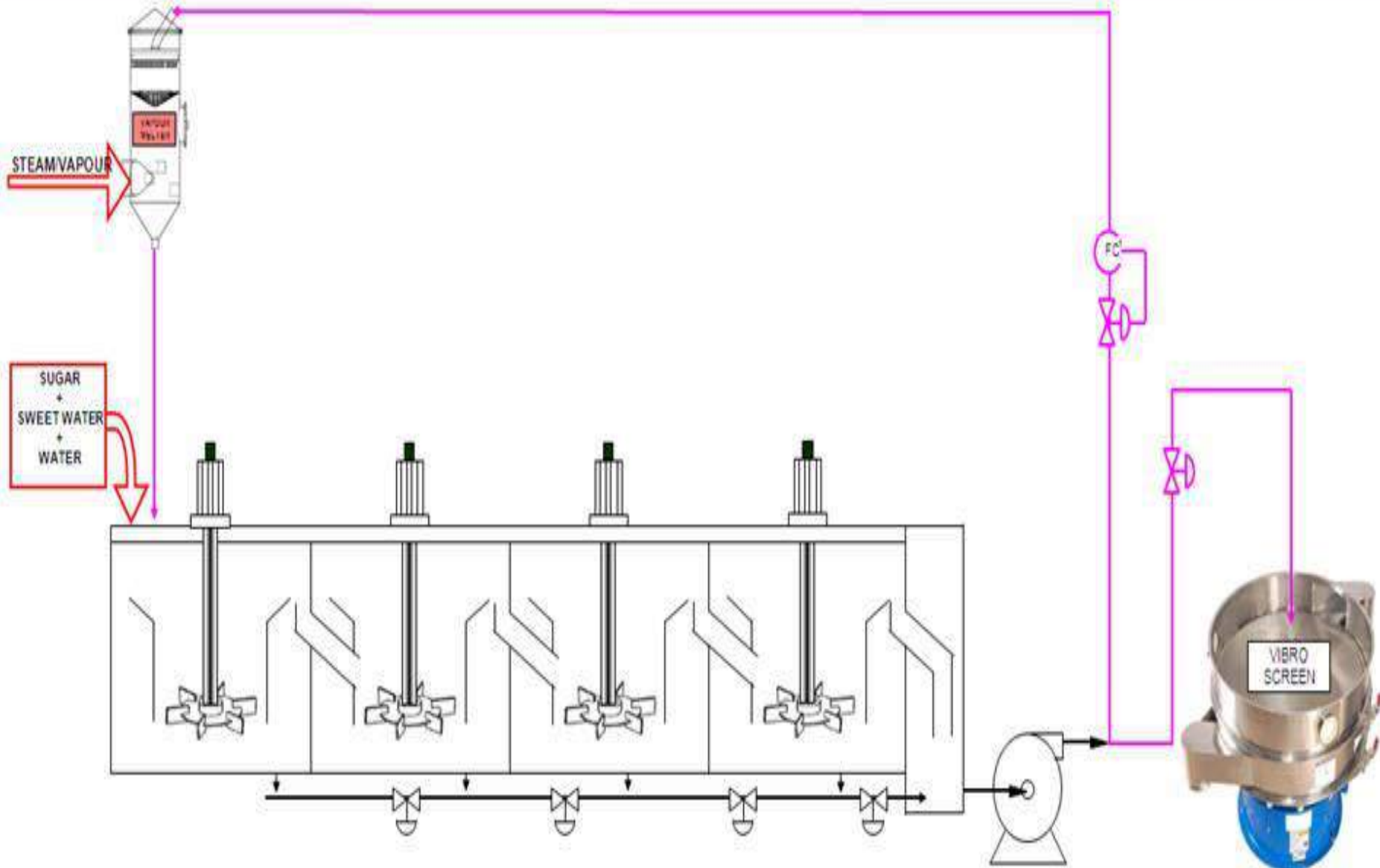
Simple Flow chat for raw sugar process



Simple Flow chat for refined sugar process



RAW SUGAR MELTER



SPECIFICATIONS OF RAW SUGAR

Sr.No.	Characteristic	Requirement
1	POL (min in %)	95.6
2	R.S. by mass (max in %)	1
3	Sulphited ash % by mass (max %)	0.8
4	Ash % by mass (max in %)	0.8
5	Safety factor (min in %)	0.3
6	Crystal size (material to be retain on 0.5mm IS sieve %)	95
7	Sulphur dioxide (max in ppm)	20

SPECIFICATION OF VHP(very high pol) RAW SUGAR

Sr.No.	Characteristic	Requirement
1	POL (min in %)	99.0 to 99.5
2	Moisture (Max in %)	0.08 to 0.15
3	R.S. by mass (max in %)	0.1 to 0.12
4	Ash % by mass (max in %)	0.1 to 0.13
5	Colour in ICUMSA	800 to 1200 IU
6	Starch (max in ppm)	200 to 250
7	Dextran (max in ppm)	100 to 150

Specification of Refined Sugar:

Refined Sugar Specifications (II REVISION) In INDIAN STANDARD IS 1151:2003

Sr.No.	Characteristic	Requirement
1	Loss on drying %by mass (Max)	0.05%
2	<u>Polarization</u> (Min.)	99.7
3	RS% by mass (Max)	0.04
4	Conductivity Ash% by mass (Max)	0.04
5	<u>Color ICUMSA unit</u> (Max)	60 IU
6	SO ₂ Content mg/kg (Max)	15 PPM
7	Lead mg/kg (Max.)	0.5
8	Chromium mg/kg (Max)	20

Specifications of Plantation white Sugar as per IS 5982:2003

S.No.	Description	Unit	Values
1	Polarization	% min.	99.5
2	Colour	IU max	150
3	Moisture	% max	0.1
4	Conductivity Ash, percent by mass	% max	0.1
5	<u>Reducing sugar</u> percent by mass,	% max	0.1
6	Sulphur dioxide,	max. ppm	70
7	Lead	max. ppm	5

$$\text{Safety factor} = \frac{\text{Moisture \% Sugar}}{100 - \text{Pol \% Sugar}}$$

Buffer tank Capacity

▶ Buffer tank Capacity

- ▶ It is required holding capacity of 30 to 40 minutes retention time. Buffer tank helps to maintain the constant flow of liquor (syrup or melt).

