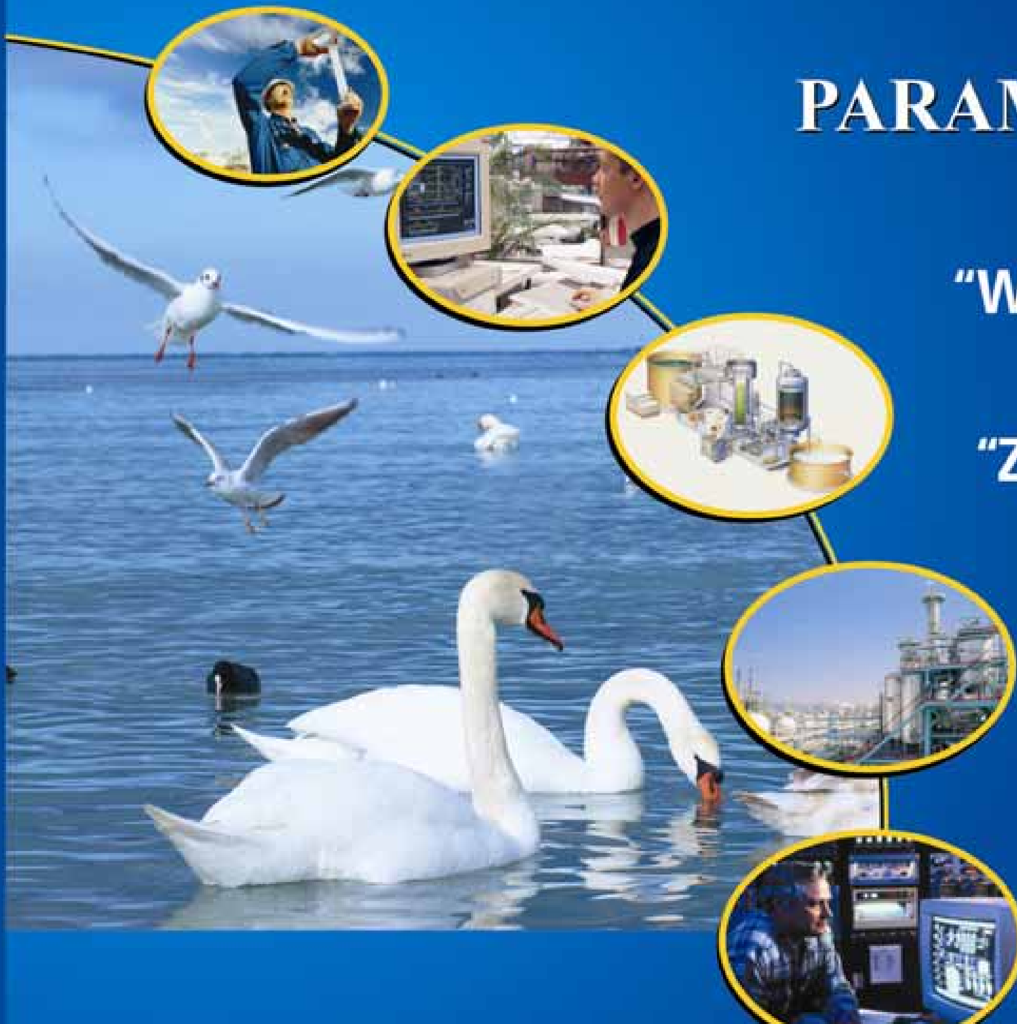
PARAMOUNT LIMITED



"Waste Water Recycling" & "Zero Liquid Discharge"

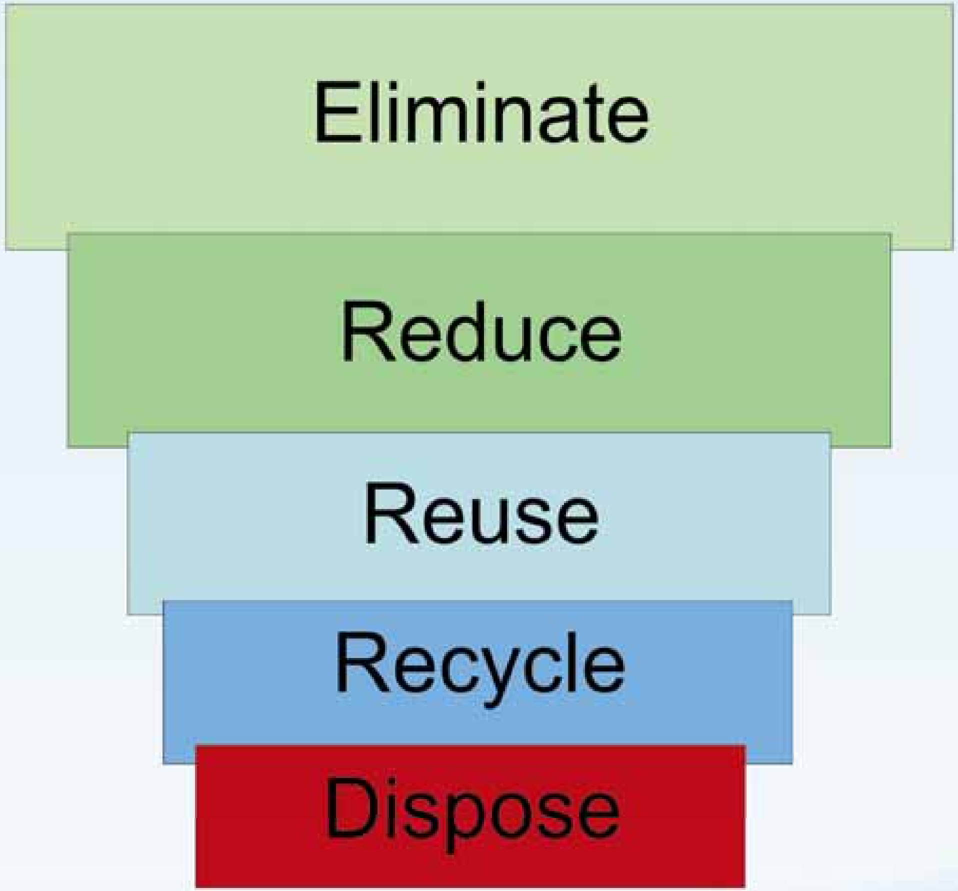
...A Total Water & Environment Management Company

Zero Liquid Discharge

In the end of the 1980's, together with increased environmental awareness within society and industry, "Zero discharge" changed from a technical description of 100% wastewater recycling to a "goal". The principle of "zero discharge" is recycling of all industrial wastewater.

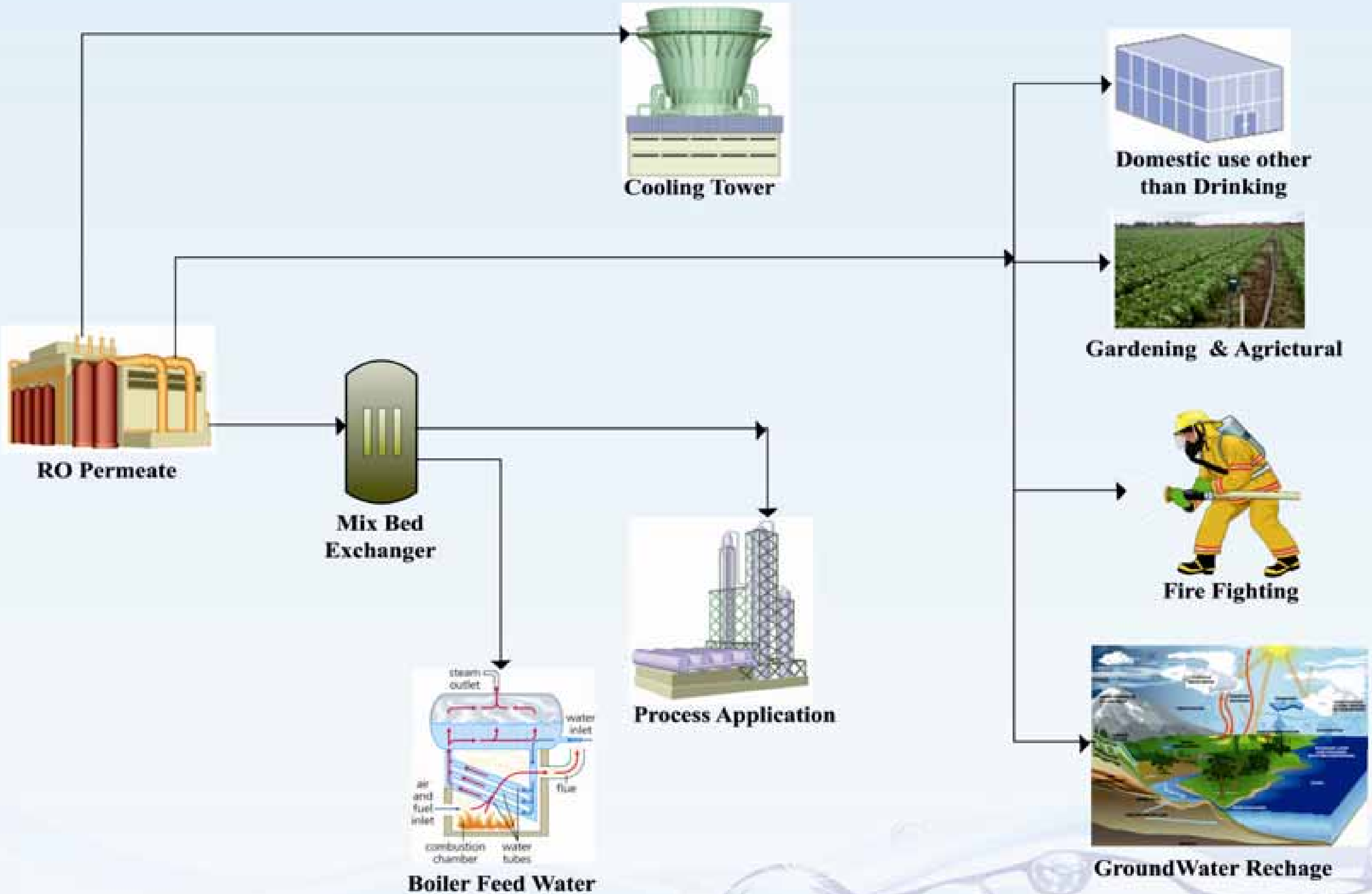
This means that wastewater will be treated and used again in the process. Because of the water reuse wastewater will not be released on the sewer system or surface water.

Waste Hierarchy Pyramid



Water Reuse Applications

PARAMOUNT



Waste Water Treatment

PARAMOUNT

PRIMARY TREATMENT

- PRIMARY TREATMENTS
  COAGULATION / FLOCCUALTION THROUGH:
  - SOLID CONTACT REACTOR / HRSSC
  - PARALLEL PLATE / TUBE SETTLERS
  - DISSOLVED AIR FLOATATION

SECONDARY TREATMENT

- ACTIVATED SLUDGE PROCESS
  - ANAEROBIC REACTOR
  - ATTACHED GROWTH AEROBIC BIOLOGICAL SYSTEM
  - MBR

Technologies – Primary Treatment

PARAMOUNT

Clarifier

Clariflocculator

Solid contact clarifier

Tube settler

Dissolved Air Floatation

Oil skimmer

High Speed Clarifiers – MULTIFLO/ PULSATOR

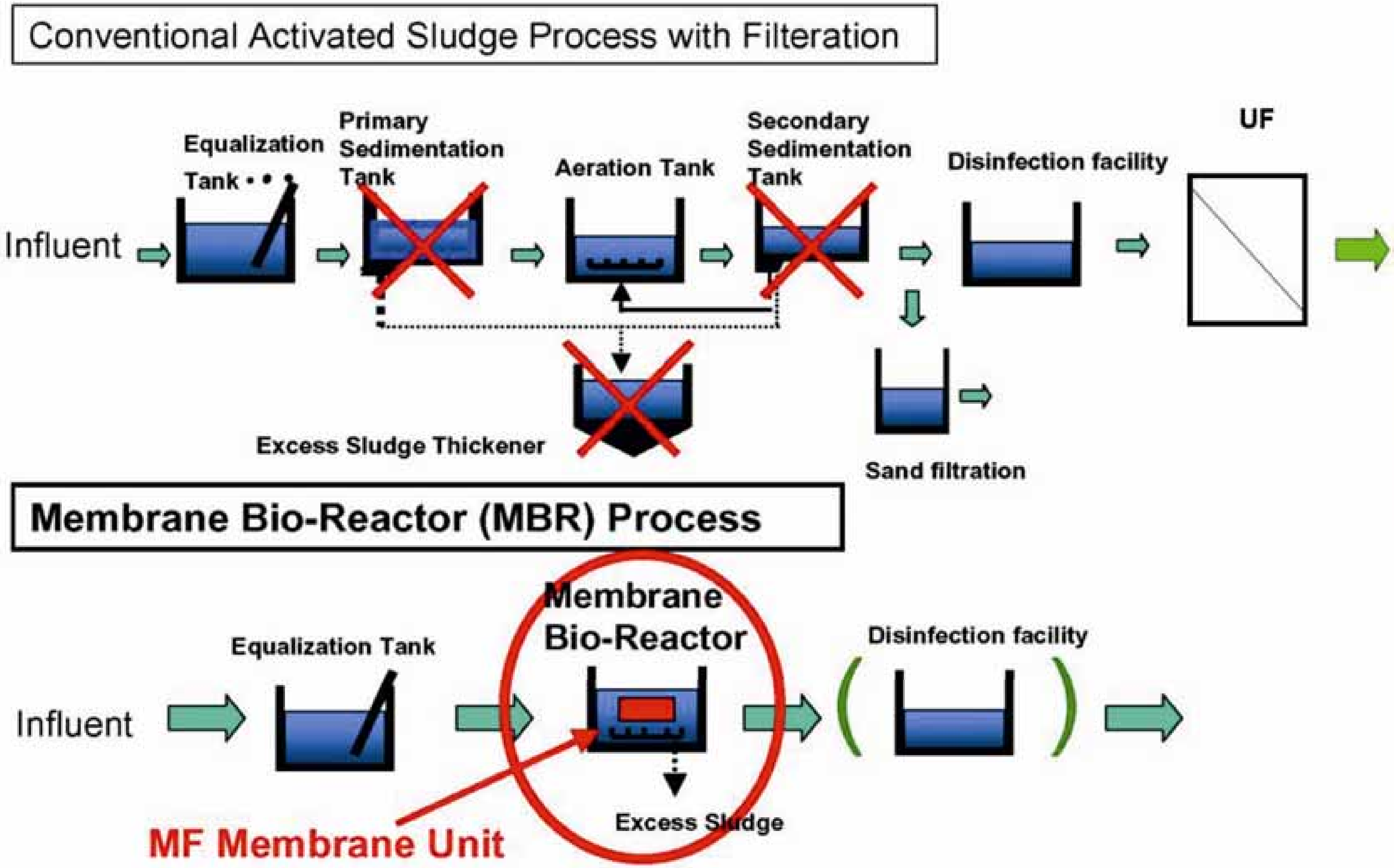
Waste Water Treatment techologies – Secondary Treatment

