INDUSTRIAL WATER & WASTEWATER TREATMENT AND CONSERVATION

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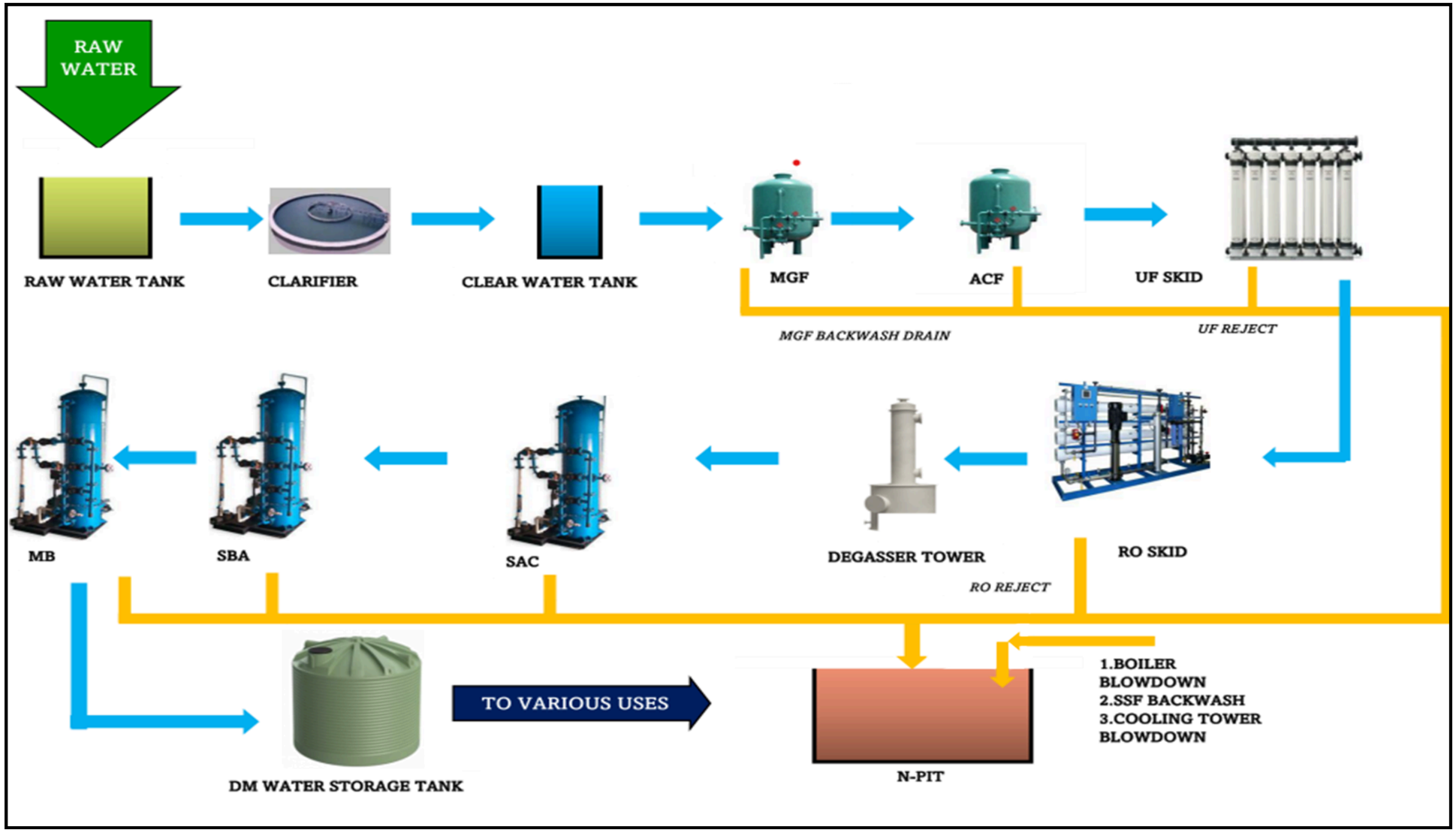
OBJECTIVE

1. Necessity of quality water for cycle make-up and cooling process for industry.
2. Conservation of water – Recycling of maximum quantity of wastewater
3. Effluent Discharge norms fixed and adherence to norms
4. Commitment of industry to environmental protection which is paramount and all measures to be taken to reduce water consumption and minimize the wastewater discharge
5. At Holtec, lots of study and research is done to meet the above requirements and this presentation depicts various water sources, technology we have adopted for both cycle make-up water and process water

DIFFERENT TYPES OF INPUT WATER FOR BOILER MAKE-UP

S. No.	Type	Normal Constituents					Normal Scheme for Boiler make-up water
		TDS (ppm)	TSS (ppm)	Turbidity (ntu)	Colloids	COD/ BOD	
1.	Bore-well water	Yes	No	No	No	No	For TDS<150 : MGF → SAC→Degasser SBA MB For TDS>150 : MGF→RO→Degasser→SAC→SBA MB (Or) MGF→RO-01→RO-02→EDI
2.	River water, Canal water, Mine water	Yes	Yes	Yes	Yes	Low Yes	TDS<150 :CLA →MGF →SAC →Degasser →SBA MB→UF TDS>150 :CLA→MGF→UF→RO→Degasser→SAC SBA→MB (Or) CLA→MGF→UF→RO-01 →RO-02→EDI