Syrup or Melt heater

- ▶ The material heated up to 80 to 85°C by using tubular heater or direct contact heater.

- ▶ Heating surface calculation for tubular juice heater

- ▶ Formula:

$$S \times K = M \times C_p \times \text{Log}_e \frac{(T_v - t_i)}{(T_v - t_o)}$$

- ▶ Where

- ▶ S = Heat transfer surface area in m²

- ▶ M = Quantity of material to be heating kg/hr

- ▶ C_p = Specific heat of material in Kcal/kg/°C.

- ▶ ΔT = Temperature difference from inlet to outlet of the heated material in °C

- ▶ ΔT_m = LMTD = Log Mean Temperature Difference.

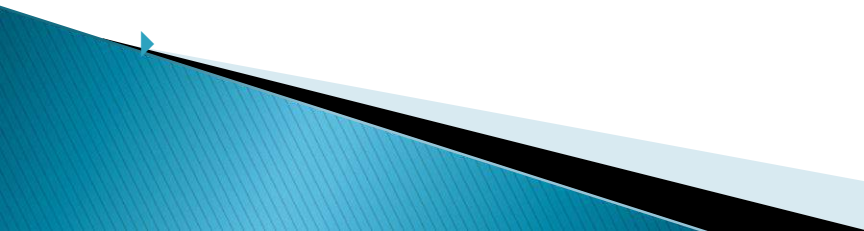
- ▶ K = **Overall heat transfer Coefficient** Kcal/m²/hr/°C = 6 × T_v × [U / 1.8]^{0.8}

- ▶ T_v = Heating vapour temperature

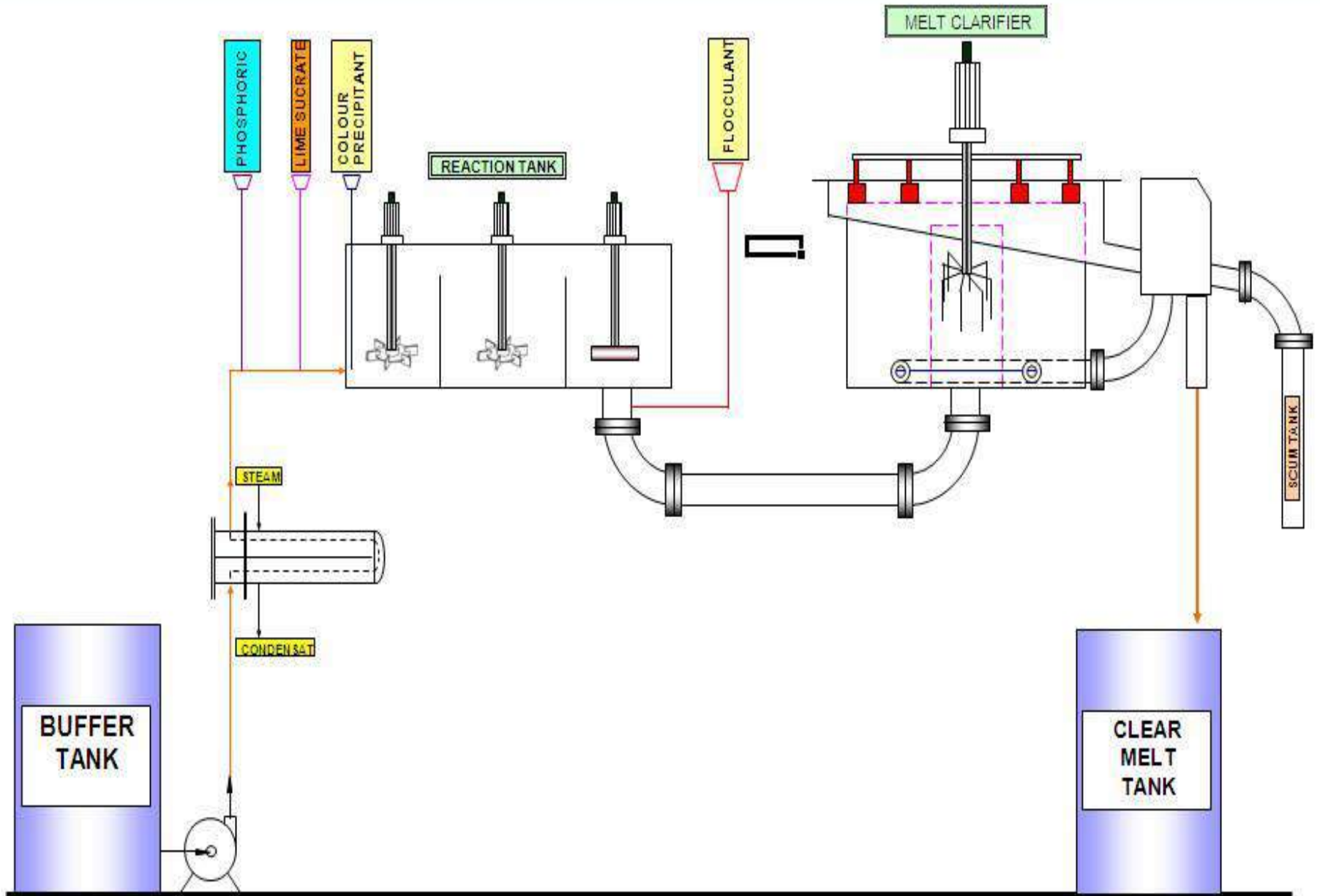
- ▶ t_i / t_o = syrup or melt inlet/outlet temperature.

