STP Technologies & Their Cost Effectiveness

Indian Scenario

- In India cities and towns generate 38000KL waste water daily.
- Sewage treatment facilities are limited in our country and many of the treatment facilities are not functioning properly.
- The organic pollutant (measured as BOD/COD/SS) removal performances of conventional technologies employed in a majority of STPS under GAP/NRAP have been extensively studied and reported.
- But microbial pollutants(measured as MPN of Total and faecal coliforms) removal performances are not getting monitored properly.

Indian Scenario (contd)

- Total urban wastewater generation: 38255mld
- STPs Capacity : 11788 mld
- STPs number wise : 38% ASP, 28% WSP, 20% UASB, 14% others
- STPs capacity wise: 60% ASP, 26% UASB, 6% WSP, 8% others
- CPCB and SPCBs are the regulatory agencies for water quality monitoring

Ministry of Environment & Forest Recommendations

- Ministry of Environment and Forest , Govt of India constituted a committee in 1999 to recommend coliform standards for treated sewage discharged into the rivers and lakes.

Parameter	Not to exceed	Discharge into/on
BOD(mg/l)	30	Water body
BOD(mg/l)	100	Land for irrigation
TSS(mg/l)	50	Water body
TSS(mg/l)	200	Land for irrigation
Faecal Coliform(MPN/100ml)	1000 desirable 10000 max permissible	Water body or for agriculture and aquaculture

Ministry of Urban Development Recommendation

- Ministry of Urban Development and Poverty alleviation constituted in the year 2004 a committee to determine the norms for coliform level in the treated wastewater specific to the stretch of the river Yamuna in Delhi.
- The Committee made the following recommendations which have been mentioned in the adjacent table:-

Parameter	Value	Remarks
Faecal Coliform (MPN/100ml)	500	Desirable
Faecal Coliform (MPN/100ml)	2500	Maximum Permissible
BOD	3 mg/l or less	

Standard for discharge of treated sewage into the stretch of River Yamuna in Delhi

Parameter	Not to exceed	Remarks
BOD	10 mg/l	Immediate goal
Faecal Coliform	2500 MPN/100ml	See adjacent note

- Note- Tertiary Treatment after conventional treatment processes like ASP or TF is required to achieve the recommended standards for BOD and FC. Tertiary Treatment options include chemicals aided flocculation, sedimentation with or without post granular media filtration and or chlorination.

Overview of Wastewater Treatment Processes

Sewage Treatment Process Selection

Treated Sewage Quality : Meet Std.