TYPICAL WATER TREATMENT SCHEME WITH POST DM PLANT



COMPARISON OF DM AND EDI TECHNOLOGY

Sr No	Action	DM	EDI
1.	Operation	Manual or automatic	Fully automatic
2.	Operation time	20 hrs/day	22 hrs/day
3.	Degasser	Required	Not required
4.	Chemicals used	HCl and NaOH	No chemical
5.	Effluent Generation and TDS	Very high	No effluent
6.	Impact on environment	Fresh chemicals are added affecting environment	No impact
7.	Operation safety	Less due to chemical handling	More safer

COMPARISON OF DM AND EDI TECHNOLOGY

Sr No	Action	DM	EDI
8.	Manpower	High	Low
9.	Bulk chemical handling	Required	Not required
10.	Space Requirement	High	Low
11.	Operator skill	Low	High
12.	Capacity Enhancement	Generally, not possible	Possible with addition of modules

Considering above, EDI is preferred over conventional DM.

SEAWATER DESALINATION

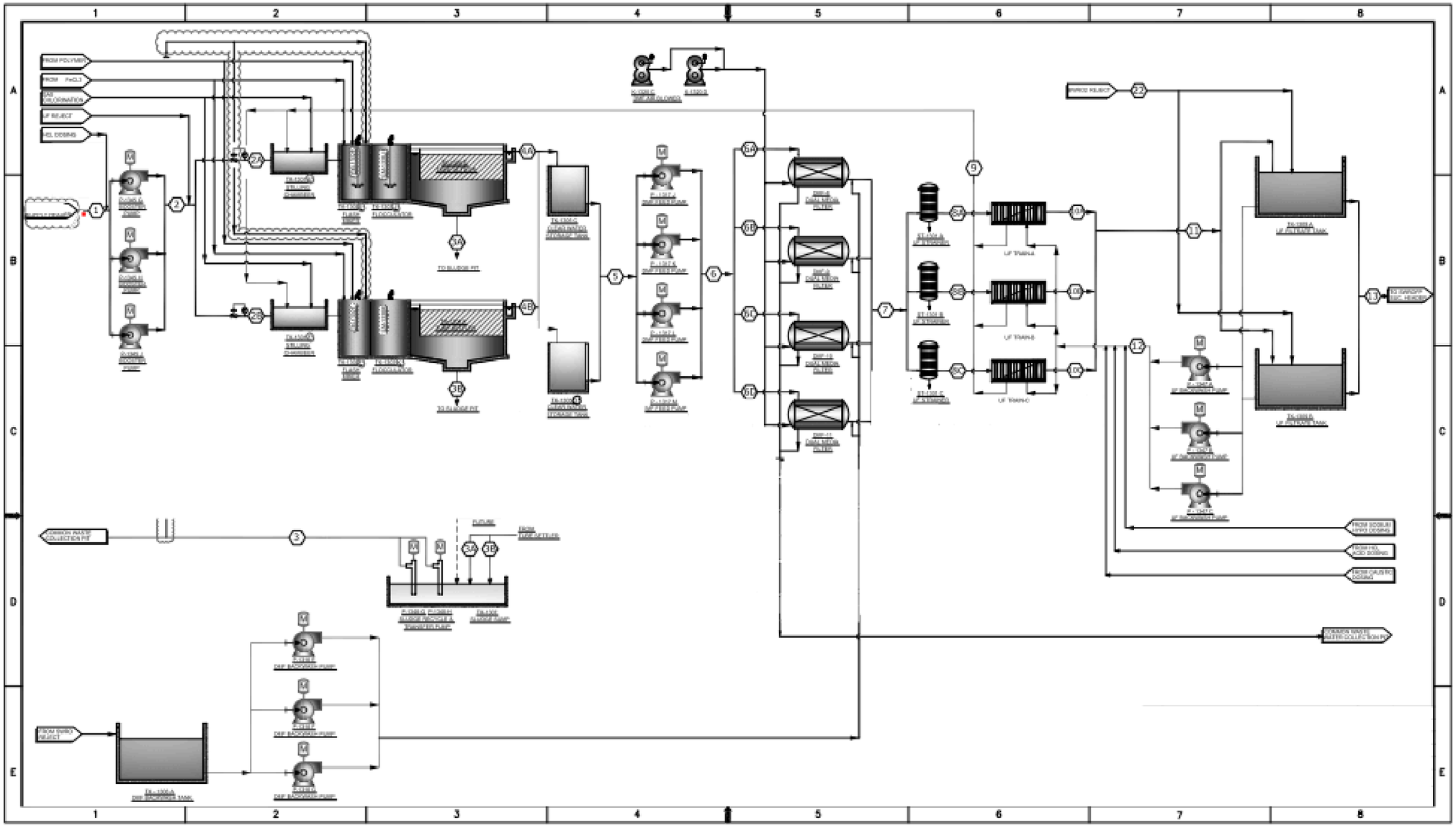
S. No.	Type	Normal Constituents					Normal Scheme
		TDS (ppm)	TSS (ppm)	Turbidity (ntu)	Colloids	COD/ BOD	
1.	Seawater	High 30000-33000	Yes	Yes	Yes	Yes	Seawater intake ➔ Stilling Chamber ➔ Lamella clarifier/tube settler ➔ UF ➔ RO (permeate -500 ppm) Further treatment same as freshwater treatment

- Recovery will be around 40 to 50%.
- Pressure required for water will be high (around 60 to 70kg/cm2) to pass through the RO membrane, So power intensive.
- Energy recovery device shall be used to pressurize RO feed water with RO reject water pressure.