- ▶ U = velocity of syrup in tubes.

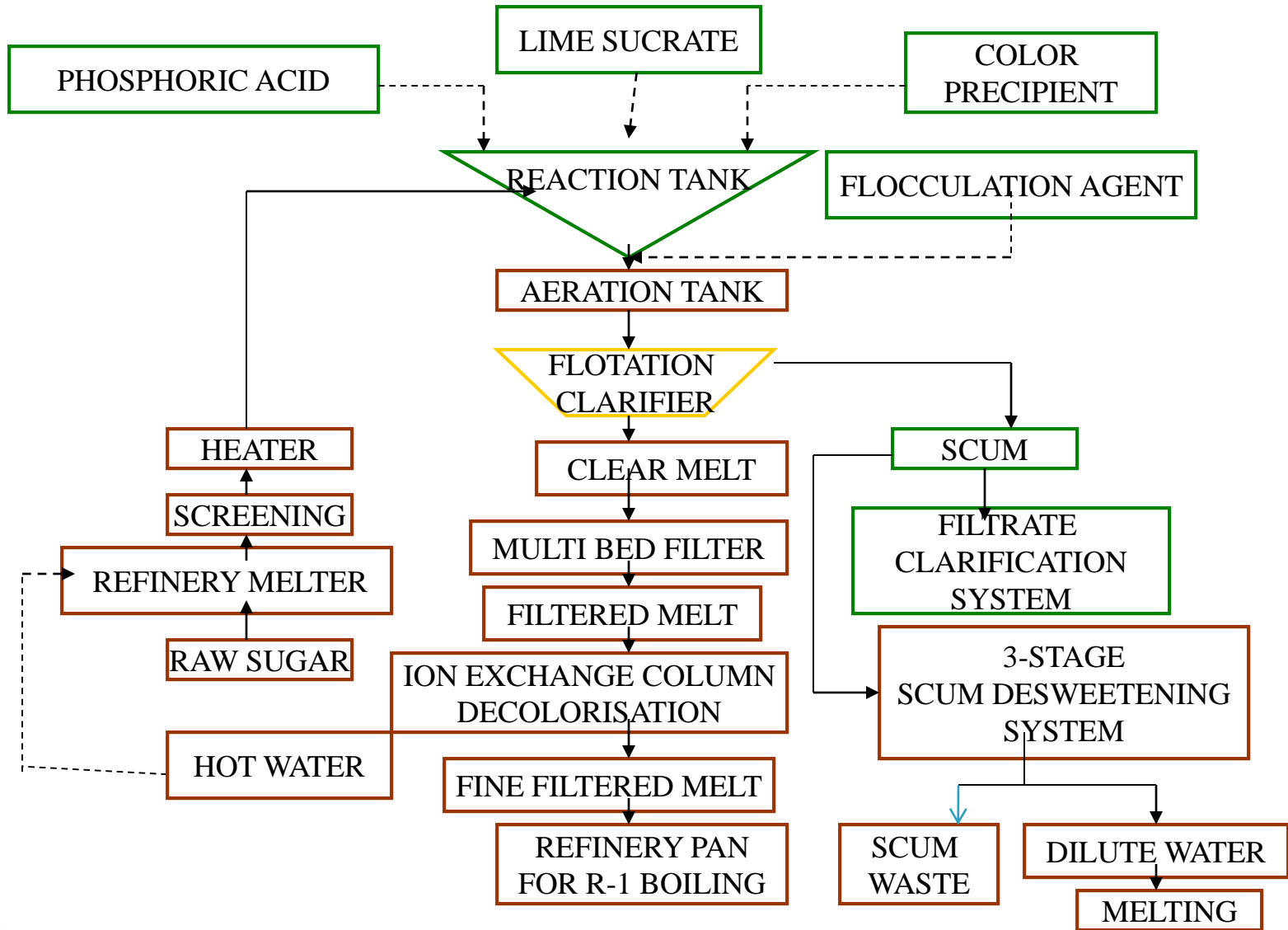
- ▶ **Reaction and Aeration Vessel** : The retention time of the reaction vessel consider 4 to 5 minutes retention time with agitator for uniform mixing. The RPM of the agitator maintained 60 to 90.