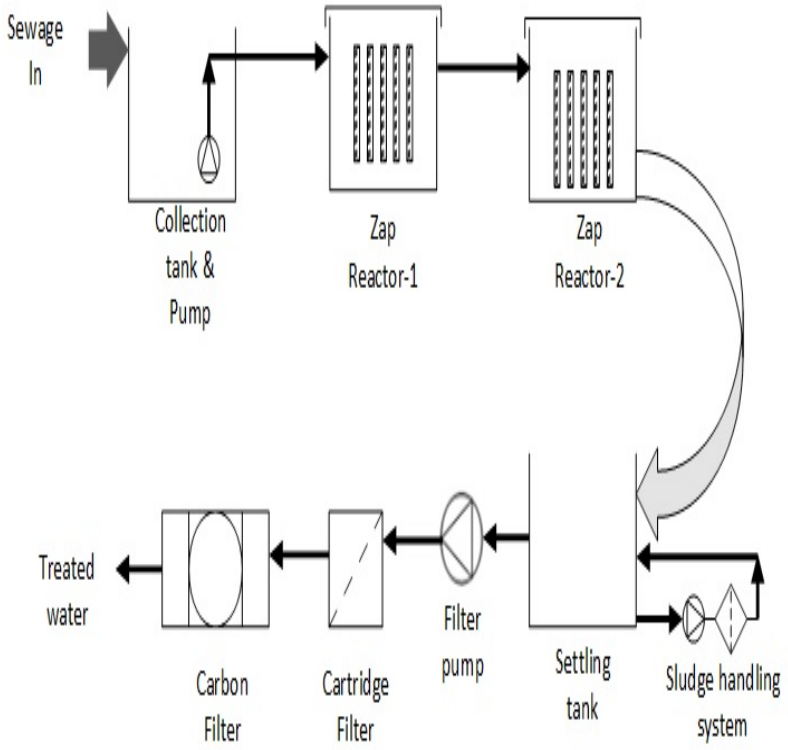
Power Requirement : Minimize

Land Requirement : Minimize

Capital Cost: Optimum Utilization

O&M Cost: Lower Running Cost

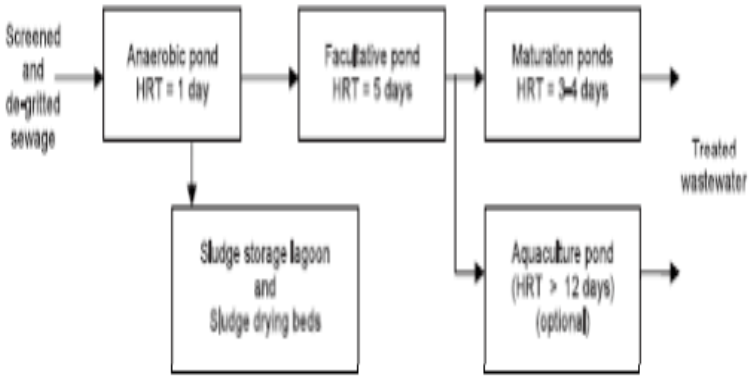
Electro Oxy Coagulation Technique



Performance of the Unit

- Can reliably produce high quality effluent with low BOD, TSS, Faecal coliform and high D.O.levels.
- Disinfection is part of System by Ozonation
- BOD reduction of the order of 95% or so.
- Suspended solids reduction is high (> 95%)
- Metal removal is efficient, low sludge generated
- Coliform reduction can be up to 3 units.
- Low Power Consumption
- Low cost , easy to operate & Expandable.
- Detention time: 30 Minutes (max)

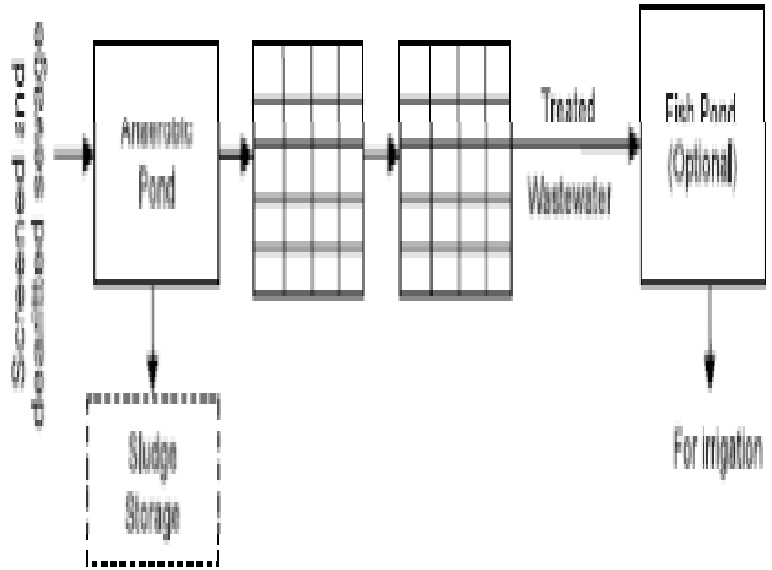
Waste Stabilization Pond Systems



Performance of the Unit

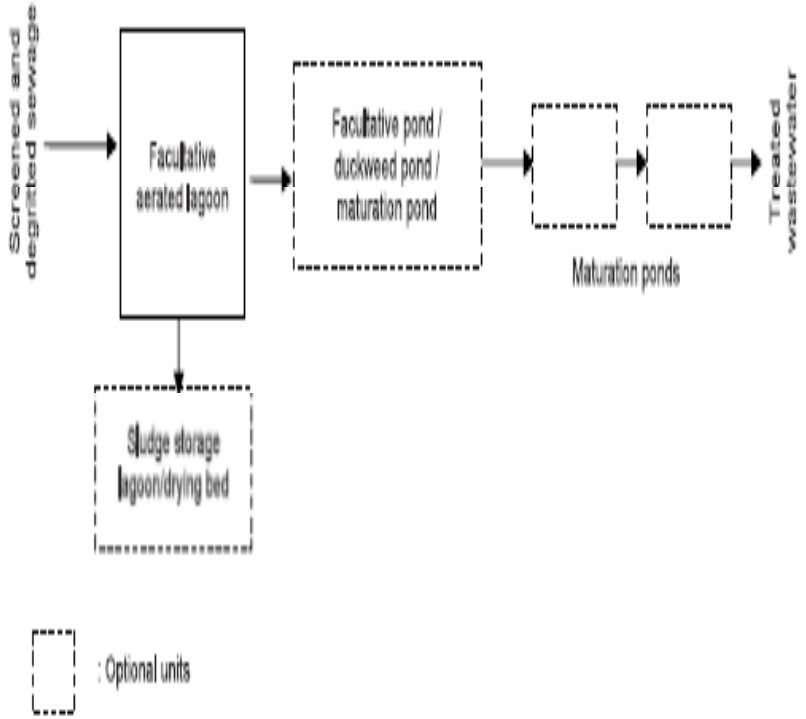
- Can reliably produce high quality effluent with low BOD,SS,Faecal coliform and high D.O.levels.
- BOD reduction of the order of 90% or so.
- Suspended solids reduction is somewhat low due to possible overflow of algae.
- Coliform reduction can be up to 6 units.
- Total Nitrogen removal between 70-90%.
- Total Phosphorus removal between 30-45%.
- Detention time: 6 to 8 days