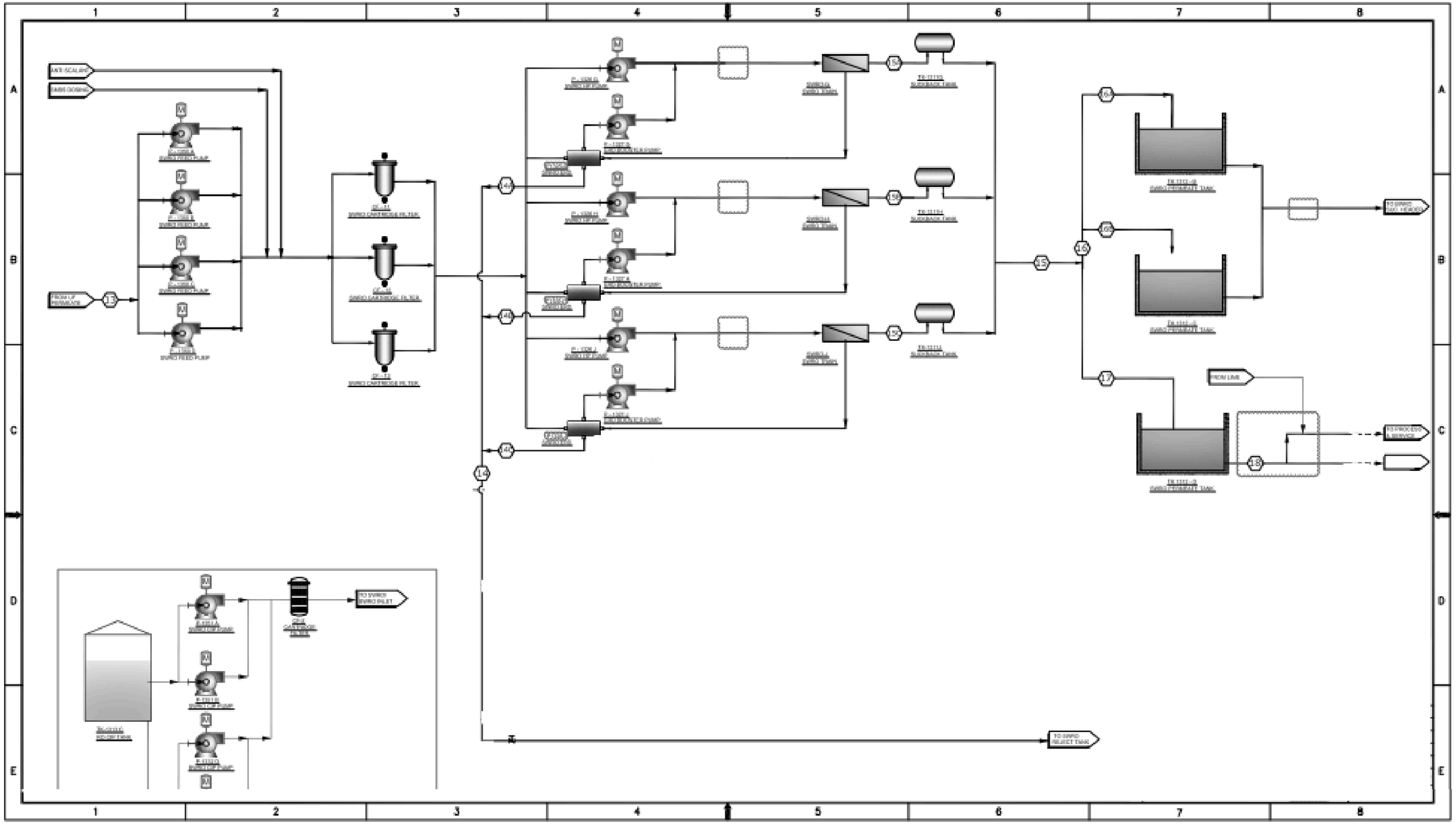
DESALINATION PLANT MATERIAL

- Low Pressure Pipe - Intake-HDPE
- Low Pressure Pipe - In the Plant-GRP with vinylester resin or GRE with Epoxy Resin.
- High Pressure Pipe - Super duplex PREN minimum 40 S32550 Or S32750 ASTM A790
- Other piping system – SS316 or SS316L ASTM A312
- Good disinfection system required either gas chlorination system or chlorine dioxide system(CLO2).