 - ▶ **Flotation Clarifier** :
 - ▶ The Flotation clarifier holding volume calculated on the basis of retention time. It will be provided **35 minutes** and height of the clarifier **having 1.7 to 1.75 Mtrs.** Center well of the clarifier height having 150 mm to 200 mm less then the clarifier height.
 - ▶ Liquor outlet coil Dia. calculate on the basis of velocity **0.3 to 0.4m/sec.** Perforated holes to be provided below the coil and its number calculated on the basis of coil cross sectional area (To be take 100 to 120% on coil cross section area).
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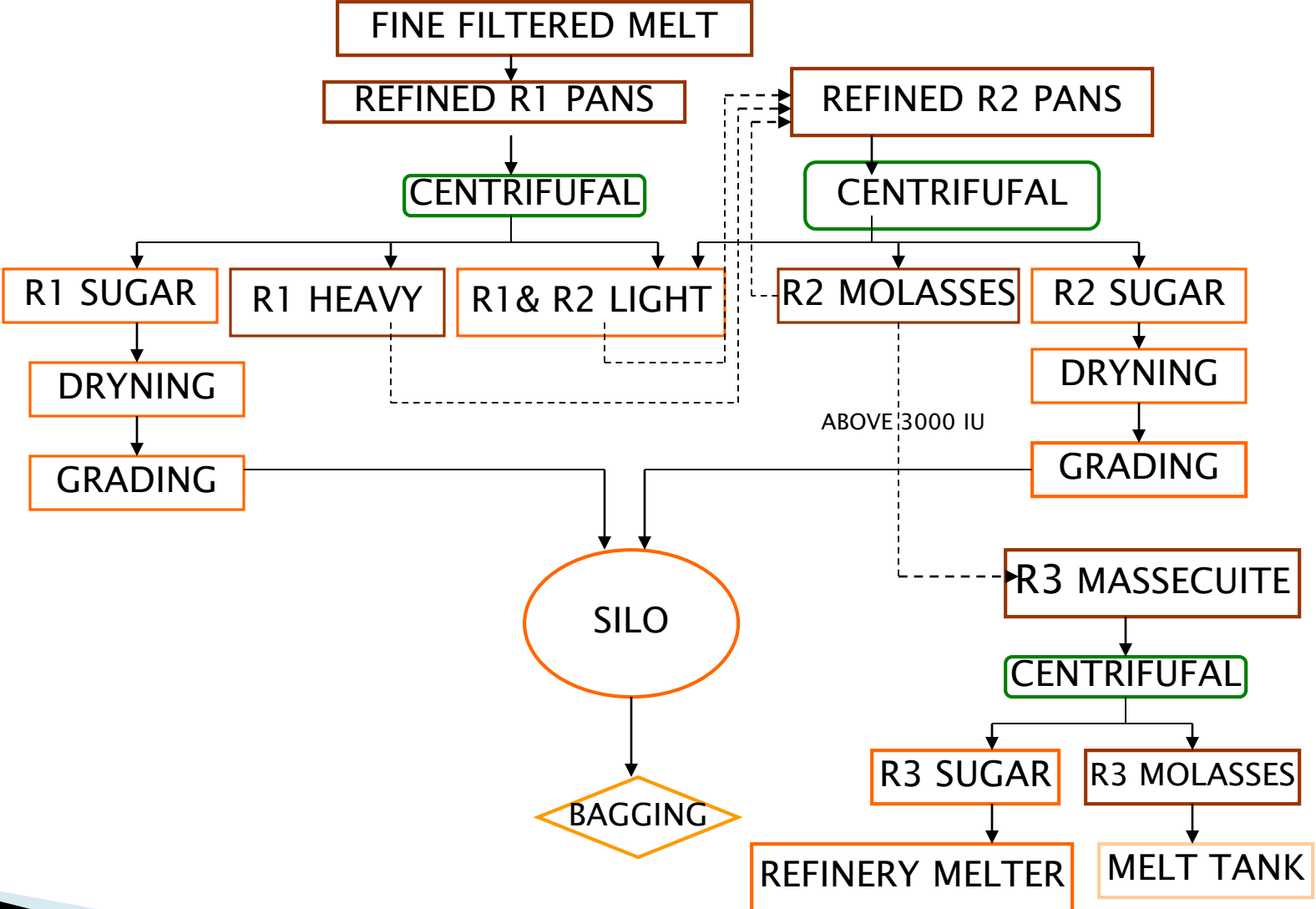
MELT CLARIFICATION SYSTEM



MELT CLARIFICATION



REFINED SUGAR CRYSTALLIZATION & CURING



Decolorisation:

The Clarified melt passed through adsorption columns which are made up of different types of colour absorbents like granular activated carbon namely lead & trail column. The liquor coming out from leaf column is known as intermediate liquor which pumped again to top of trail column. The liquor coming out from trail column is termed as decolouried or fine liquor . The following colour absorbents also used in decolourization process. For further decolourisation & demineralization after filtration this melt treated with different types, such as

- Granular Activated Carbon
- Powdered carbon
- Bone char / Bone black
- Ion exchange resins

WHY DECOLOURISATION ?

COLOUR IN RAW & REFINED SUGAR:-

IT IS THE COLOUR OF NON SUGAR CONTAMINANTS THAT IS RESPONSIBLE FOR THE “COLOUR” OF RAW SUGAR AND THAT OF REFINERY PRODUCTS.