PARAMOUNT

- **ASP** (Activated Sludge Process with floating Aeration)
- **MBBR** (Moving Bed Bio Reactor)
- **ASBR** (Advanced Sequence Batch Reactor)
- **MBR** (Membrane Bio Reactor)

Membrane Bio Reactor (MBR)

PARAMOUNT

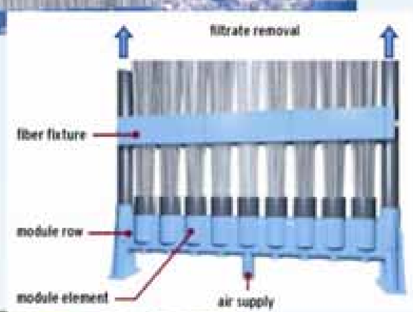


Membrane types

PARAMOUNT

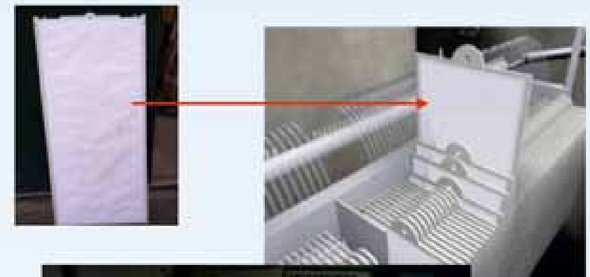
- Three main membranes Technologies are available in the market

Hollow Fibers



External Tubular Membranes

Flat Sheet Membranes



MBR Configurations

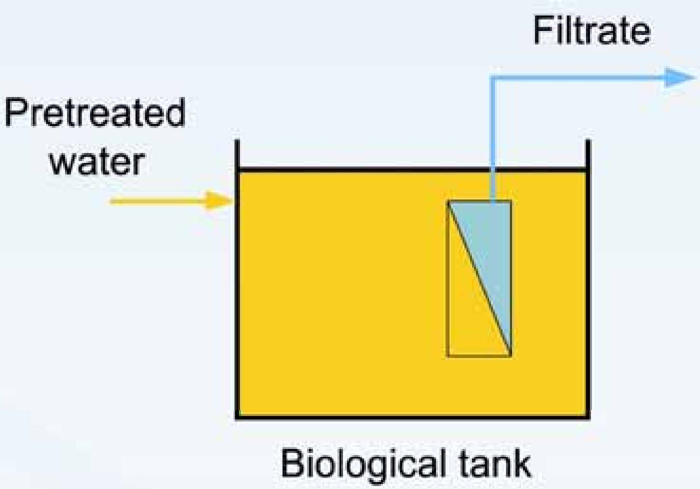
PARAMOUNT

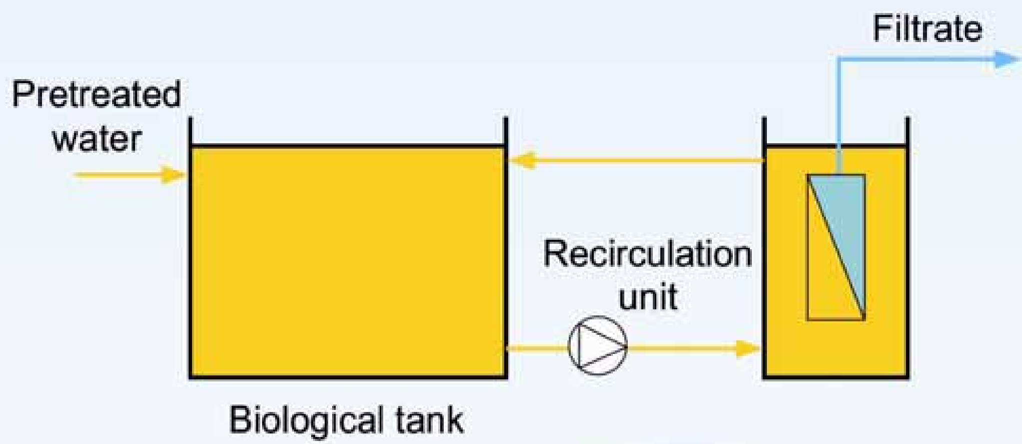
Two configurations according to the existing site constraints, the type of membrane selected & the design criteria.

Submerged System: Membrane immersed within the Biological reactor

or

External MBR: Membrane installed in a separated tank





Two MBR Configurations to fit all wastewater applications

Advantages of MBR

PARAMOUNT

Advantages Of MBR

Quality
Disinfection, No Bacteria
No SS nor colloids
Biodegradable COD removed

Robust
No Bulking sludge
No sludge loss
Load Adjustment

Water Reuse
Direct irrigation
Perfect RO Pre-treatment

Compactness
High sludge concentration
Aeration Volume 1/3 of conventional
No primary settler

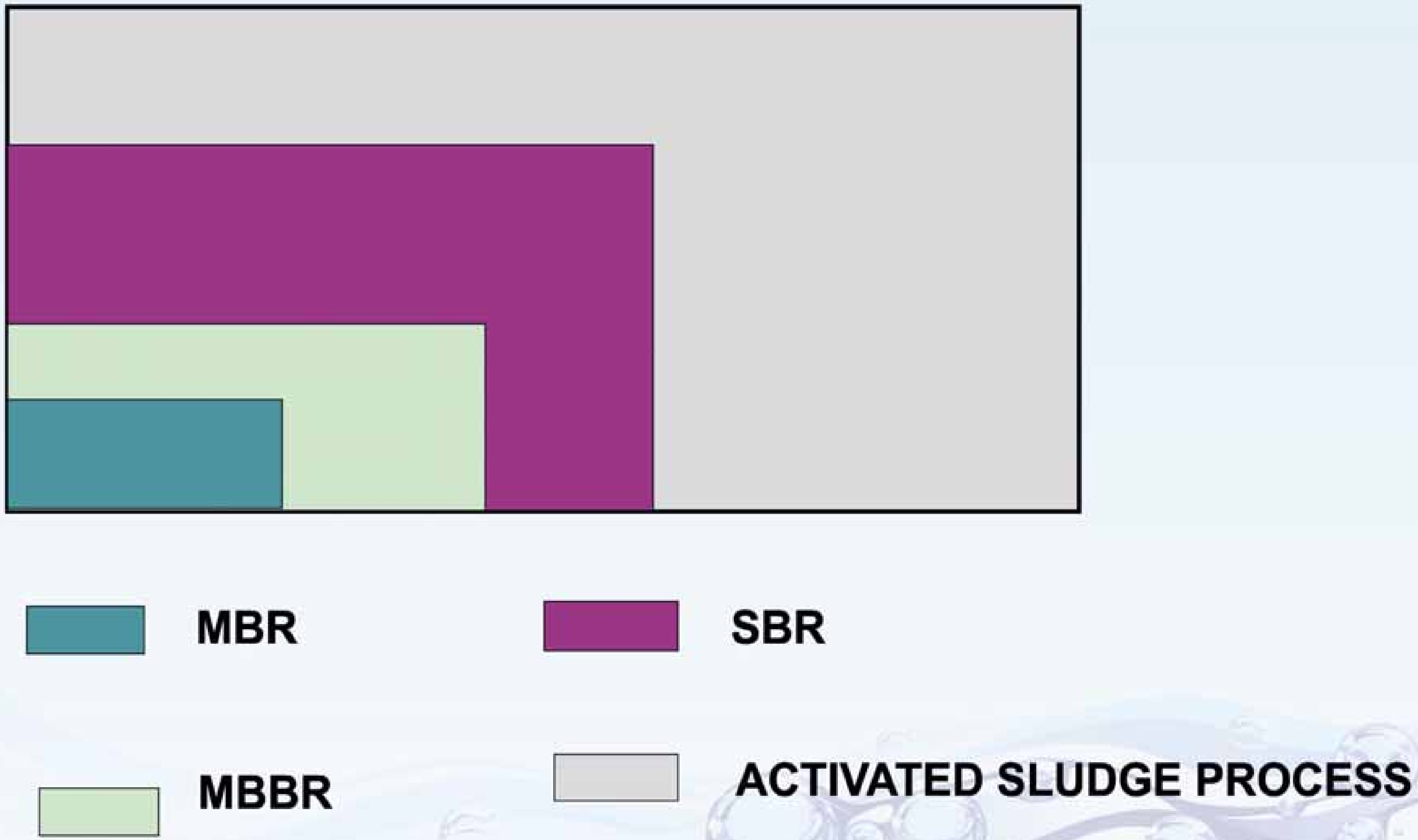
Neighbourhood
Closed system
Odour control
No open water surface

Flexibility
Large operating window
Easy modular extension

Simplicity
Hydraulic is simple
Low pressure membranes

Refurbishment
Use of existing plant
Is easier and less costly

Area Requirement for ETP

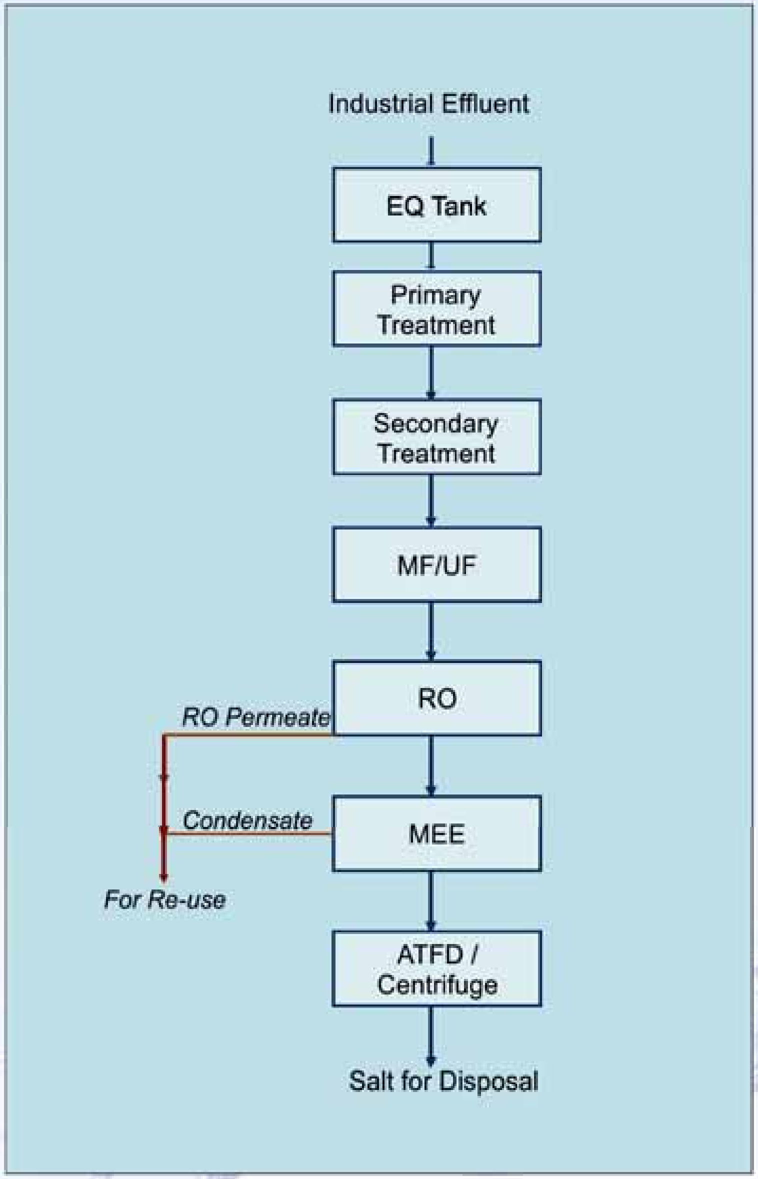


Comparison of Waste Water Technologies

PARAMOUNT

	MBBR	ASP	ASBR	MBR
Biomass type	Fixed to plastic suspended carriers	Free biomass suspended in water	Free biomass suspended in water	Free biomass suspended in water
Recommended Technology	Space constraint & upgradation of existing ETP. For horticulture.	Space available & skilled operation not required. For safe discharge	Load fluctuation & treated quality for horticulture	Recycle & reuse of treated effluent
Operation & Maintenance	Medium skilled	Unskilled	Skilled	Highly Skilled
Solids inlet sensibility	No. 3-5 mm screening necessary	No	No	Yes. 1mm screening necessary
Flow variations sensibility	Yes. Limited to 2nd clarifier capacity	Yes. Limited to 2nd clarifier capacity	No	Yes. Buffer tank needed
MLSS (g/l)	5 - 7	3 – 5	4 – 6	10 – 12
Treated effluent quality (ppm)	TSS: 50 BOD: 20	TSS: 100 BOD: 30 – 50	TSS: 20 – 40 BOD: 10 - 20	TSS: BDL BOD < 5