Typical Scheme for Seawater Desalination



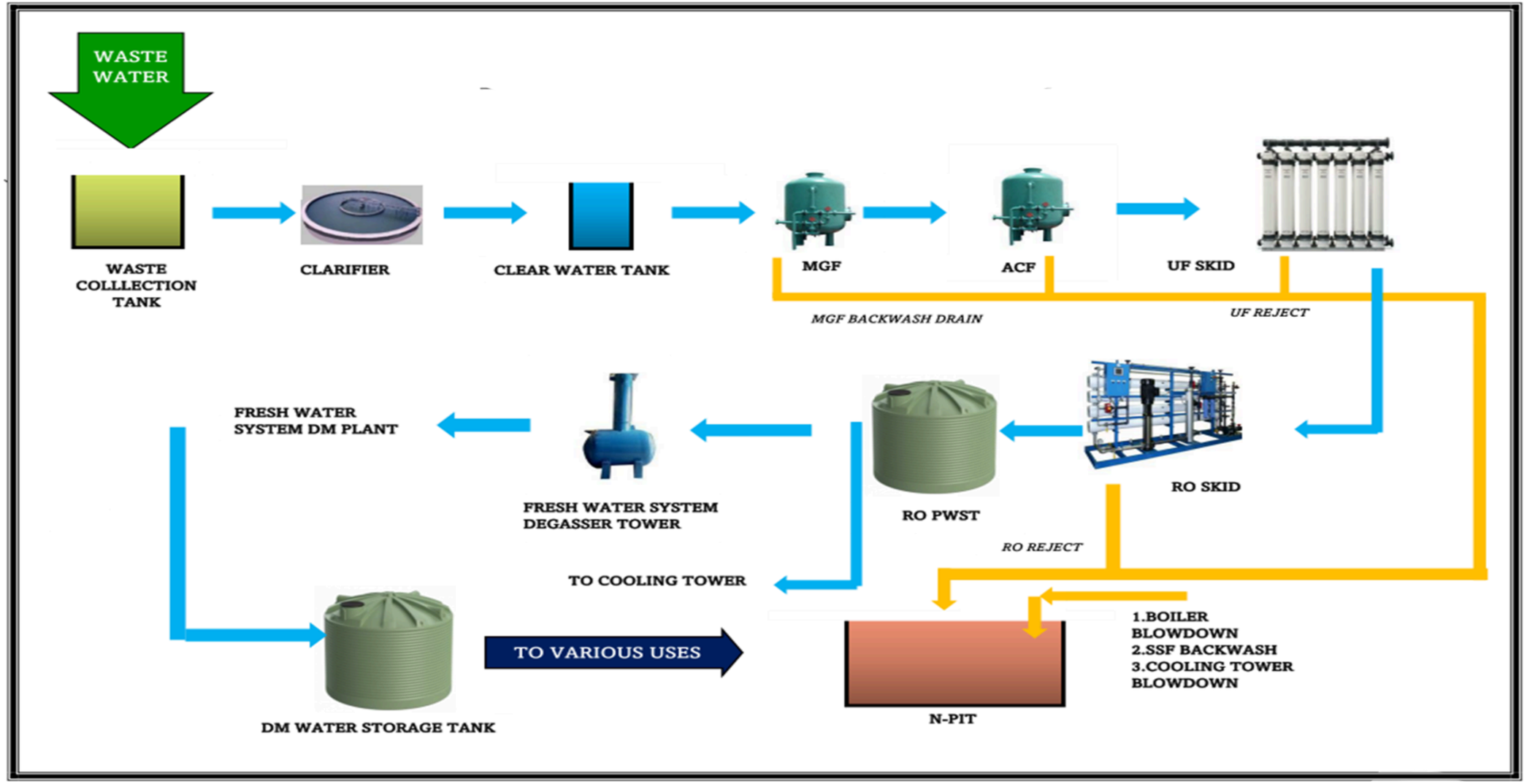
Typical Scheme for Seawater Desalination



Different Types of Industrial Wastewater and Their Treatment

S. No.	Type	Normal Constituents						Normal Scheme
		TDS (ppm)	TSS (ppm)	Turbidity (ntu)	Colloids	COD/ BOD	Oil/Grease	
1.	Industrial wastewater (Cement, Power, Pharma etc.)	Yes High	Yes	Yes	Yes	Yes Low	Yes	CLA ➡ MGF ➡ UF ➡ RO Further treatment depends on usage of treated wastewater.
2.	Food, Oil, Gas, Sugar	Yes High	Yes High	Yes	Yes	Yes High	Yes High	CLA ➡ DAF ➡ MGF ➡ UF ➡ RO Further treatment depends on usage of treated wastewater.