ION EXCHANGE RESIN

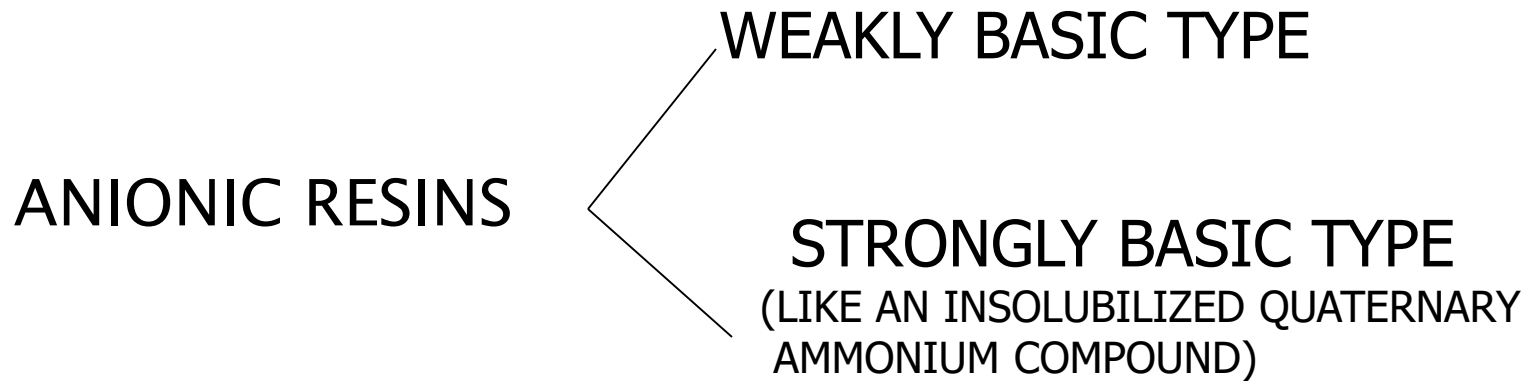
ION EXCHANGE RESINS ARE POLYMERS THAT ARE CAPABLE OF **EXCHANGING PARTICULAR IONS** WITHIN THE POLYMERS WITH ION IN A SOLUTION THAT IS PASSED THROUGH THEM.

TYPES OF ION EXCHANGE RESIN

▶ BASED ON NATURE OF IONS:-

1. ANIONIC OR BASIC RESINS TO REMOVE COLOUR.
2. CATIONIC OR ACIDIC RESINS TO REMOVE CERTAIN INORGANIC CONSTITUENTS.

TYPES OF ION EXCHANGE RESIN



RESIN USED IN DECOLOURISATION

STRONG BASE ANION TYPE RESIN IS MOST USEFUL FOR DECOLOURISATION AS MOST OF THE COLOURANTS PRESENT IN SUGAR MELT ARE OF NEGATIVELY CHARGED.

THE RESIN IS USED IN THE CHLORIDE FORM TO AVOID PRODUCING STRONGLY ALKALINE OFF-LIQUORS

TYPES OF ION EXCHANGE RESIN

BASED ON POROSITY:-

1. GEL TYPE.
2. MACROPOROUS TYPE.

GEL TYPE HAVE HIGHER EXCHANGE CAPACITY BUT ARE MORE SUSCEPTIBLE TO FOULING AND OSMOTIC SHOCK IN COMPARISON TO MACROPOROUS.