Typical Flow Chart for ZLD



The Membrane Tertiary Treatment Solution

PARAMOUNT

Effluent from ETP →

MicroFiltration

→

Reverse Osmosis

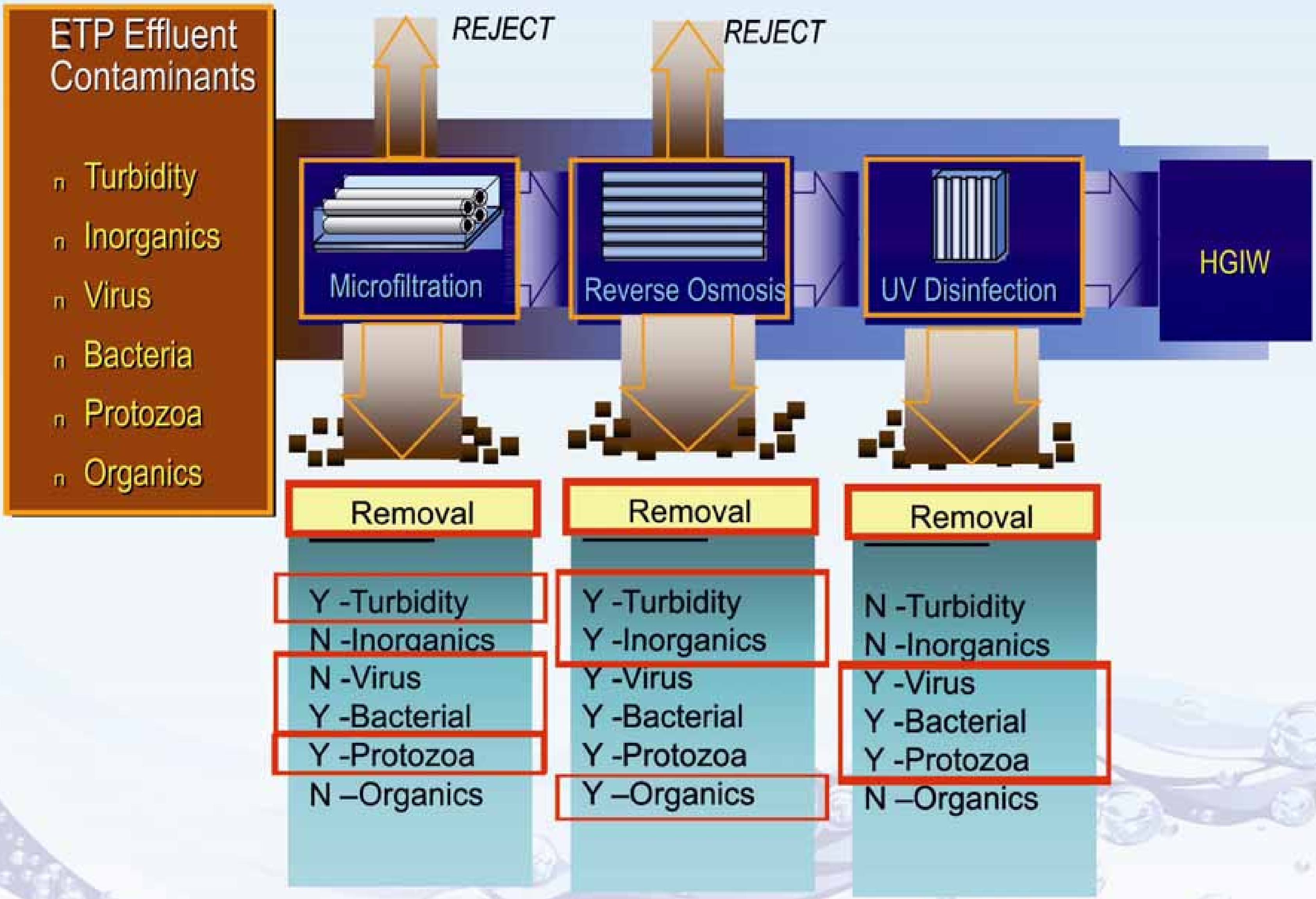
→

UltraViolet

→ HGIW

The Membrane Tertiary Treatment Solution

PARAMOUNT



MF/UF Technologies Available in the Market Today

PARAMOUNT

Submerged vs Pressurised

MF/UF Technologies Available in the Market Today

PARAMOUNT

Microporous hollow fibers

	A_m	B_z	C_a	D_h	E_n
	Submerged		Pressurised		
	MF	UF	MF	UF	UF
Mode of operation	Dead-end		Cross-flow	Dead-end	
Filtration	Outside - In			Inside - out	
Membrane material	PP	PVDF		PES	
Pore size (um)	0.2	0.02	0.1	0.025	
Fiber orientation	Vertical	Horizontal	Vertical		Horizontal
Backwash	AIR + WATER				WATER

MicroFiltration (MF) Membrane System Design

Performance

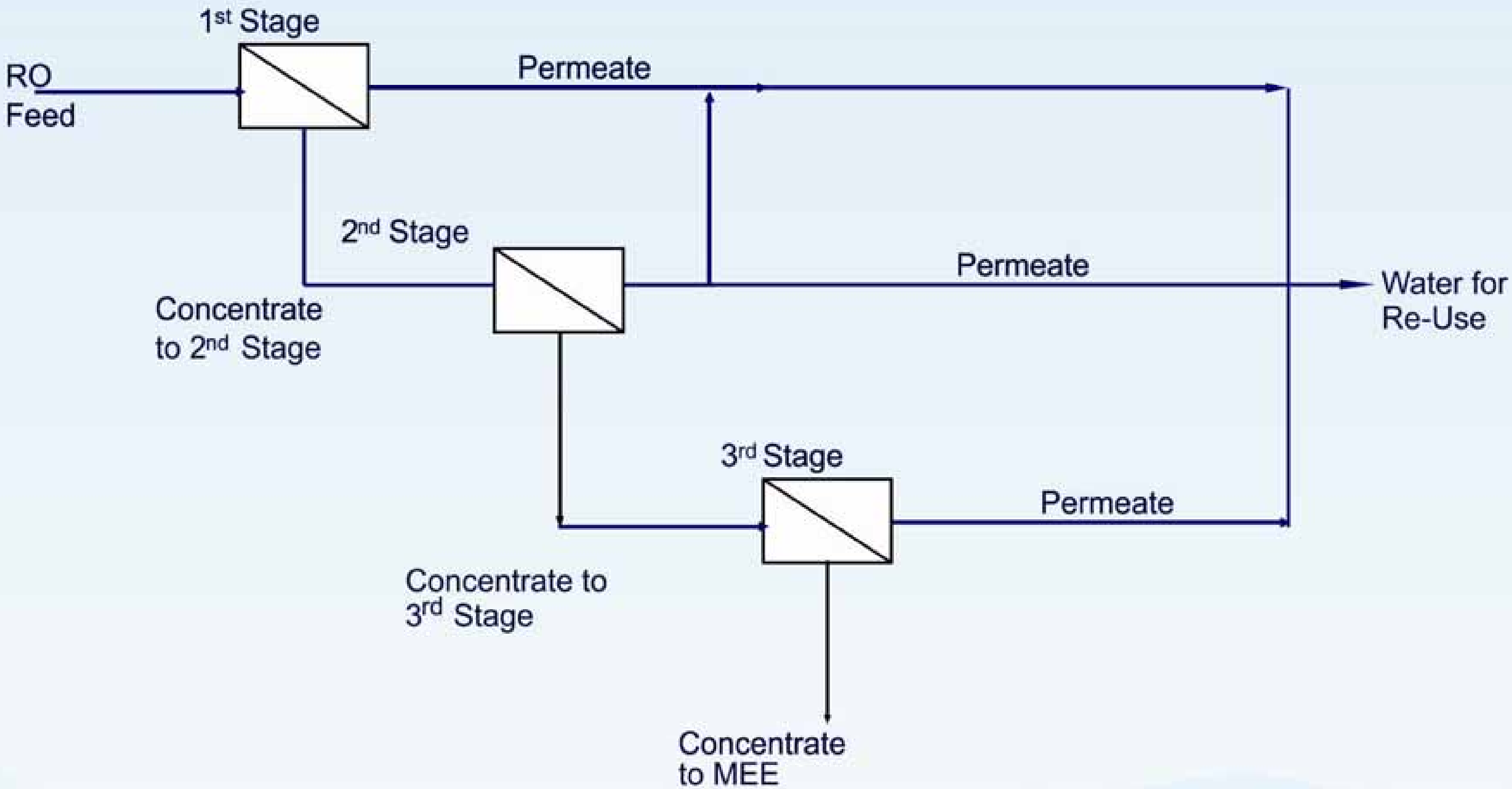
- Design Flux: approx. 33l/m2.h
- Recovery: 90% (min)
- Filtrate SDI: < 3.0
- Filtrate Turbidity: < 0.5 NTU

Configuration (for submerged)

- 13 to 14 Membrane trains/Cells
- 14 racks/ train: 32 sub-modules/rack

Typical RO Membrane Systems – PFD

PARAMOUNT



Combination to achieve maximum recovery subject to inlet conditions.

Purpose of Evaporation

PARAMOUNT

- To concentrate solution by removing the vapor from a boiling liquid solution
- In the majority of cases, evaporation refers to the removal of water from an aqueous solution.
- Example: concentration of aqueous solutions of sugar, sodium chloride, sodium hydroxide, glycerol, glue, milk & orange juice. Apart from this now a days MEE is used to achieve the Zero Liquid discharge.
- In all the process application the concentrated solution is the desired product and in case of ZLD the condensate is desired product.
- In a few cases, water, which contains a small amount of minerals, is evaporated to give a solids-free water to be used as boiler feed, for special chemical processes.
- Evaporation processes to evaporate seawater to provide drinking water have been developed and used.

Processing Factors

- Concentration in the liquid
  - low viscosity: high mass transfer coefficient
  - high viscosity: low mass transfer coefficient
  - adequate circulation and/or turbulence must be present to keep the coeffeicient from becoming too low

- Solubility
  - solubility increases with temperature
  - crystallization may occur when a hot concentrated solution is cooled to room temperature

- Temperature sensitivity of materials
  - food and biological materials may be temperature sensitive and degrade at higher temperature or after prolonged heating.

Processing Factors

PARAMOUNT

- Foaming or frothing
  - food solution such as skim milk and some fatty-acid solution form a foam or froth during boiling.
- Pressure and temperature
  - high operating pressure: high boiling point
- Scale deposition and materials of construction
  - Some solutions deposit solid materials called scale on the heating surfaces.
  - results in the overall heat-transfer coefficient decreases and evaporator must be cleaned.

Methods of Operation of Evaporators

PARAMOUNT

- Single-effect evaporators
- Forward-feed multiple-effect evaporators
- Backward-feed multiple-effect evaporators
- Parallel-feed multiple-effect evaporators

Single-effect evaporators

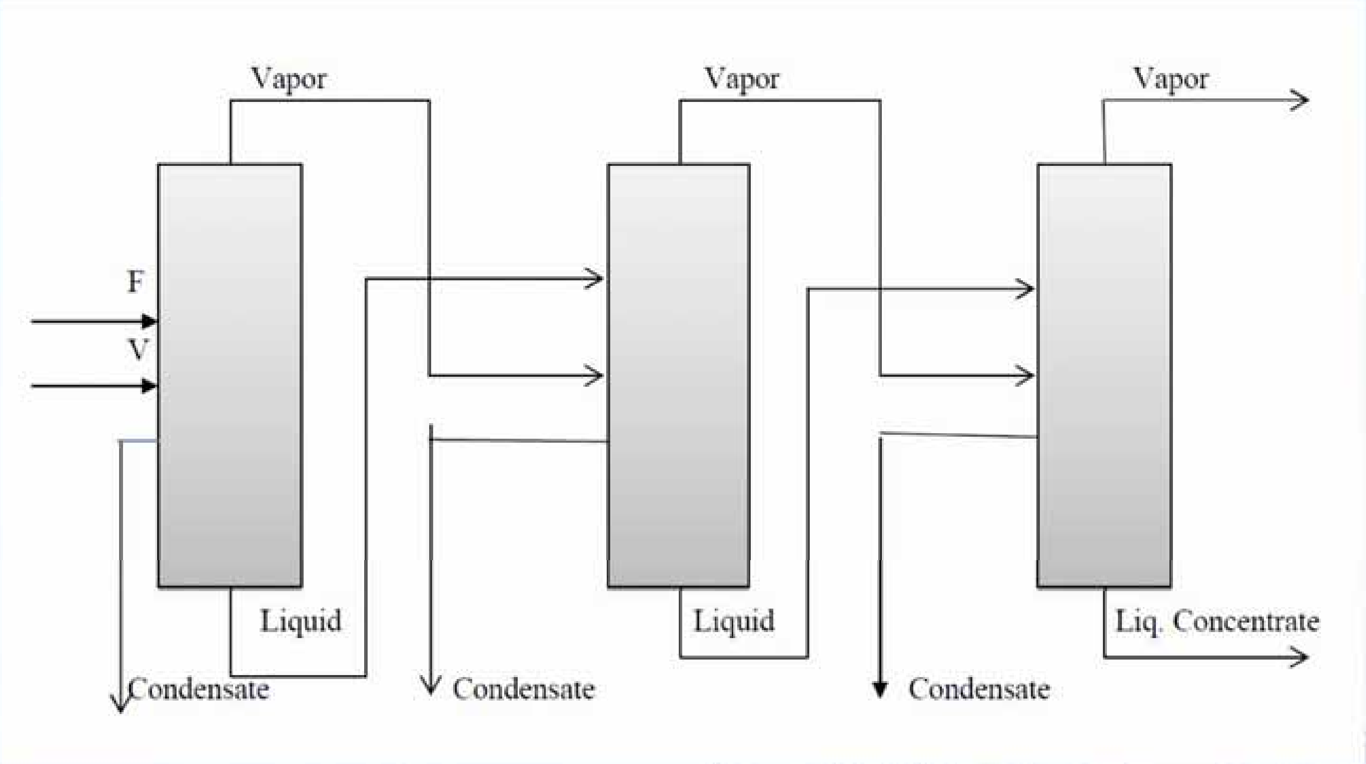
PARAMOUNT

- Single-effect evaporators are often used when the required capacity of operation is relatively small and/or the cost of steam is relatively cheap compared to the evaporator cost.
- However, for large-capacity operation, using more than one effect will markedly reduce steam costs.