Duckweed Pond System



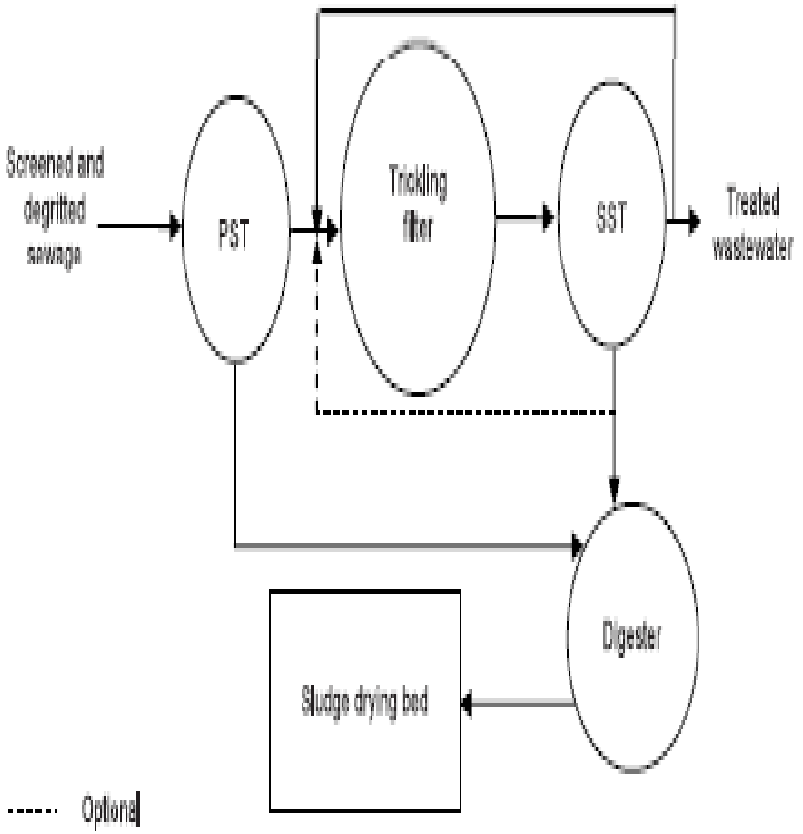
- Retention period 7-21 days
- Shallow depth of water from 1.25-2.0 mts.
- For settled wastewaters BOD and SS removal upto 30 mg/l is achievable
- High mineral and nutrient removal rate due to uptake of duckweeds.
- Capital cost of the same order of WSP with additional cost of floating cell material.

Facultative Aerated LAGOON (FAL)



- No primary or secondary settling required with no sludge recirculation.
- Anaerobic bottom layer and aerobic top layer.
- Simultaneous degradation of sludge in the bottom layer and organics in the top layer.
- BOD removal 70-90%
- Suspended solids removal 70-80%
- Coliform removal 60-99%