▶ BASED ON TYPE OF MONOMER :-

1. STYRENE TYPE.
2. ACRYLIC TYPE

ACRYLIC RESINS ARE ARE MORE RUGGED AND RESISTANT TO FOULING BUT ARE LESS EFFECTIVE DECOLOURIZER THAN THE STYRENE TYPE

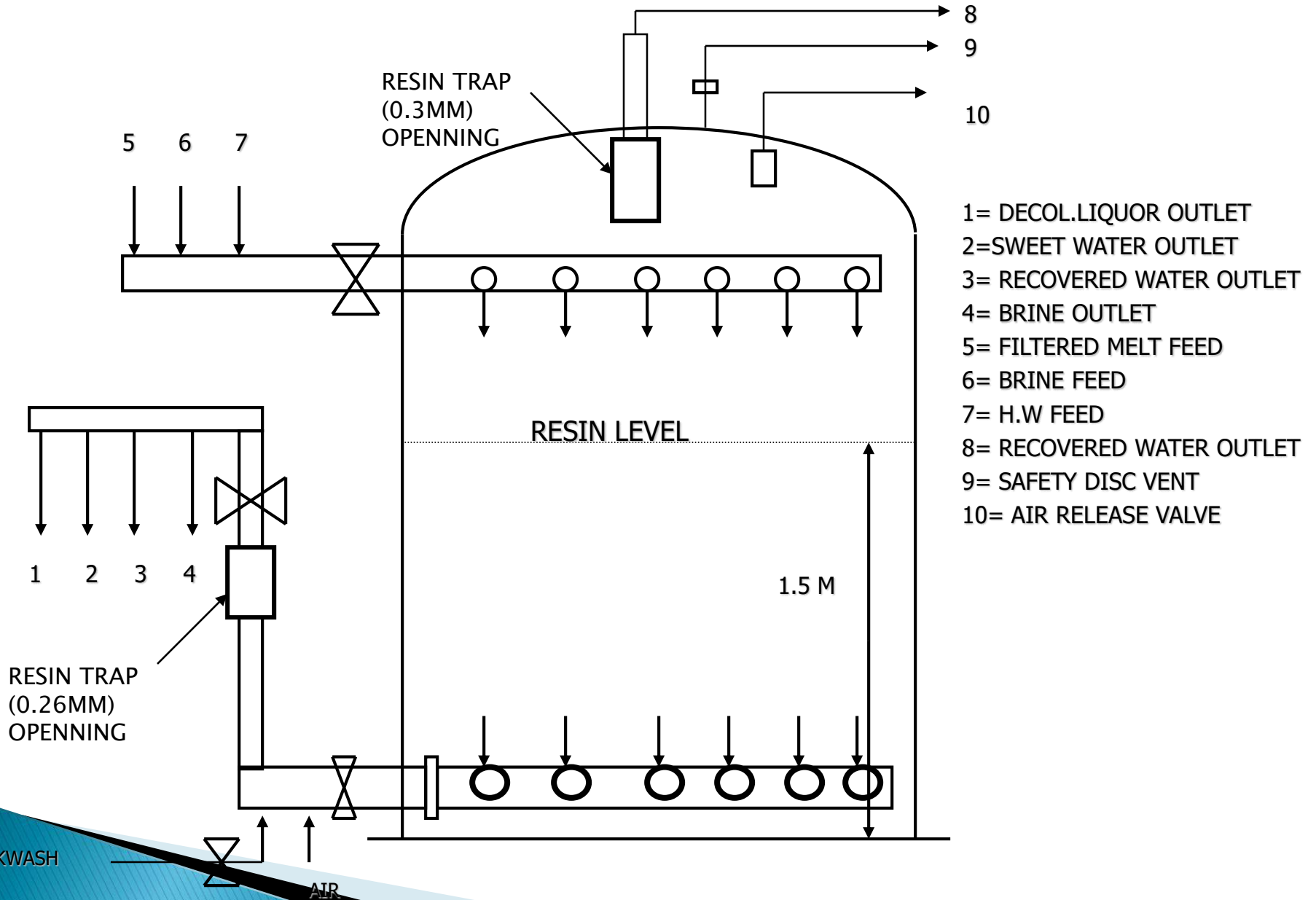
STYRENE Vs ACRYLIC

<u>CHARACTERISTIC</u>	<u>STYRENE</u>	<u>ACRYLIC</u>
1. MATRIX	POLYSTYRENE	POLYACRYLIC
2. FUNCTIONAL GROUP	QUATER. AMMONIUM	QUATER. AMMONIUM
3. MOBILE ION	CHLORIDE	CHLORIDE
4. EXCHANGE CAPACITY	MIN.1.0 eq/ltr (Total cap. Of chloride form)	MIN.0.8 eq/ltr
5. MOISTURE FORM)	58-64% (Cl ⁻ FORM)	66-72% (Cl ⁻
6. DENSITY	1.05-1.08	1.05-1.08
7. AVG. SIZE	0.6-0.8 MM	0.65-0.85 MM

ACRYLIC RESIN HAVE LESS HYDROPHOBIC INTERACTION WITH NON-POLAR PART OF COLORANTS AND MORE RESISTANT THEN STYRENIC RESIN TO HIGH COLOUR FEED LEVELS.

STYRENIC RESIN HAVE HIGH DECOLOURIZATION RATE AND BETTER CAP. WITH LOWER COLOUR FEED LEVELS

I.E.R. COLOUMN

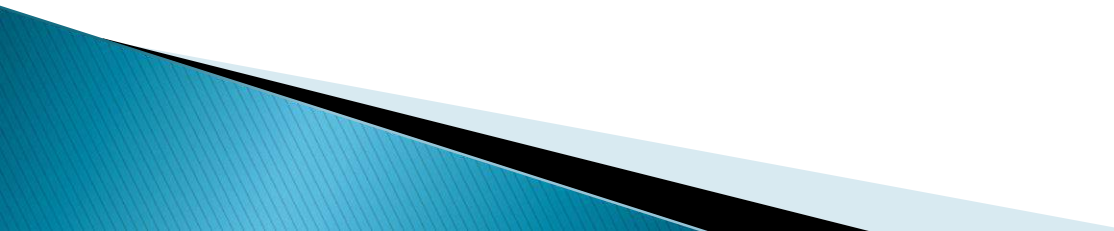


REGENERATION

- ▶ IN REGENERATION COLOURING MATTERS ARE DETACHED FROM RESIN 'S ACTIVE SITES TO MAKE THEM AVAILABLE FOR FURTHER DECOLOURISATION IN NEXT CYCLE.
- ▶ IN THIS PROCESS 2.5 BED VOLUME OF ALKALINE BRINE SOLUTION (10 % NaCl+1% NaOH) IS PASSED THROUGH CELL.

DEEP BED FILTRATION UNIT

CONTENT

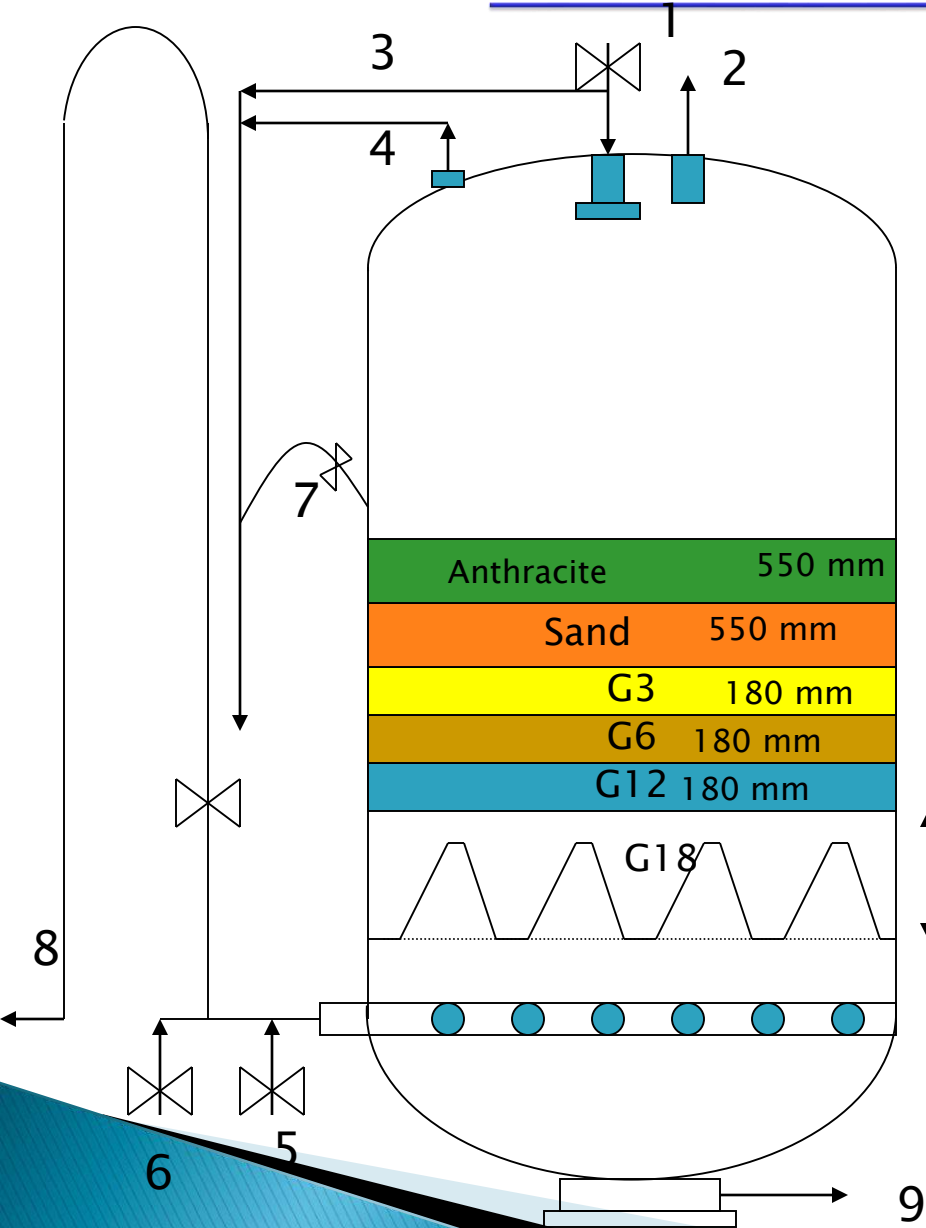
- ▶ DEEP BED FILTER.
 - ▶ WORKING OF D.B.F.
 - ▶ REGENERATION CYCLE.
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DEEP BED FILTER