Forward Feed - MEE

PARAMOUNT

FORWARD FEED ARRANGEMENT: In this arrangement the feed and steam is introduced inthe first effect. Pressure in the first effect is highest and pressure in last effect is minimum, sotransfer of feed from one effect to another can be done without pump.



Forward feed arrangement in Multi effect Evaporator

Forward-feed multiple-effect evaporators

PARAMOUNT

- If the feed to the first effect is near the boiling point at the pressure in the first effect, 1kg of steam will evaporate almost 1 kg of water.
- The first effect operates at a temperature that is high enough that the evaporated water serves as the heating medium to the second effect.
- Here, again, almost another kg of water is evaporated, which can then be used as the heating medium to the third effect.
- As a very rough approximation, almost 3 kg of water will be evaporated for 1 kg of steam in a three-effect evaporator.
- Hence, the steam economy, which is kg vapor evaporated/kg steam used, is increased.
- This also holds approximately for more than three effects.

However, the increased steam economy of a multiple-effect evaporator is gained at the expense of the original first cost of these evaporators.

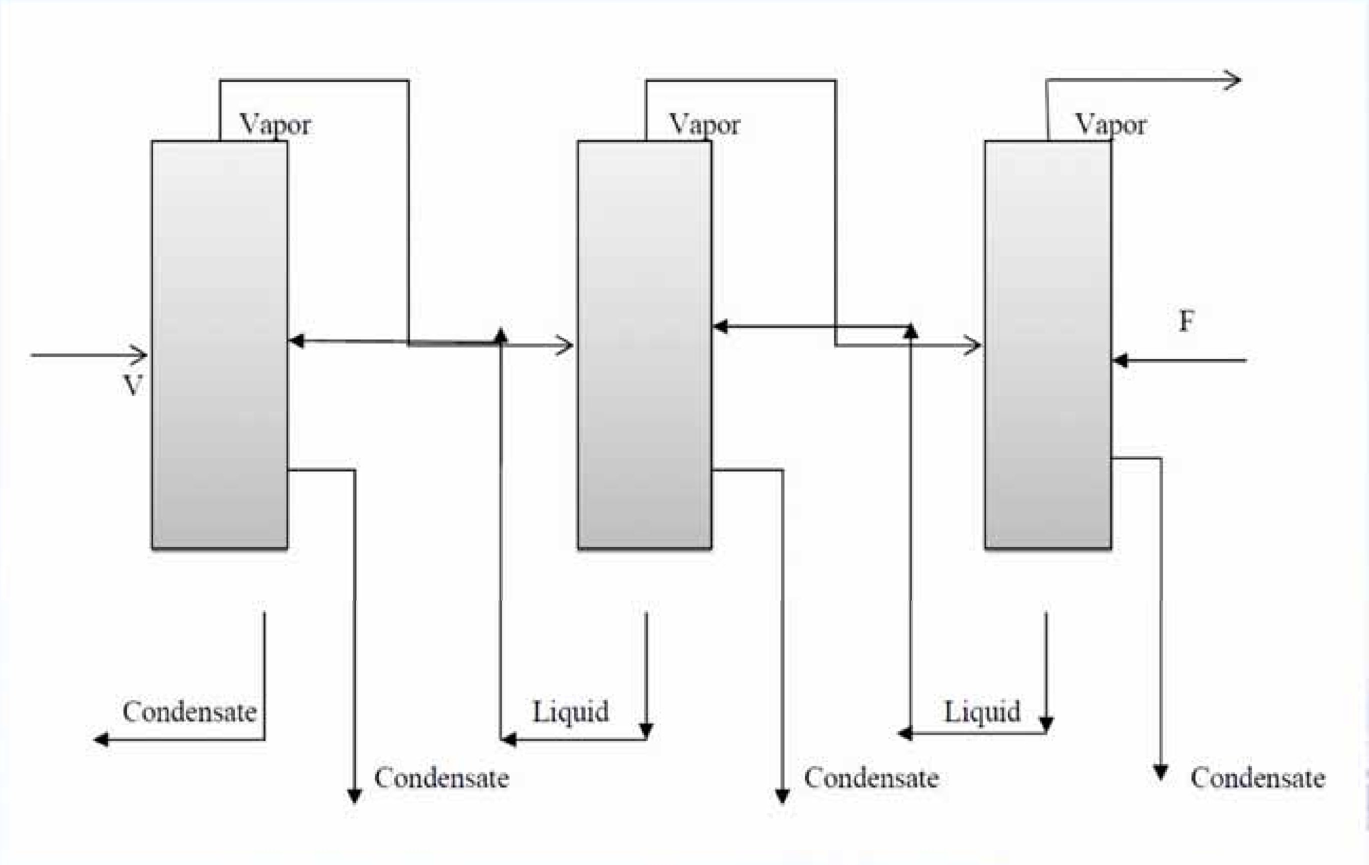
Forward-feed multiple-effect evaporators

PARAMOUNT

- In forward-feed operation the fresh feed is added to the first effect and flows to the next in the same direction as the vapor flow.
- This method of operation is used when the feed is hot or when the final concentrated product might be damaged at high temperatures.
- The boiling temperatures decrease from effect to effect. This means that if the first effect is at P1 = 1 atm abs pressure, the last effect wilt be under vacuum at a pressure P3.

Backward Feed - MEE

BACKWARD FEED ARRANGEMENT: In this arrangement feed is introduced in last effect and steam is introduced in first effect. For transfer of feed, it requires pump since the flow is from low pressure to higher pressure. Concentrated liquid is obtained in first effect.



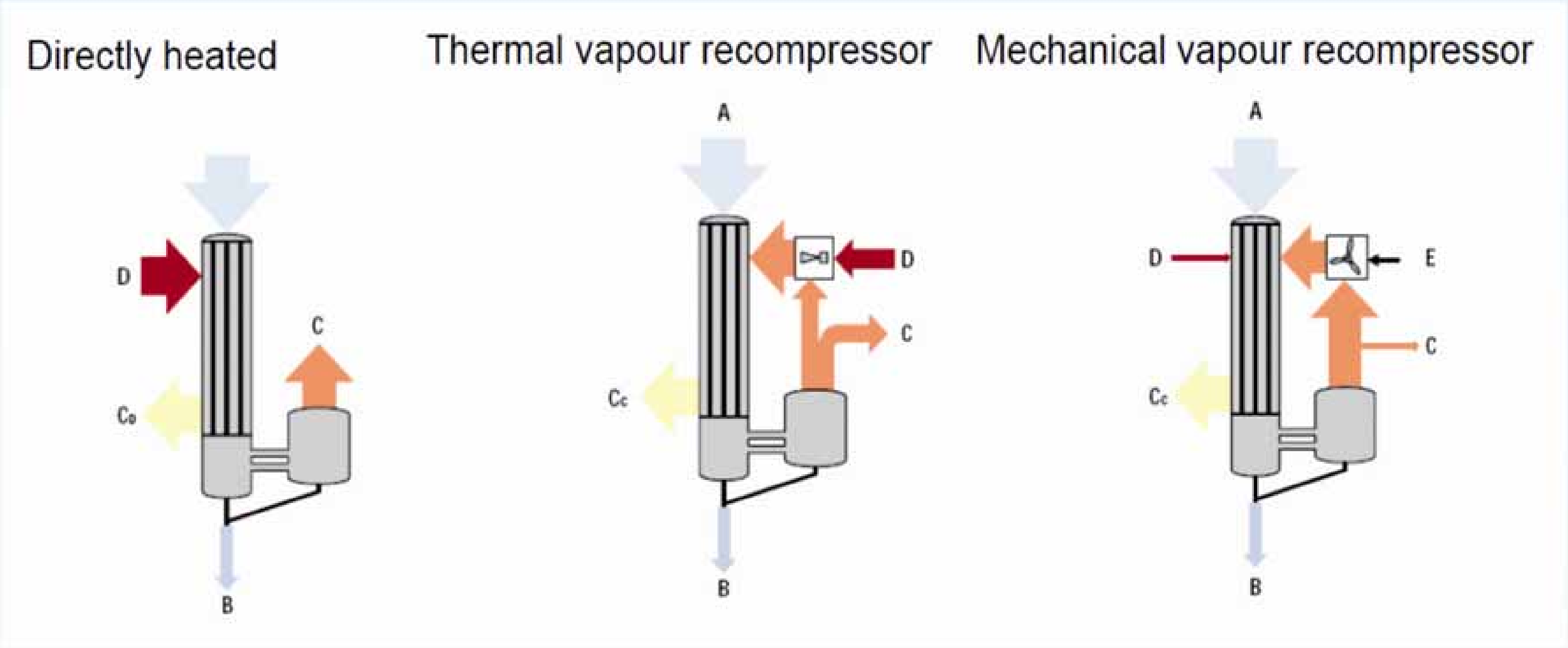
Backward feed arrangement in Multi effect Evaporator

Backward-feed multiple-effect evaporators

PARAMOUNT

- In the backward-feed operation for a triple-effect evaporator, the fresh feed enters the last and coldest effect and continues on until the concentrated product leaves the first effect.
- This method of reverse feed is advantageous when the fresh feed is cold, since a smaller amount of liquid must be heated to the higher temperatures in the second and first effects.
- However, liquid pumps must be used in each effect, since the flow is from low to high pressure.
- This reverse-feed method is also used when the concentrated product is highly viscous.
- The high temperatures in the early effects reduce the viscosity and give reasonable heat-transfer coefficients.

Types of Vapour Recompression



A : Product
B : Concentrate
C : Vapour
D : Steam
E : Electrical energy
Cc: Steam condensate

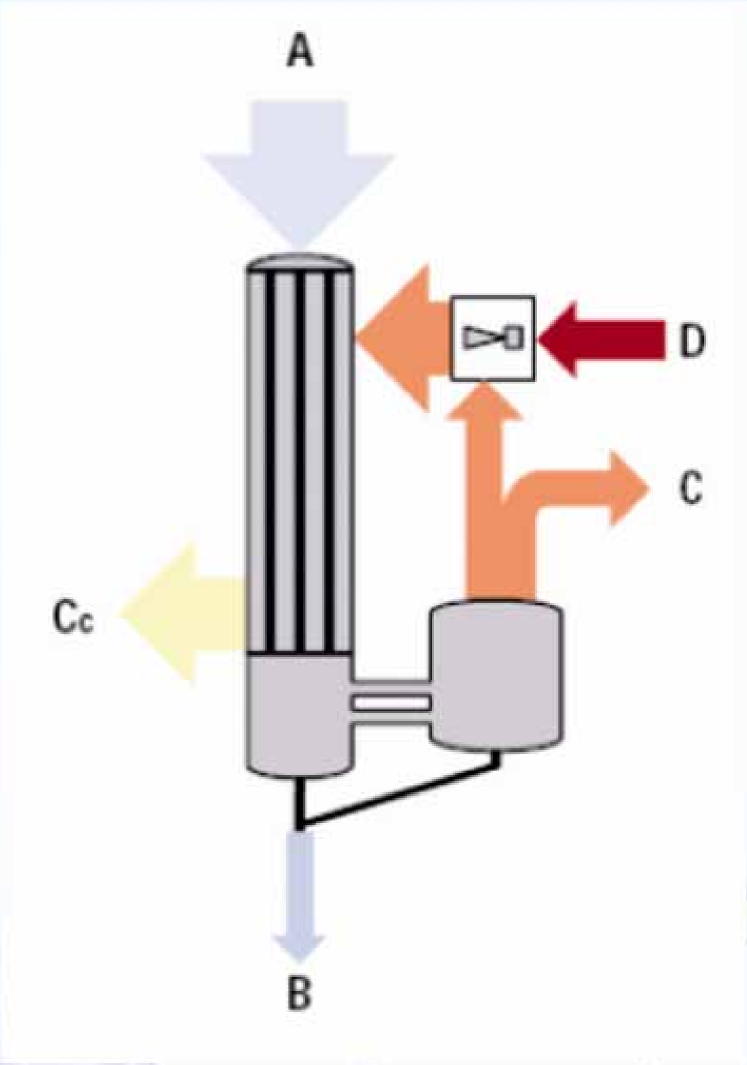
Thermal Vapour Recompressor

PARAMOUNT

During thermal vapour recompression, vapour from a boiling chamber is recompressed to the higher pressure of a heating chamber according to the heat pump principle; i.e. energy is added to the vapour.