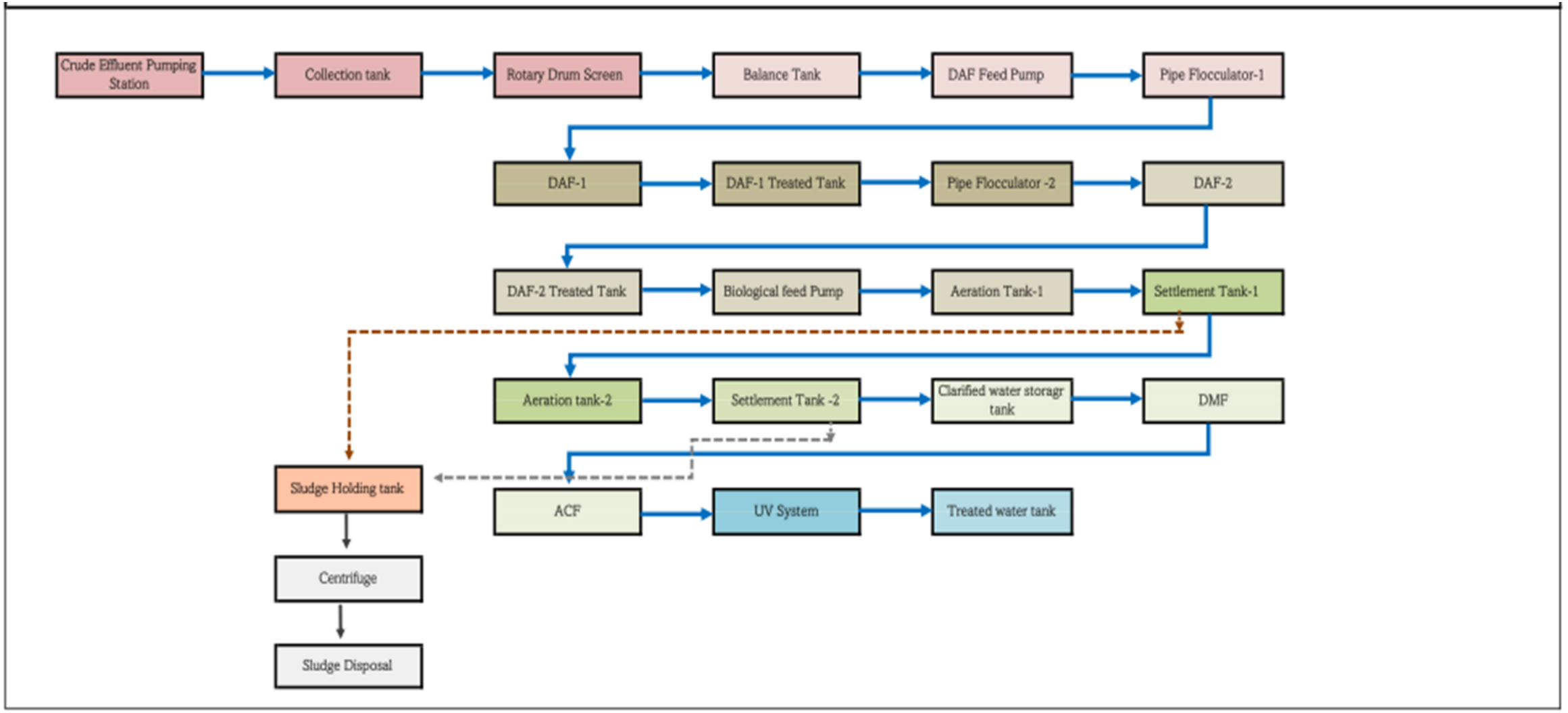
Typical Industrial Wastewater Treatment Scheme and Zero Liquid Discharge



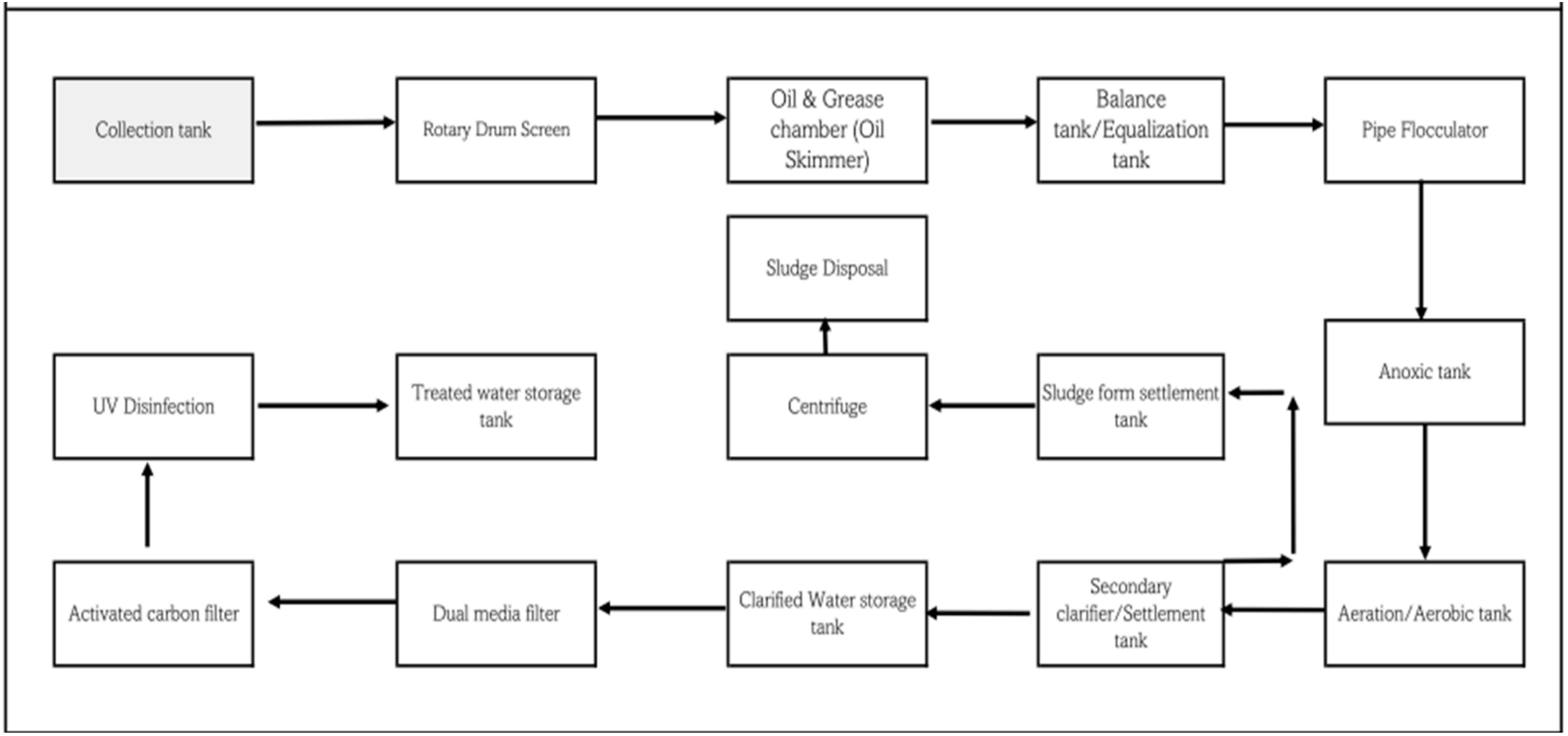
Different Types of Sewage Water & Their Treatment