- ▶ DBF IS INSTALLED BETWEEN CLARIFIER AND IER TO ARREST THE SUSPENDED PARTICLE COMING WITH CLEAR MELT, TO FACILITATE LOW PRESSURE WORKING OF I.E.R CELL.
- ▶ DBF ARRESTS THE PARTICLES > 50 Micron

To make the best use of all the bed, the solids should be entrapped throughout the bed interstices.

DEEP BED FILTER



- 1 = Melt feed
- 2 = Air release valve
- 3 = Back wash out
- 4 = Safety disc
- 5 = Air for backwash
- 6 = Melt feed for backwash
- 7 = Drain down
- 8 = Melt outlet
- 9 = Drain

Gravel size

- G18 = 9.25–19.1 mm
- G12 = 6.35–9.25 mm
- G6 = 2.54–6.35 mm
- G3 = 1.0–2.0 mm
- Sand = 0.5–1.0 mm

REGENERATION

- ▶ DBF RUNS UNDER PRESSURE AS IT'S BED GETS LOADED WITH IMPURITIES IT'S PRESSURE RISES AND WHEN PRESSURE EXCEEDS 10 Psig , IT UNDERGOES TO REGENERATION.
- ▶ CYCLE TIME OF DBF DEPENDS ON WORKING OF CLARIFIER,GENERALLY IT'S CYCLE TIME IS 4-6 Hrs .

◆ Membrane process filtration

The membrane processes have been involved with major revolutions in industry branches such as petroleum, gas, pharmacy, biotechnology, water, wastewater, food processing and medicine.