For this purpose, thermal vapor recompressor are used.

A certain quantity of live steam, the so-called motive steam, is required for the operation of a thermal vapour recompressor. This motive steam quantity must be transferred to the next effect or to the condenser as surplus residual vapour. The surplus energy contained in the residual vapour approximately corresponds to the amount of energy supplied in the motive steam.



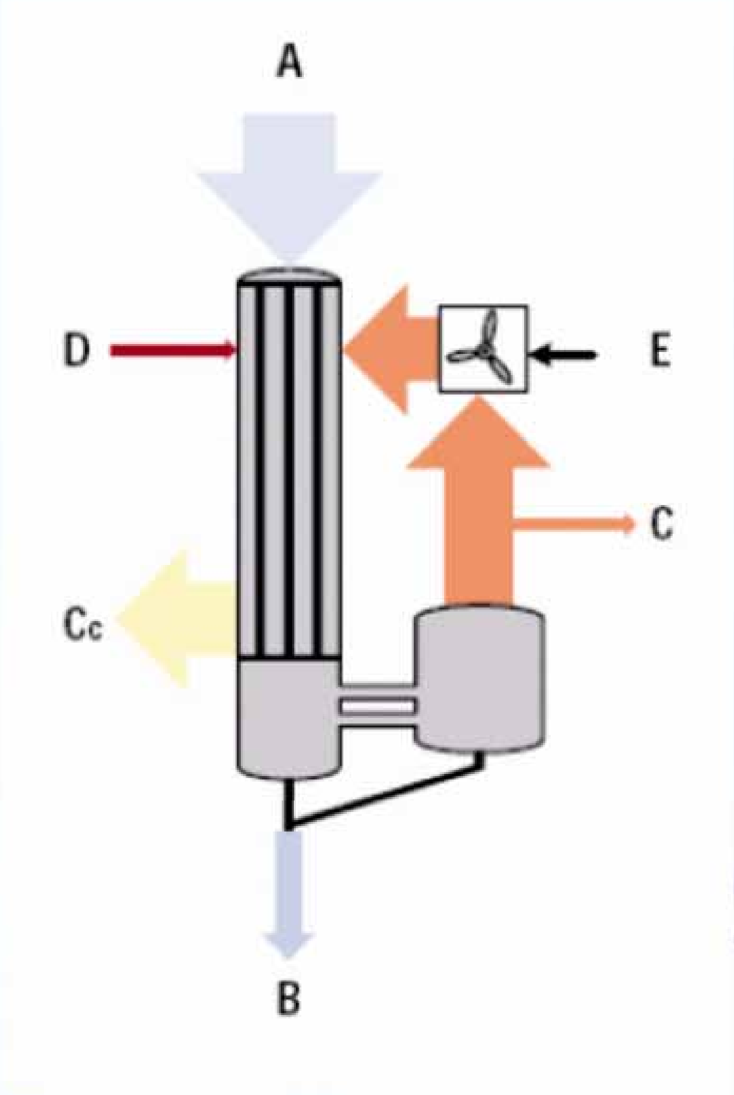
Mechanical Vapour Recompressor

PARAMOUNT

In mechanical vapor compression, positive displacement compressors or multi stage centrifugal compressors are generally used to raise the pressure and temperature of the generated vapors.

Since mechanical compressors do not require any motive steam, all vapors can be compressed to elevated pressure and temperature eliminating the need for subsequent recovery system.

After compression of vapor and subsequent condensation of the same, hot condensate leaves the system.



The main features of MVR are as follow :

* Most energy efficient evaporation technology (n-effect)
* Flexible and simple to use
* Generally single effect (reduced footprint)
* No steam and cooling water consumption (boiler and cooling tower cost reduction)
* Suitable for moderate boiling elevation products

Low specific operating cost

Case Studies

Waste Water Recycle

&

Zero Liquid Discharge

PARAMOUNT

PARAMOUNT

Swil Copper Ltd

Flow : 225 m3/day

(Copper Smelter)

ZLD Using Evaporative Cooling & Waste Gases

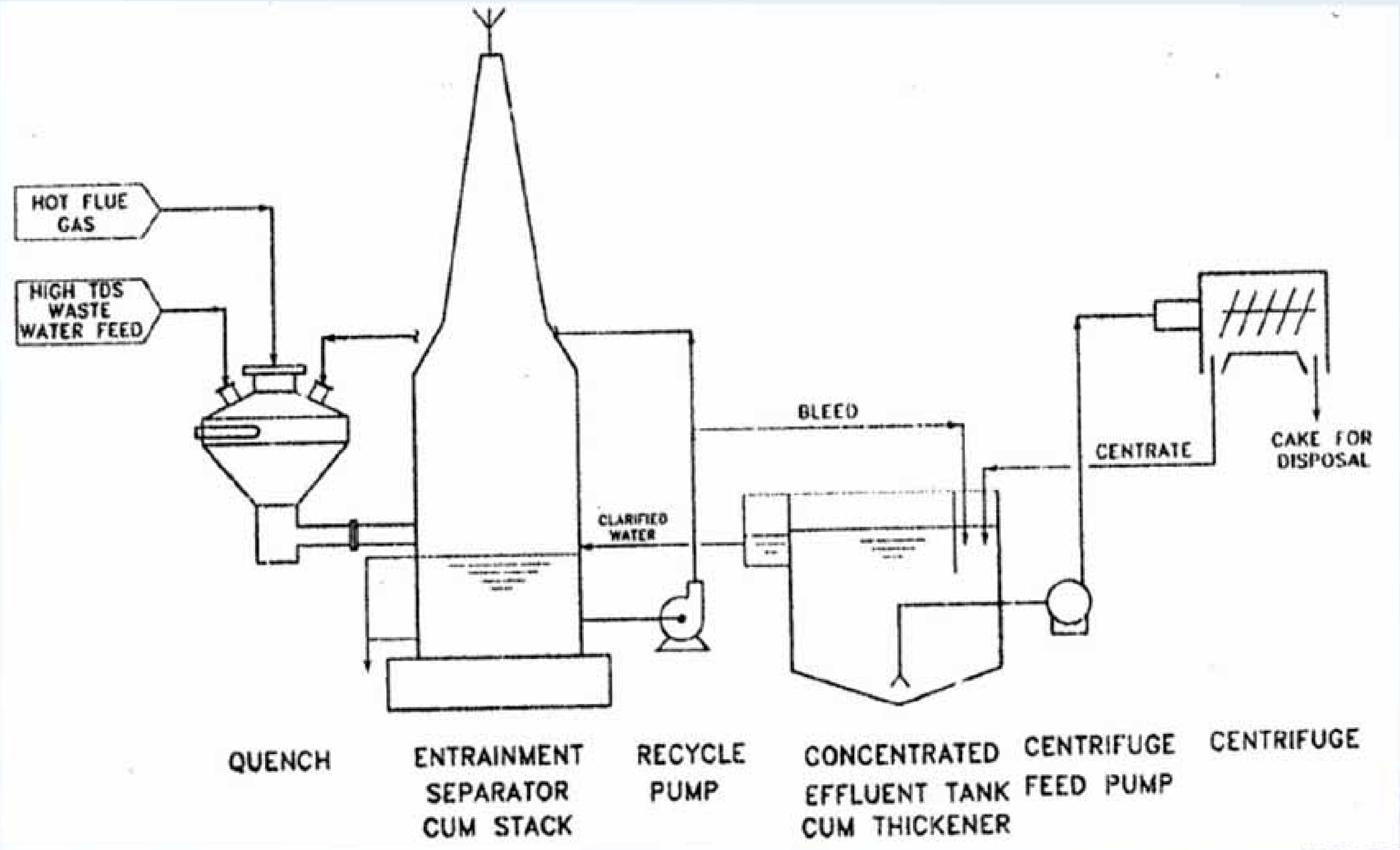
PARAMOUNT

"Paramount's Innovative approach to zero discharge using "Quench"

Paramount Design- Technical Approach

- Paramount offers a system that uses the concept of evaporative cooling . But it is looked at from a different perspective. In normal practice,
- A Quench is used to cool the hot gas by having a direct contact water spray to reduce the gas temperature. Water is evaporated and converted to steam which is based on evaporative cooling.
- But in case of Paramount's design of Quench for concentrating the high TDS bearing waste water,
- Quench is used to evaporate the water using waste water heat rather than the conventional concept of cooling the gases with water.

ZLD Using Evaporative Cooling & Waste Gases



ZLD Using Evaporative Cooling & Waste Gases

PARAMOUNT

This concept was used at M/S SWIL for evaporating water from waster containing high level of dissolved solids using waste heat in the flue gases from power plant and resulted in:

- Concentration of the waste water in the form of slurry containing suspended solids, generated due to presence of high TDS (50000-55000 ppm) and evaporation of water which is centrifuged to form a disposable cake.
- The centrate from the centrifuge is sent back to the quenching system for further evaporation and cooled gases with water vapour is discharged to atmosphere through stack.

ZLD Using Evaporative Cooling & Waste Gases

PARAMOUNT

Inlet treated effluent	:	130-225 m^3/day
TDS	:	33,000-53,000 ppm
pH	:	7-8

PARAMOUNT

Conclusion

- This concept was found highly feasible and practical solution for evaporation of waste water to achieve zero discharge goal.
- This concept was also presented to Ministry of Environment and forest and has been accepted.
- This approach also helps to achieve reduction in the initial cost of the plant including extremely low operating cost.

Mangalore Refinery

Flow : 24000 m3/day

(Refinery & Petrochemical Industry)

MRPL Charactristics

PARAMOUNT

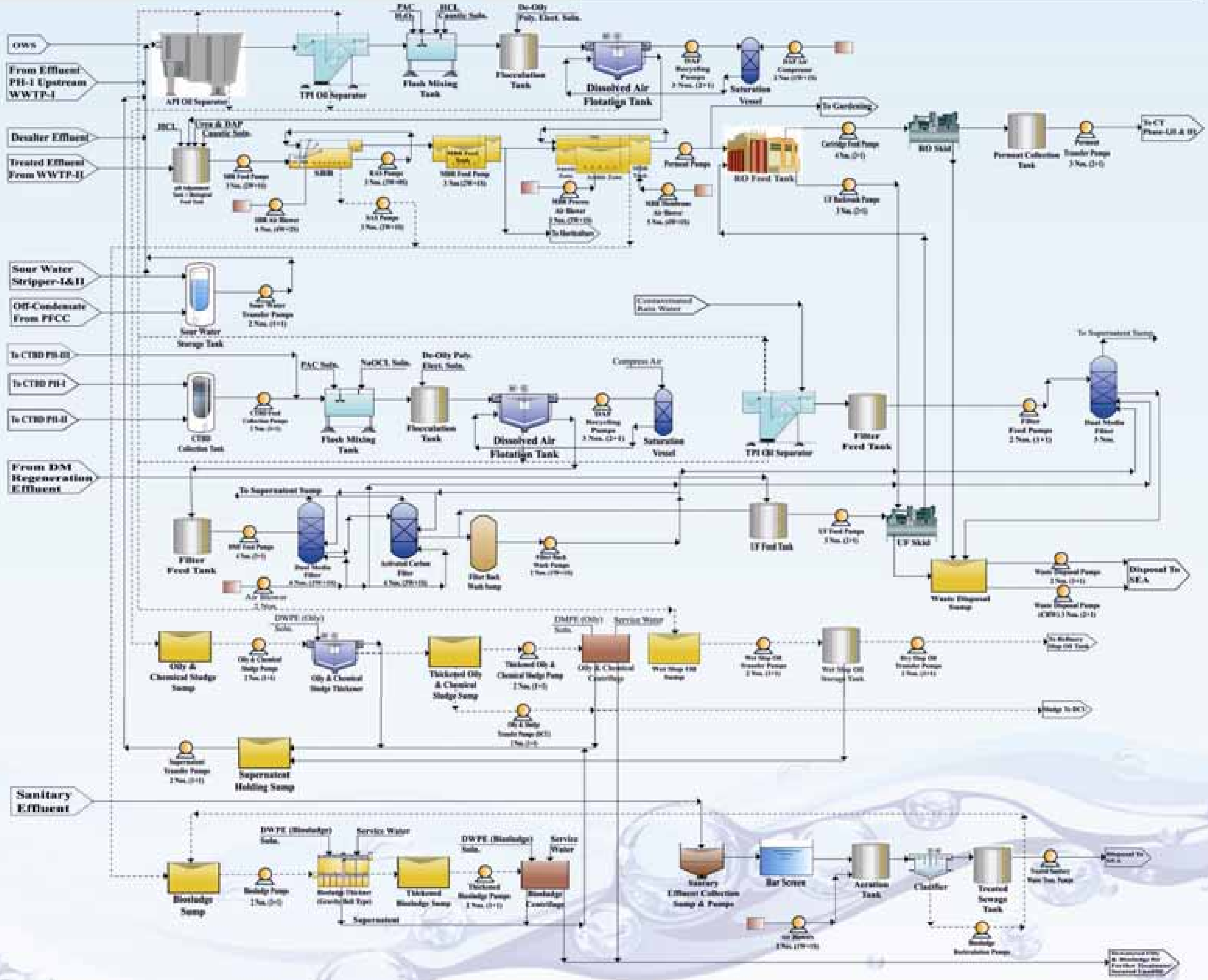
Inlet Characteristics

Parameter	Units	CTBD & DM neutralized stream after UF Concentration	From MBR Concentration	Average combined feed to RO Concentration
Total Suspended Solids	mg/l	< 1	< 5	< 3.4
TDS	mg/l	2049	1200	1540
BOD 27°C, 3 days	mg/l	4	< 3	< 3.4
COD	mg/l	17	< 20	19
M Alkalinity	mg/l	100	300	220
Calcium Hardness as $CaCO_3$	mg/l	226	85	141
Magnesium Hardness as $CaCO_3$	mg/l	126	55	83.4