Trickling filter



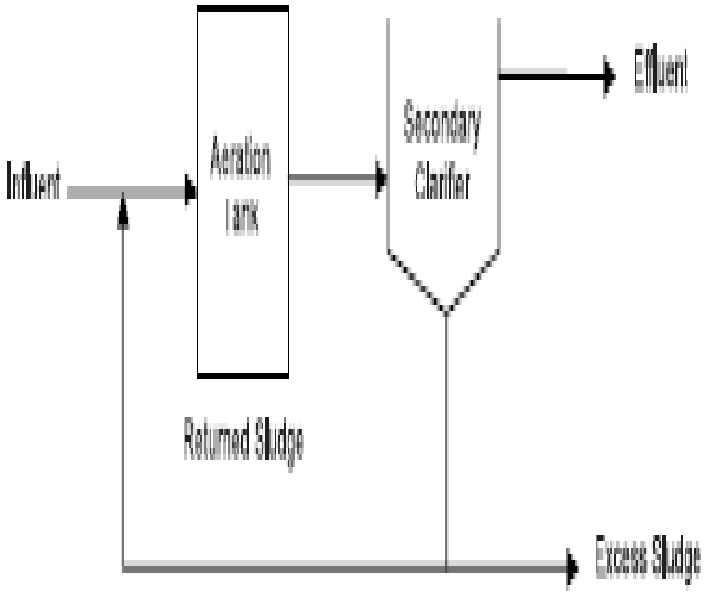
- Proven 100 year old technology
- Less monitoring required than ASP
- Rugged system with simple and silent operation.
- Consistent effluent quality
- Stand alone treatment process for sewage if operated at low rates.
- To be used in combination with ASP for efficient peformance.
- Low pathogen removal

  Bacteria, 20-90%

  Viruses 50-90%

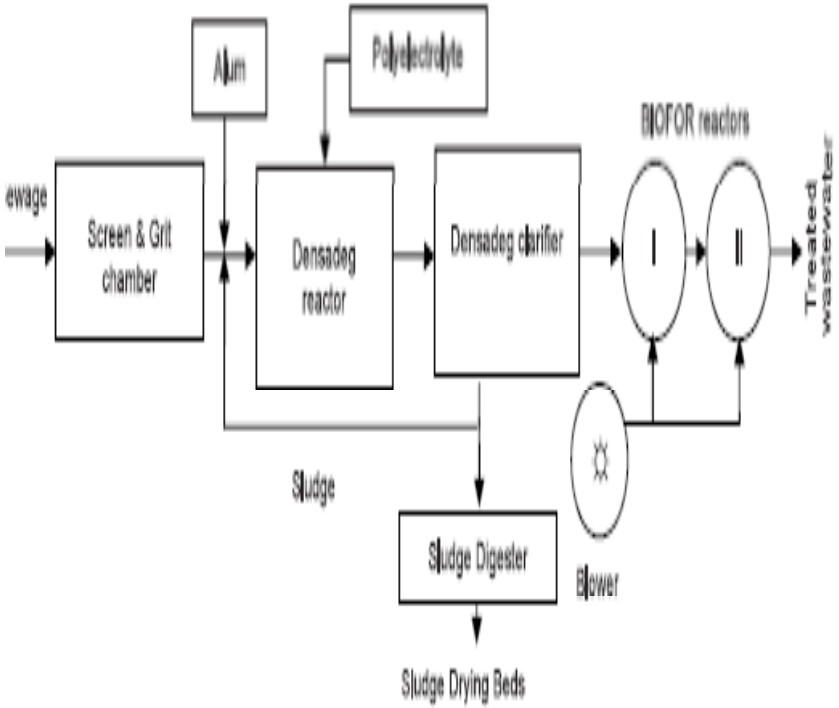
  Giardia cysts 70-90%

Activated Sludge Process (ASP)