S. No.	Type	Normal Constituents						Normal Scheme
		TDS (ppm)	TSS (ppm)	Turbidity (ntu)	Colloids	COD/ BOD	Oil/Grease	
1.	Sullage Water	Yes High	Yes High	Yes	Yes	Yes High	Yes High	Bar Screen >Settling Tank >DAF > Biological Treatment > Filtration>UV Further Treatment, MBR/MBBR > RO, if wastewater is reused.
2.	Sewage Water	Yes High	Yes High	Yes	Yes	Yes High	Yes High	Same as Sullage Water treatment

Typical Block Diagram for Effluent Treatment Plant Requiring Biological Treatment



Typical Block Diagram for Sewage Treatment Plant



SYSTEM AND EQUIPMENT

PreTreatment

1. **Aeration**

Equipment -Cascade or Gravity Aerators,
-Spray/Fountain Aerators
-Diffused aerators bubbling air through submerged pipes

Removes -Undesirable gas like H2S reduces odors, iron and manganese

2. **Clarifications**

Equipment -High-rate solid Contact clarifier
-Tube settlers
-Lamella clarifiers
-Actiflow high-rate compact clarification developed by Violia Water Technologies

Removes -Suspended solids with outlet TSS less than 20PPM.
-Turbidity with outlet turbidity less than 20NTU.
-Heavy metals
-Hardness

SYSTEM AND EQUIPMENT

3. **Filtration**

Equipment -Multi grade or dual media filter
-Activated Carbon filter

Removes -Multigrade filter TSS less than 5 PPM
-Turbidity less than 5 NTU.
-Activated Carbon filter removes Colour, odor, chlorine

4. **Oil and Grease Removal Equipment**

Equipment -Dissolved Air Floatation (DAF)
-Walnut Filter

Removes -Oil and grease to very large extent

Membrane Based System – 4 Different Types

1. **Micro Filtration:** Fully automatic
   Removes -Turbidity, colloids, Maintain silt density index by about 3
   -Virus

2. **Ultra Filtration:** Fully automatic ultra filtration system with hollow fiber membrane made of Polysulphone or Polyether Sulphone or PVDF.
   Removes -Turbidity, colloids, Maintain silt density index by about 3.
   -Virus