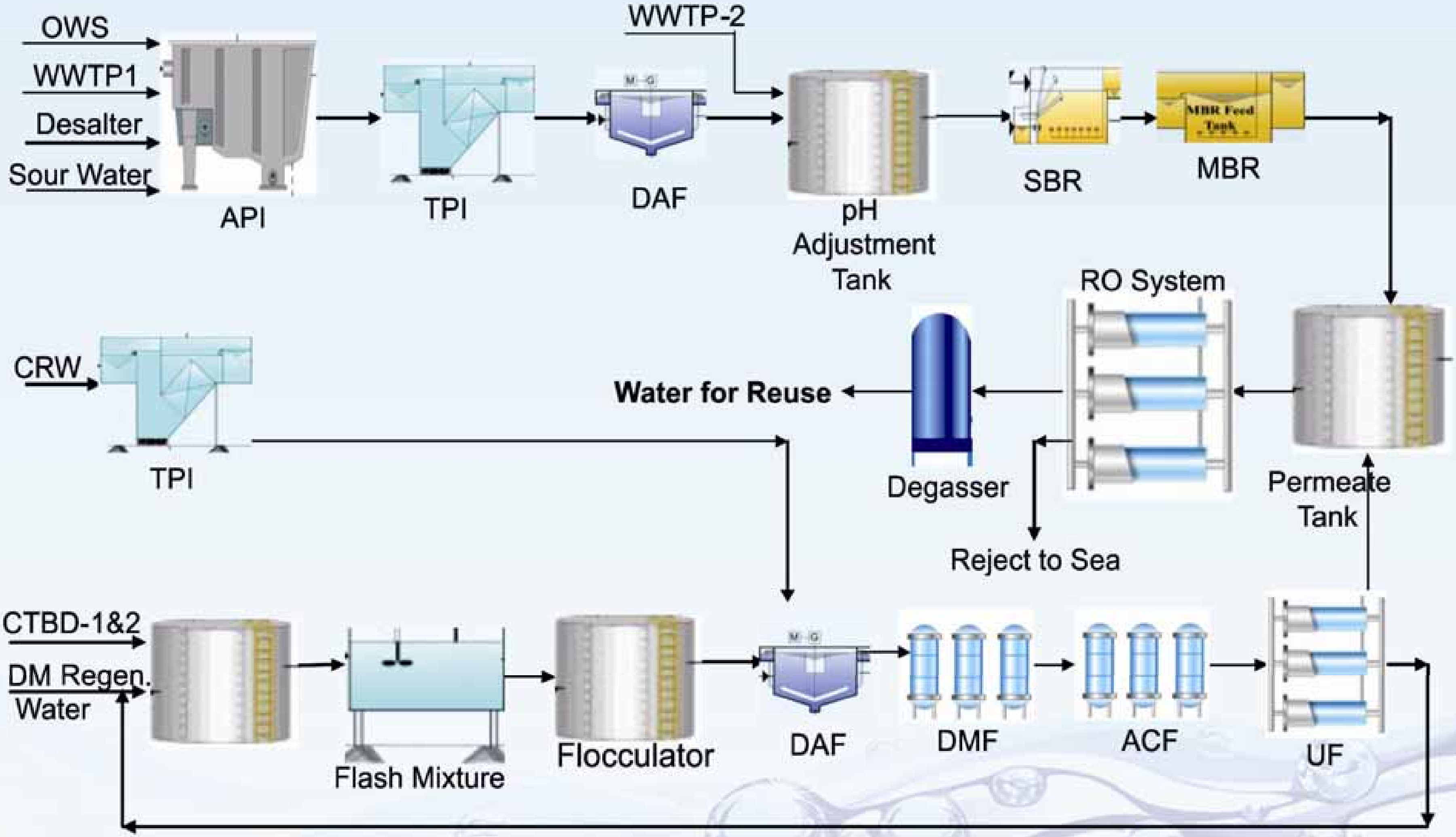
Outlet Characteristics

Parameter	Units	Concentration
Total Suspended Solids	mg/l	Nil
TDS	mg/l	80
BOD 27°C, 3 days	mg/l	BDL
COD	mg/l	BDL
M Alkalinity	mg/l	10
Calcium Hardness as $CaCO_3$	mg/l	5
Magnesium Hardness as $CaCO_3$	mg/l	3
Operating Cost	**Rs.**	**27/m3**

MRPL - Chart



Block Diagram MRPL



MRPL - Site

PARAMOUNT


TPI Unit


API Unit


DAF Unit

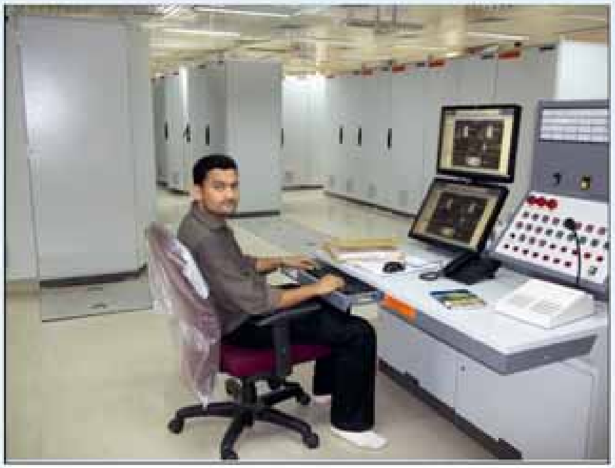

SBR Unit


MBR Unit


DMF - ACF Filter

MRPL - Site

PARAMOUNT



Control Room

Chemical House

RO Skid

RO Degasser

Micron Filter

Over All View

PARAMOUNT

Chennai Petroleum Corporation Ltd

Flow : 10,000 m3/day

(Petrochemical Industry)

CPCL Charactristics

PARAMOUNT

Inlet Characteristics

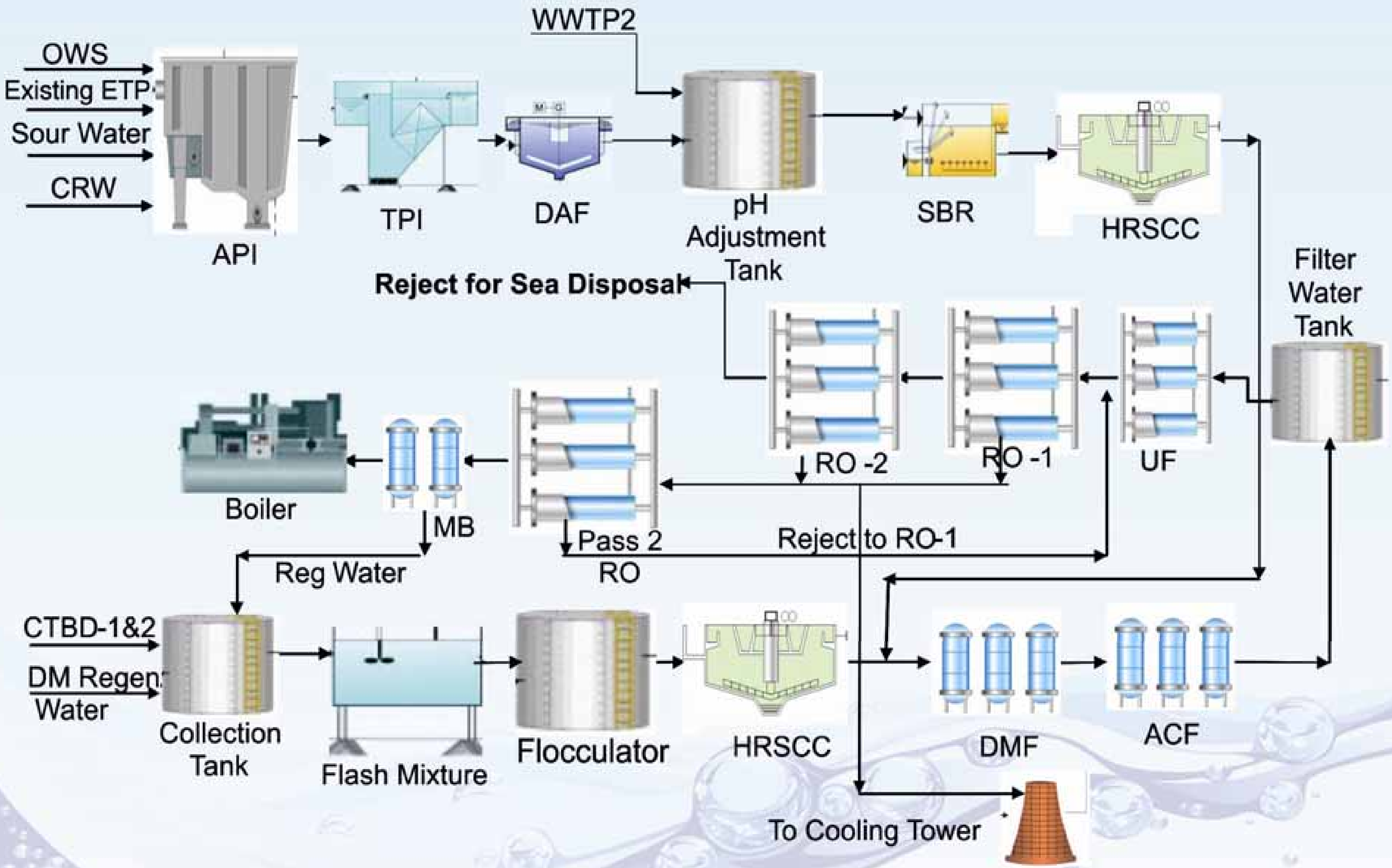
Parameter	Units	CTBD & DM neutralized stream after UF Concentration	From SBR Concentration	Average combined feed to RO Concentration
Total Suspended Solids	mg/l	< 1	< 5	< 3
TDS	mg/l	4000	1500	2500
BOD 27°C, 3 days	mg/l	5	< 5	< 5
COD	mg/l	20	< 20	20
M Alkalinity	mg/l	100	300	220
Calcium Hardness as $CaCO_3$	mg/l	226	85	141
Magnesium Hardness as $CaCO_3$	mg/l	126	55	83.4

Outlet Characteristics after MB

Parameter	Units	Concentration
Total Suspended Solids	mg/l	Nil
TDS	mg/l	< 1
BOD 27°C, 3 days	mg/l	BDL
COD	mg/l	BDL
Silica	mg/l	0.02
Operating Cost	**Rs.**	**45/m3**

Block Diagram CPCL

PARAMOUNT



RO Skid at Paramount Workshop

PARAMOUNT

RO Skid

RO Skid

UF Skid at Paramount Workshop

PARAMOUNT

Pigment Industry

Flow : 1000 m3/day

Client-1 : Asahi Songwon India Ltd

Client-2 : Meghmani Organics Ltd

PARAMOUNT

Pigment Industry

PARAMOUNT

Inlet Characteristics

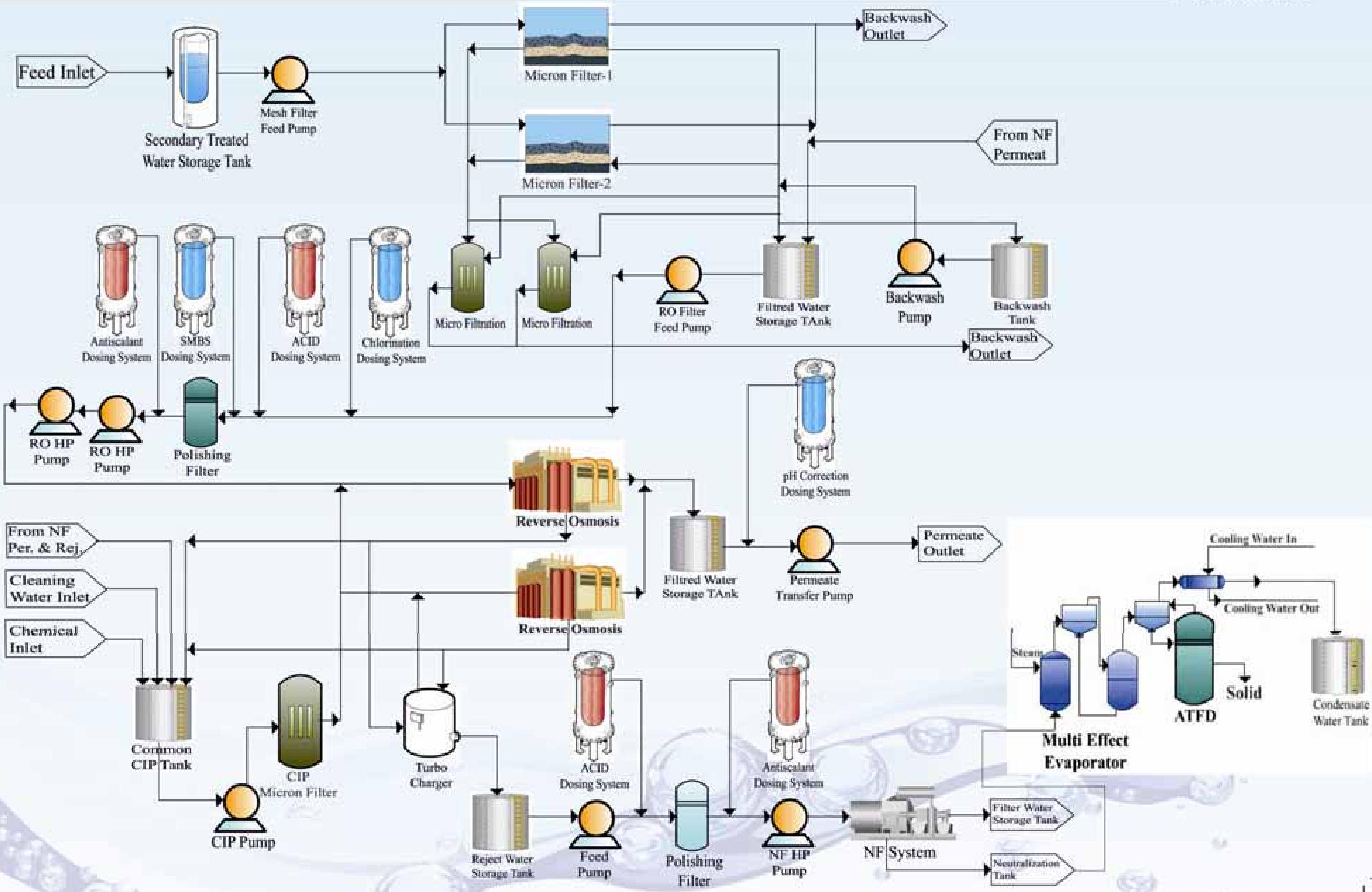
Color	:	Light Blue
Design TDS	:	10000 PPM
TSS	:	250 PPM
COD	:	1000 PPM
BOD	:	250 PPM
Ammonical Nitrogen	:	450 PPM