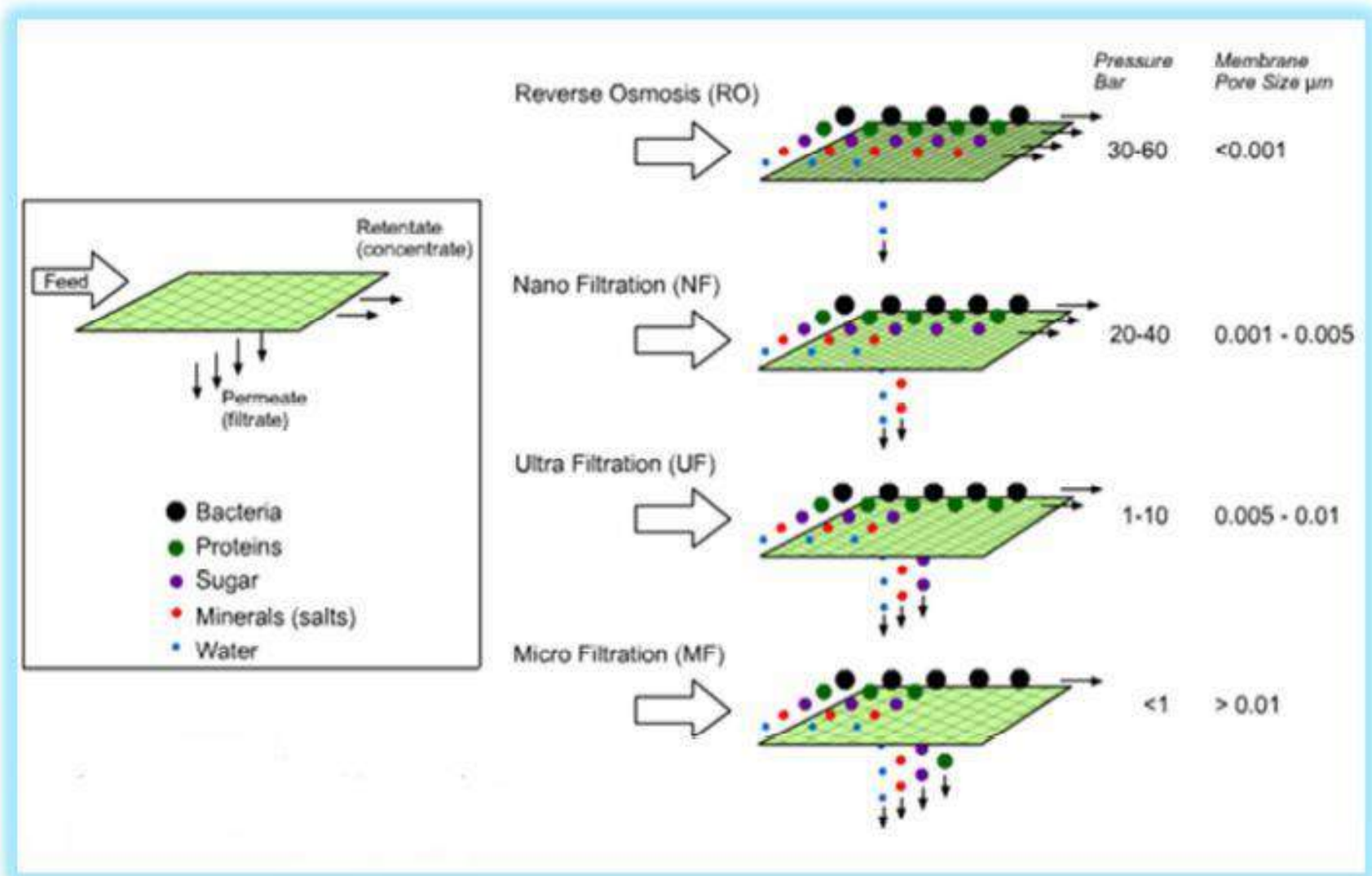


Fig 2: Nominal Molecular weight cut off of different Membrane types

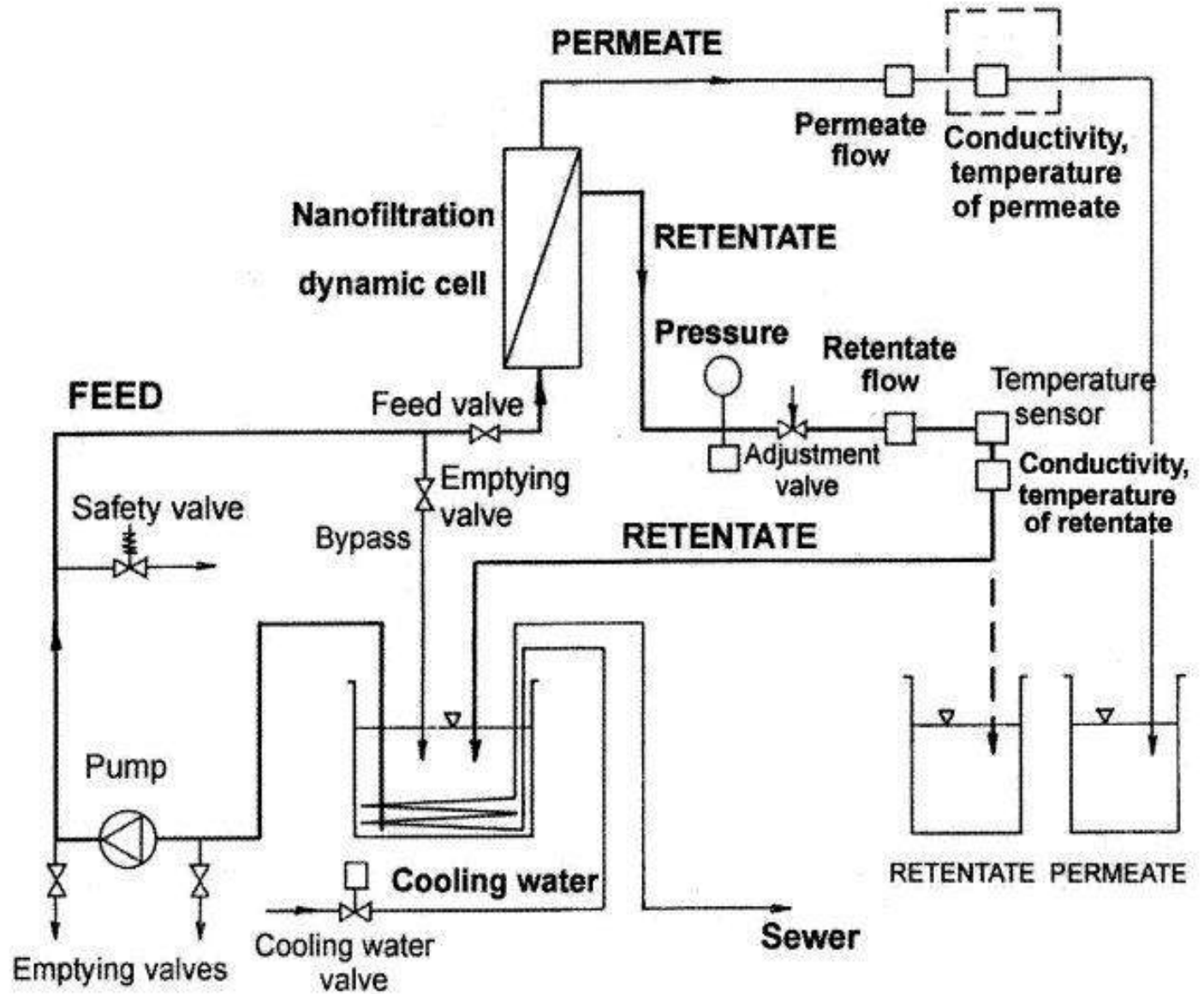


Fig. 1. Scheme of the filtration unit ARNO 600 with nanofiltration cell.