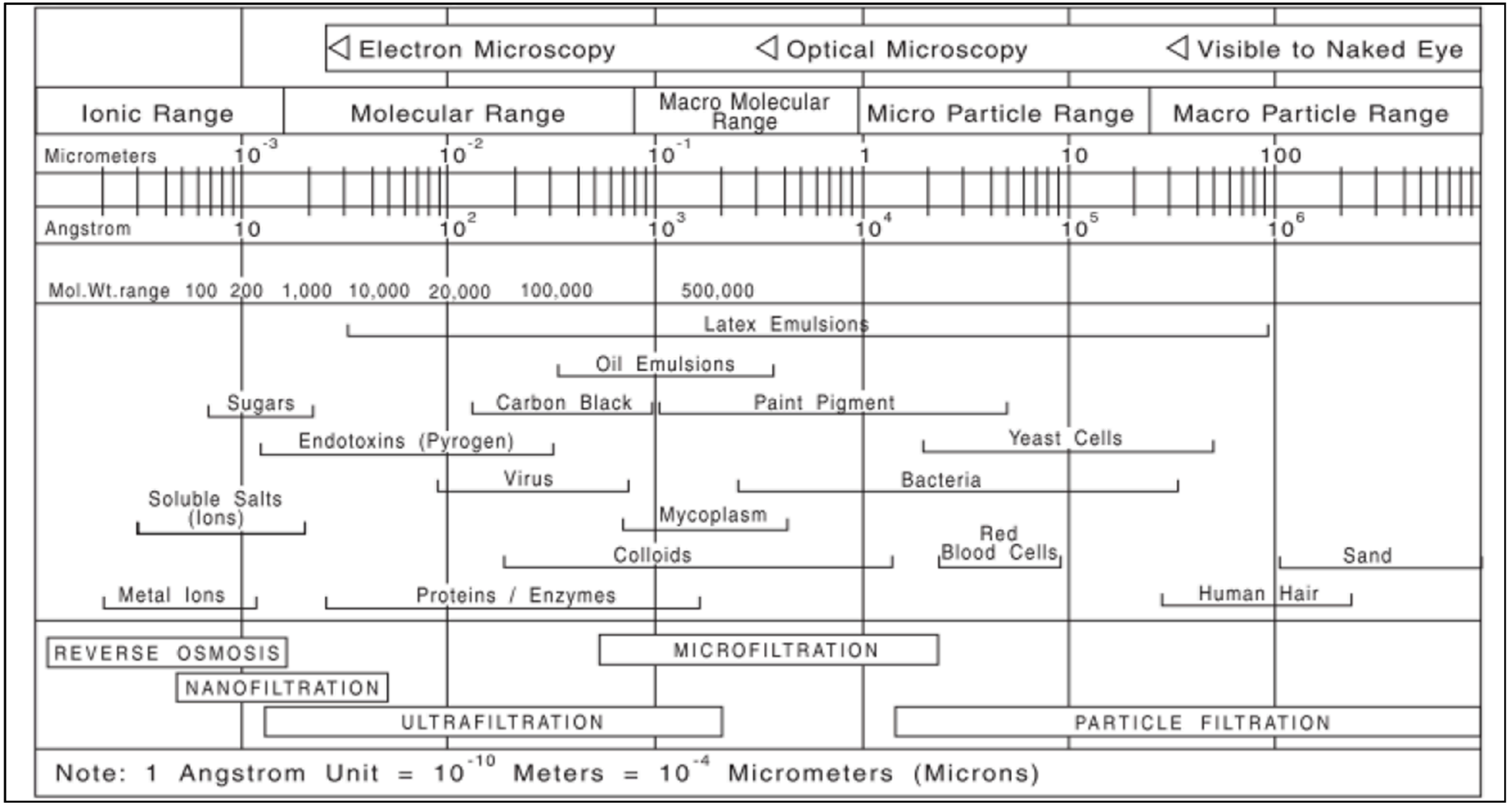
3. **Nano Filtration:** Fully automatic or semi-automatic plant
   Removes -Diatomic salts
   -Calcium and magnesium
   -Can be used for softening

4. **Reverse Osmosis System**

Fully automatic or semi-automatic system

Removes -All dissolved salts up to 98% of salt with slip of 2% in permeate water.

Ranges of Filtration Processes up to Reverse Osmosis



Post RO Treatment -Following are the Configuration

1. **DM Plant-SAC, SBA**

Removes -Cation and anion in the water with sodium slippage less than 1 PPM in SAC and silica slippage of less than 0.3 PPM in SBA.

2. **Polishing Unit -Mixed bed**

Removes -Residual cation and anion from SAC and SBA to a very low level like conductivity less than 0.2 micro-Siemens/cm and silica less than 0.02 ppm, iron less than 0.01 PPM.
-Sodium and potassium to less than 0.01 PPM etc.

3. **EDI – Combination of membrane and resin**

Removes -Residual cation and anion from SAC and SBA to a very low level like conductivity less than 0.2 micro-Siemens/cm and silica less than 0.02 ppm, iron less than 0.01 PPM.
-Sodium and potassium to less than 0.01 PPM etc.

WATER ECONOMICS AND NORMS FIXED BY AUTHORITIES

- Power plant 3.0m^3/MWH is the limit of Fresh Water Intake.
- Zero liquid discharge to be followed.
- Sugar plant can discharge only 100 liters/ton of cane crushed.
- Cement plant shall go for ZLD. All efforts to be made for ZLD.
- 95 to 97% of wastewater to be re-used.
- Treated sullage and sewage water can also be re-used.

The above guideline led to water conservation by utilizing maximum extent of wastewater for water conservation is one step by the industry.

LIQUID EFFLUENT DISCHARGE STANDARD-CPCB

1. PH 5.0-9.0% , 6.5-8.5%
2. Total suspended solids not to exceed 100PPM.
3. Oil and grease not to exceed 10 PPM
4. Temperature should not exceed 5 degree over the Intake water temperature.
5. Total Residual Chlorine 1.0 PPM max
6. BOD 30 PPM
7. COD 250 PPM
8. TDS 2100 PPM
9. Ammoniacal Nitrogen as NH3 50 PPM
10. Total Kjeldhal Nitrogen (TKN) as NH3 100 PPM
11. Free Ammonia 5 PPM.
12. Dissolved Phosphates as P 5 PPM
13. Sulphide 2 PPM

STP PLANT DISCHARGE

1. BOD - 10 PPM max
2. COD - 50 PPM max
3. TSS - 100 PPM max
4. PH - 6.5 to 8.5
5. Ammonical Nitrogen - 5 PPM max
6. Total Nitrogen - 10 PPM max
7. Fecal coliform - 100 MPN/100 ML maz

Note- Storm water is not allowed to be mixed with effluent, treated sewage water, scrubber water, Floor wash water, Storm water shall be channelized through separate drain.