Outlet Characteristics

Recovery	:	82% (3 Stage System)
Operating Cost	:	Rs.53/m3
Permeate TDS	:	<500 PPM
Permeate COD	:	<50
Permeate Color	:	Color less
Ammonical Nitrogen	:	<50 PPM

Pigment Industry

PARAMOUNT



Pigment Industry-Ceramic Micro Filtration

PARAMOUNT

Sanofi Aventis

Flow : 300 m3/day

(API / Bulk Drug Industry)

Sanofi-Aventis Ltd

PARAMOUNT

Inlet Characteristics

Design TDS	:	3000 PPM
COD	:	600 PPM
BOD	:	100 PPM

Outlet Characteristics

Recovery	:	85%(2 Stage RO system)
Operating Cost	:	Rs.30/m3
Permeate TDS	:	<250 PPM
Permeate COD	:	<30
Permeate Color	:	Color less

Sanofi-Aventis Ltd

PARAMOUNT

Inlet Characteristics (MEE)

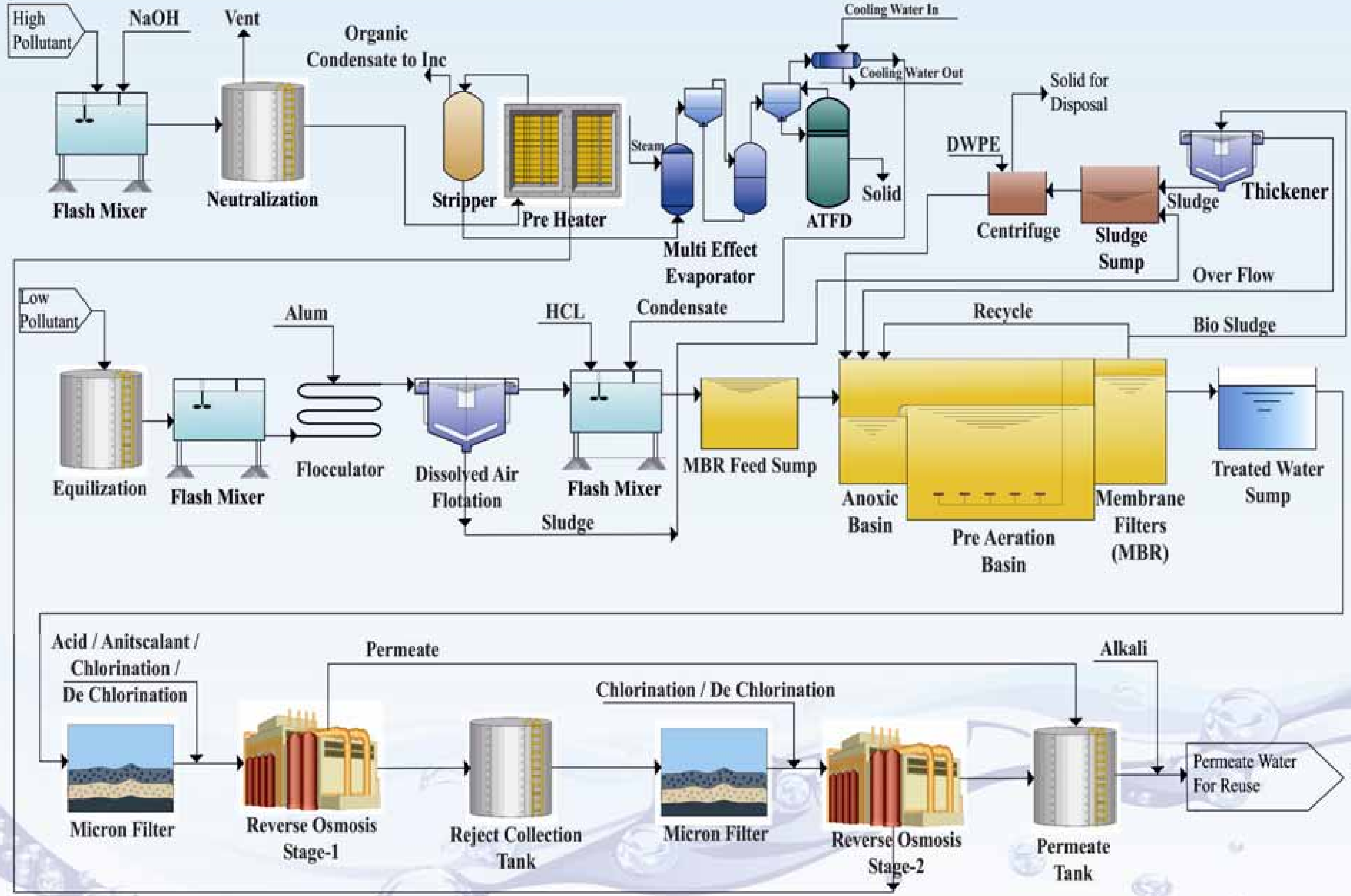
Design TDS	:	4% to 14%
COD	:	20000 PPM

Outlet Characteristics

Condensate TDS	:	<500 PPM
Condensate COD	:	<3000 PPM
Operating Cost	:	Rs.625/m3

Sanofi - Aventis

PARAMOUNT



Sanofi - Aventis - Site

Sanofi - Aventis - Site

PARAMOUNT

Sandoz

Flow : 400 m3/day

(Pharmaceutical Industry)

PARAMOUNT

Sandoz

PARAMOUNT

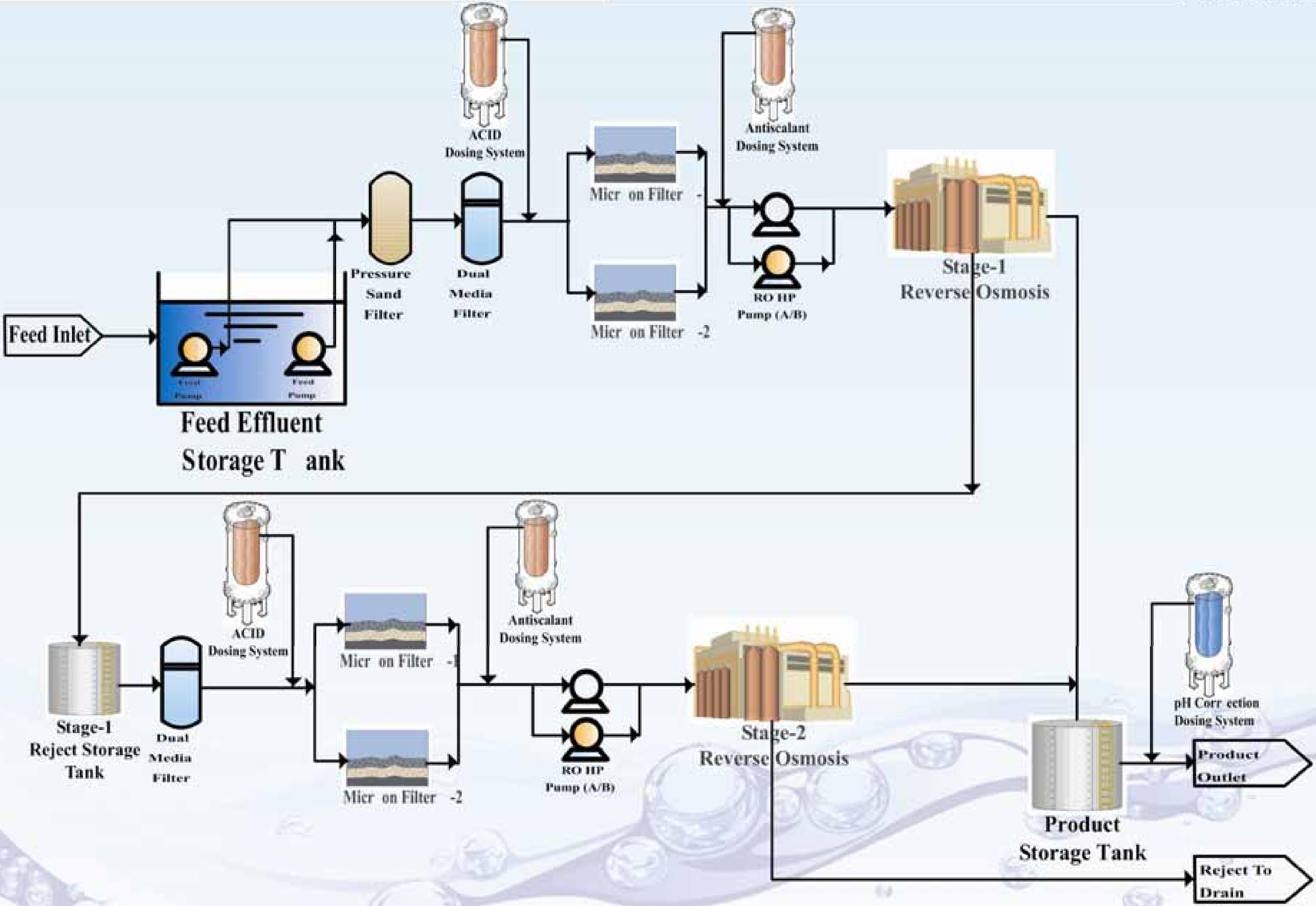
Inlet Characteristics

Design TDS	:	3000 PPM
COD	:	250 PPM
BOD	:	75 PPM

Outlet Characteristics

Recovery	:	85% (2 stage system)
Operating Cost	:	Rs.30/m3
Permeate TDS	:	<250 PPM
Permeate COD	:	<15

Sandoz



PARAMOUNT

Sandoz ETP - Reuse

Two Stage RO System

- **Client :**
  Sandoz, Mumbai.
- **Capacity :**
  400 m^3/day
  System Recovery 85%

- **Scheme :** Iron Removal Filter – DMF – Dosing System – MCF – 1st Stage RO – Dosing Sys for 2nd stage – MCF - 2nd Stage RO – post pH Correction.

Ess Kay Yarn

Flow : 50 m3/day

(Textile Dyeing Industry)

PARAMOUNT

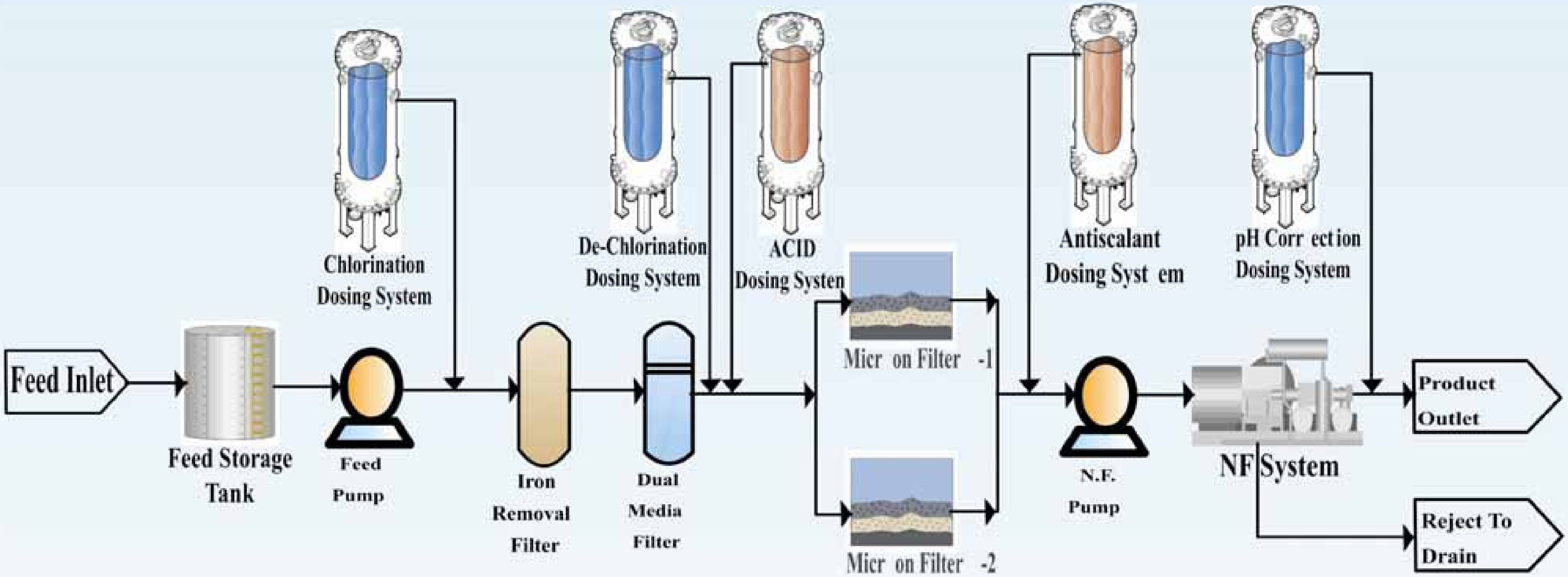
Ess Kay Yarn (Textile Industry)