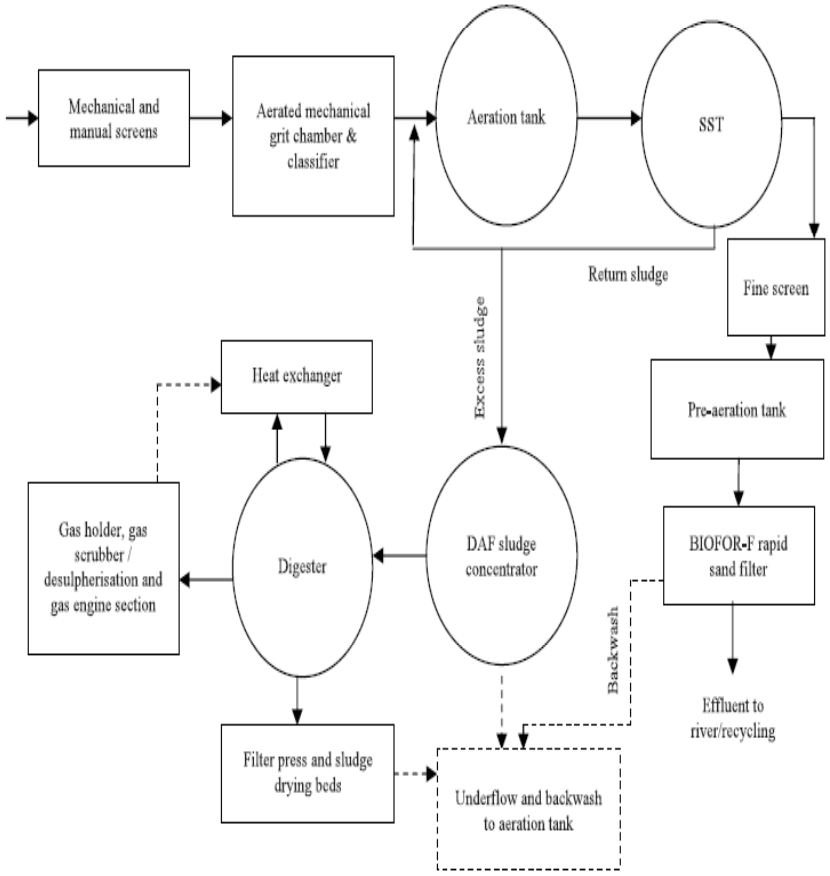
- Proven and tested methodology all over the world for the last 7-8 decades.
- Several modifications available for specific requirements.
- Uninterrupted power supply required for aeration and sludge recirculation.
- Reactor sludge levels to be carefully monitored and sludge is to be withdrawn from the system.
- 80-90% removal of bacteria.
- 90-99% removal of viruses.

BIOFOR Technology (Biological Filtration and Oxygenated Reactor)



- Enhanced primary treatment with addition of chemicals and coagulants.
- High rate primary tube settlers and integrated thickening offering space economy.
- Suspended solids and BOD removal of the order of 90% and 70% respectively in the primary clarifier.
- Low turbidity with suspended solids under 15 mg/l and total system efficiency of 98%.
- Pathogen removal of 2 on the log scale.

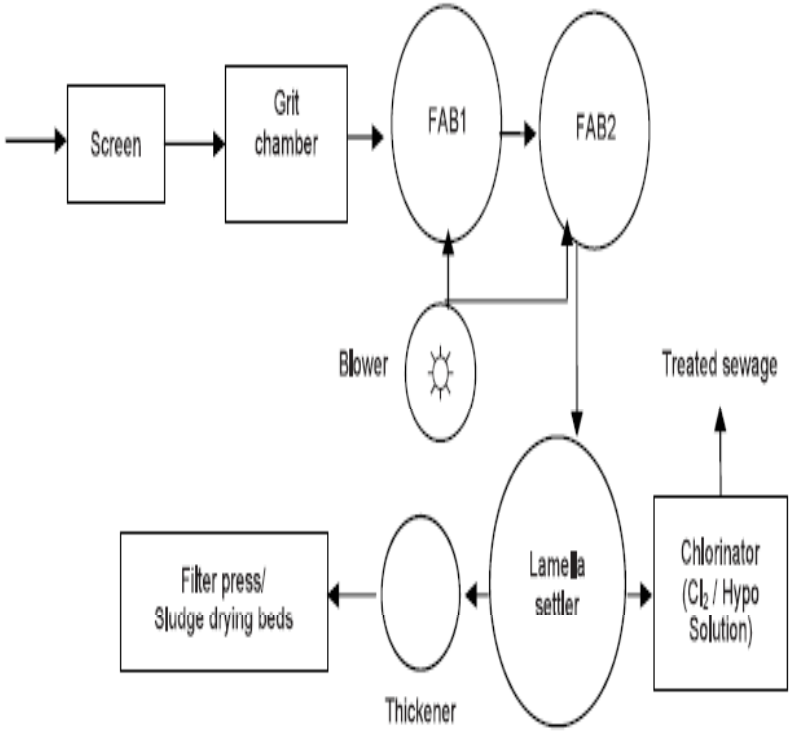
High Rate Activated Sludge BIOFOR-F Technology



- Compact layout as a result of high rate processes.
- Higher aeration efficiency through diffused and tapered aeration system.
- Space saving as primary sedimentation is dispensed.
- Compliance with strict discharge standards.
- Absence of aerosol and odor nuisance in the working area.
- Self-sufficient in energy requirement due to gas engine based cogeneration sysytem.