WATER QUALITY STANDARDS

- Feed water, Drum water standard - IS 10496 (High Pressure)
- Feed water , Drum water - IS 10392 (Low and Medium Pressure)
- Drinking water - IS 10500
- For cooling water make up - ISO 22449-1, IS 8188

BOILER MAKEUP WATER QUALITY

- PH at 25 degree C(After PH correction) - 8.5 to 9.2
- Conductivity at 25 degree - < 0.2 micro-Siemen/cm
- Total Iron - < 0.01 PPM
- Total silica (Reactive silica + Colloidal silica) - < 0.02 PPM
- Total Copper - < 0.03 PPM
- Sodium as Na. and Potassium as K - < 0.01 PPM
- Total hardness - < 0.004 PPM
- Total dissolved solids before PH correction - < 0.1 PPM
- Total CO2 - < BDL
- Total Suspended Solids - < BDL
- Oil and grease - < BDL

Recommended Cooling Tower makeup water-With Chemical treatment done in the Cooling Tower such as corrosion control, deposit control, bio fouling control and alkanity control.

Circulating Water

- TDS can go as high as - 4000PPM
- Hardness as Caco3 - 2200PPM
- Alkalinity as Caco3 - 250 PPM
- Calcium as Caco3 - 1200 PPM
- Chloride as Caco3 - 1000 PPM
- Sulphate as Caco3 - 2600 PPM
- Total phosphate PO4 - 14 PPM
- Zinc - 2 PPM
- Reactive silica Sio2 - 200PPM
- Iron as Fe - 3PPM
- MgSio2 Product - <85000

AUTOMATION AND CONTROL FOR WTP

- Clarifier Operation is mostly Manual.
- MGF & ACF Operation can be Manual or Automated.
- In Automatic operation of MGF and ACF all frontal piping valves will be pneumatic operated and will be operated based on pressure drop across the MGF and ACF – Preferred is manual operation.
- UF is fully Automatic operated by PLC or DCS. Manual operation not possible.
- RO Can be Fully automatic or semi-automatic . Semi-automatic is preferred. That is tripping will be automatic and restarting will be manual.
- DM Plant Can be operated Manually or Automatic. For Automatic operation of DM plant, all frontal piping valves will be pneumatic operated.

AUTOMATION AND CONTROL FOR WTP

- WTP Dosing- RO feed-HCL dosing, SMBS dosing will be automatic PH correction dosing automatic based PH Measurement.
- Cooling tower H_2SO_4 dosing will be fully automatic based on PH measurement.
- The STP can be manual operated or auto operated.
- The plants will be PLC or DCS operated. The WTP will be locally operated and will be hooked up with plant DCS to provide information only.
- Efforts shall be made to go in for fully automatic plant for getting consistent quality of water and also to take instant corrective action.
- High level of instrumentation shall be used.
- All dosing systems shall be automatic.

RECOMMENDED SIZING CRITERIA FOR EQUIPMENT AND PIPING

Sr. No.	Equipment	Sizing Criteria
1	High-Rate Solid Contact Clarifier	Rise rate : maximum 1.8m/hr Retention time : 2 hr and 30 min
2	Lamella Clarifier, Tube settler	Rise rate : 1.2m/s approx.
3	MGF/DMF	Surface velocity : 11m/hr Blower sized for 55m/hr
4	ACF	Surface velocity : 15m/hr
5	UF	Gross permeate : 1.25 times the net permeate Forward flux rate : 75 lmh Backwash flux rate : 175 lmh CIP flux rate : 140 lmh

RECOMMENDED SIZING CRITERIA FOR EQUIPMENT AND PIPING

Sr. No.	Equipment	Sizing Criteria
6	RO	HPP selection : for 25deg Max flux rate : 20 lmh CIP pump capacity : 9m³/pressure tube Pressure tube design : ASME Sec X
7	Degasser	Surface velocity : 60m/hr
8	SAC & SBA	Surface velocity : 40m/hr
9	MB	Surface velocity : 60m/hr

ALLOWABLE PIPING VELOCITY

Sr. No.	Piping	Size (Nb)	Velocity (m/s)
1	Water pump suction	Below Nb 50	0.6-0.8
		Nb 50 – Nb 150	0.7-1.0
		Nb 200 and above	0.7-1.2
2	Water pump discharge	Below Nb 50	0.9-1.0
		Nb 50 – Nb 150	1.2-2.0
		Nb 200 and above	1.5-2.2
3	Hydrochloric Acid	Not to exceed 1m/s	
4	Caustic Soda	Not to exceed 1m/s	
5	Sulphuric Acid	Not to exceed 0.5m/s	
6	Sodium HypoChlorite	Not to exceed 1m/s	

CONCLUSION

- Different type of water used for the industrial purpose have been elaborated in detail for the benefit of end user.
- The guideline/selected schemes are based on our longstanding experience in various WTPs resulting into maintaining quality, conservation of water and automation of system thereby trouble-free operation of plant.

THANK YOU

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