PARAMOUNT

Capacity of plant	:	50 m3/day
Color	:	Dark Blue
Design TDS	:	22000 PPM
COD	:	9000 PPM
BOD	:	3500 PPM
Recovery	:	50%(3rd Stage system)
Operating Cost	:	Rs.40/m3
Permeate TDS	:	<500 PPM
Permeate COD	:	<50
Permeate Color	:	Color less

Ess Kay Yarn

PARAMOUNT



Ess Kay Yarn

PARAMOUNT

RO Skid

RO Skid

Mazda Colors

Flow : 500 m3/day

(Color & Pigment Industry)

Mazda Colors

PARAMOUNT

Inlet Characteristics

Design TDS	:	5000 PPM
COD	:	600 PPM
BOD	:	100 PPM

Outlet Characteristics

Recovery	:	75%
Operating Cost	:	Rs.32/m3
Permeate TDS	:	<250 PPM
Permeate COD	:	<30
Permeate Color	:	Color less

Mazda Colors

PARAMOUNT

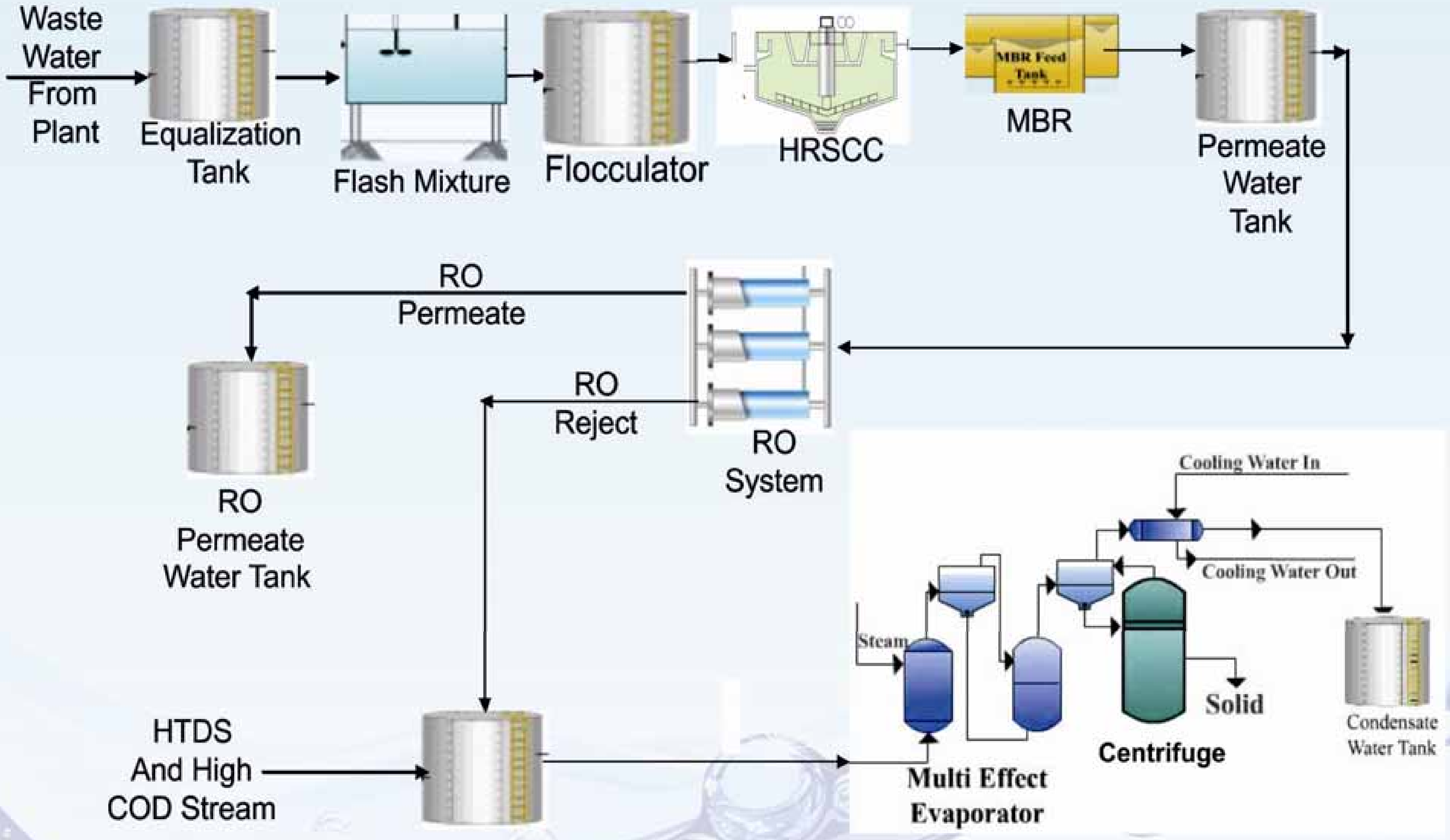
Inlet Characteristics (MEE)

Design TDS	:	4%
COD	:	30000 PPM

Outlet Characteristics

Condensate TDS	:	<100 PPM
Condensate COD	:	<50 PPM
Operating Cost	:	Rs.660/m3

Block Diagram Mazda Colors



Mazda Colors - Site

PARAMOUNT

PARAMOUNT

Micro Inks

Flow : 1500 m3/day

(Ink Manufacturing Unit)

Micro Inks

PARAMOUNT

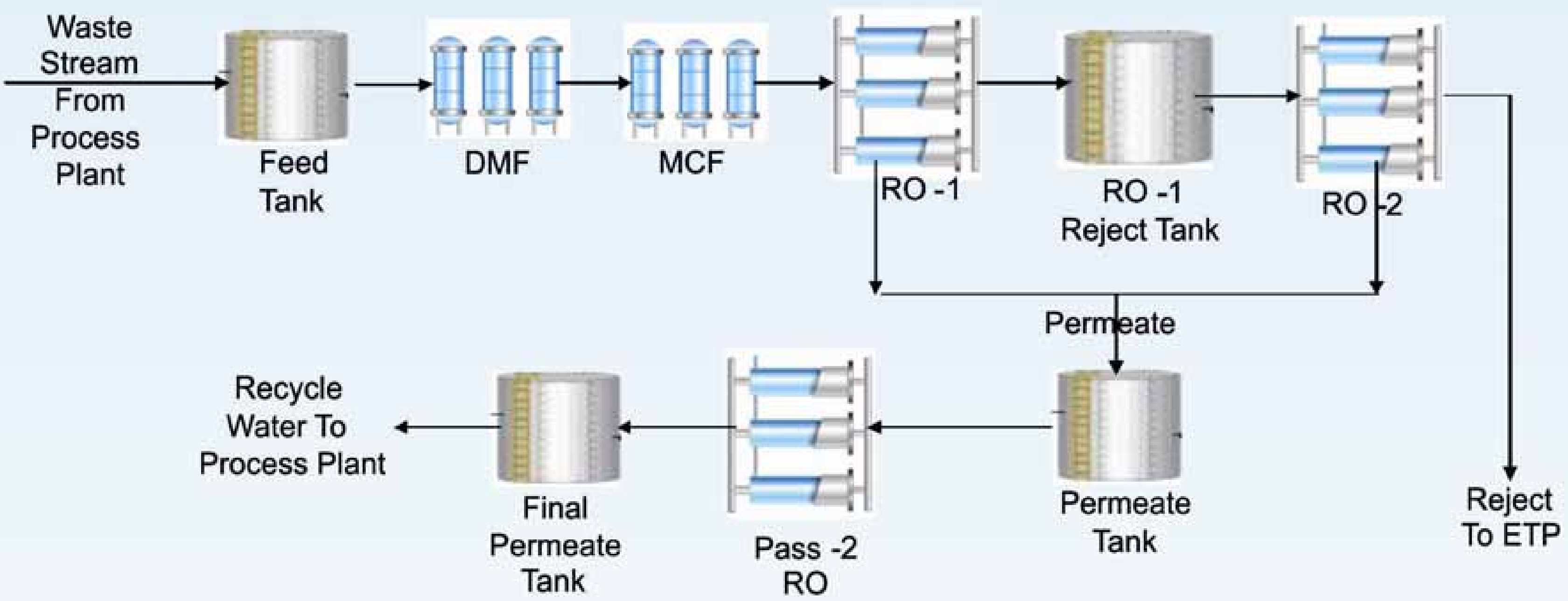
Inlet Characteristics

Design TDS	:	5000 PPM
COD	:	1500 PPM
BOD	:	400 PPM

Outlet Characteristics

Recovery	:	85% (2 stage & 2 Pass system)
Operating Cost	:	Rs.40/m3
Permeate TDS	:	<100 PPM
Permeate COD	:	<15

Block Diagram Micro Inks



PARAMOUNT

Anubha Fabrics Pvt. Ltd.

Flow : 600 m3/day

(Yarn Manufacturing Unit)

Anubha Fabrics Pvt. Ltd

PARAMOUNT

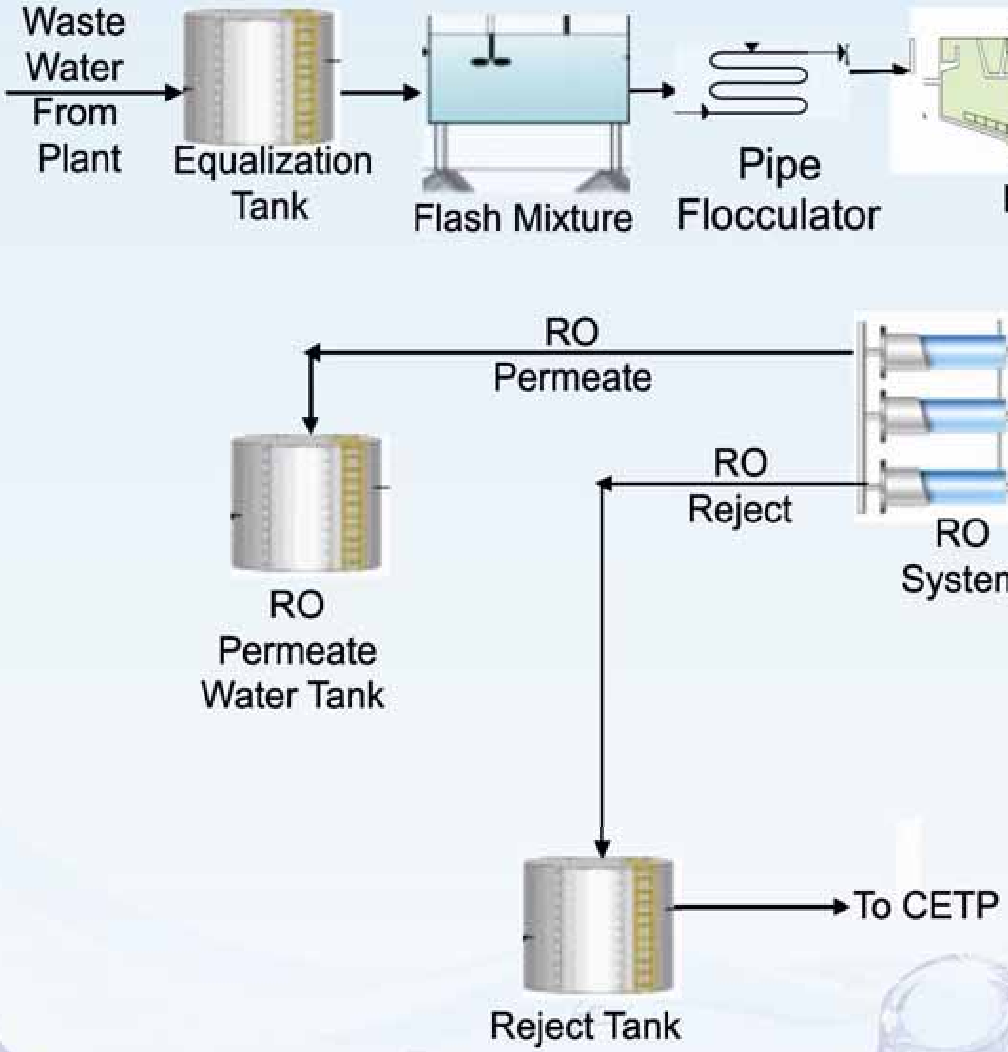
Inlet Characteristics

Design TDS	:	1500 PPM
COD	:	300 PPM
BOD	:	100 PPM
Oil	:	100 PPM

Outlet Characteristics

Recovery	:	75%
Operating Cost	:	Rs.35/m3
Permeate TDS	:	<100 PPM
Permeate COD	:	<10

Block Diagram Anubha Fabrics Pvt. Ltd



Thank You

PARAMOUNT LIMITED

(Formerly Paramount Pollution Control Limited)
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