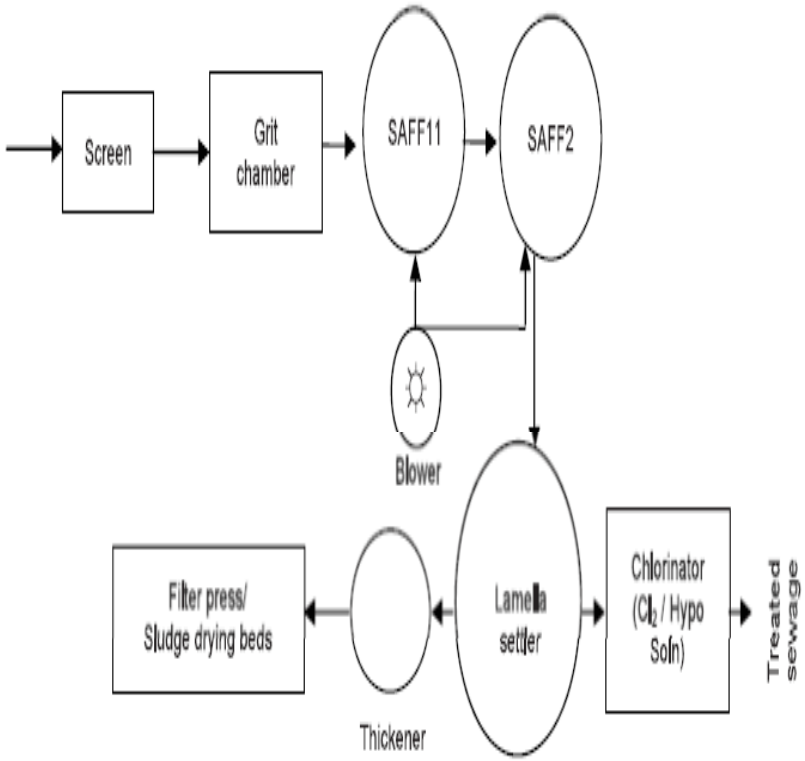
Notes :

Fluidized Aerated Bed (FAB)



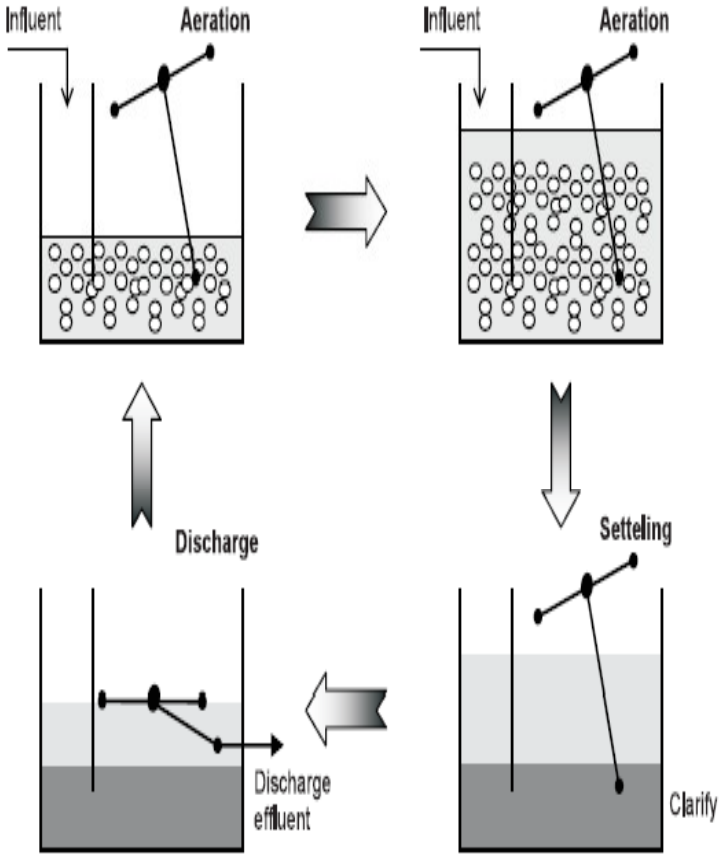
- Two stage biological oxidation.
- Treatment scheme without primary sedimentation and sludge digestion.
- Reactors upto depth 5m ensures low land requirement.
- High BOD removal with effluent concentration less than 10 mg/l
- High Suspended solids removal with effluent concentration less than 20 mg/l
- Faecal coliforms removal of the order of 2-3 on log scale.

Submerged Aeration Fixed Film Technology (SAFF Technology)



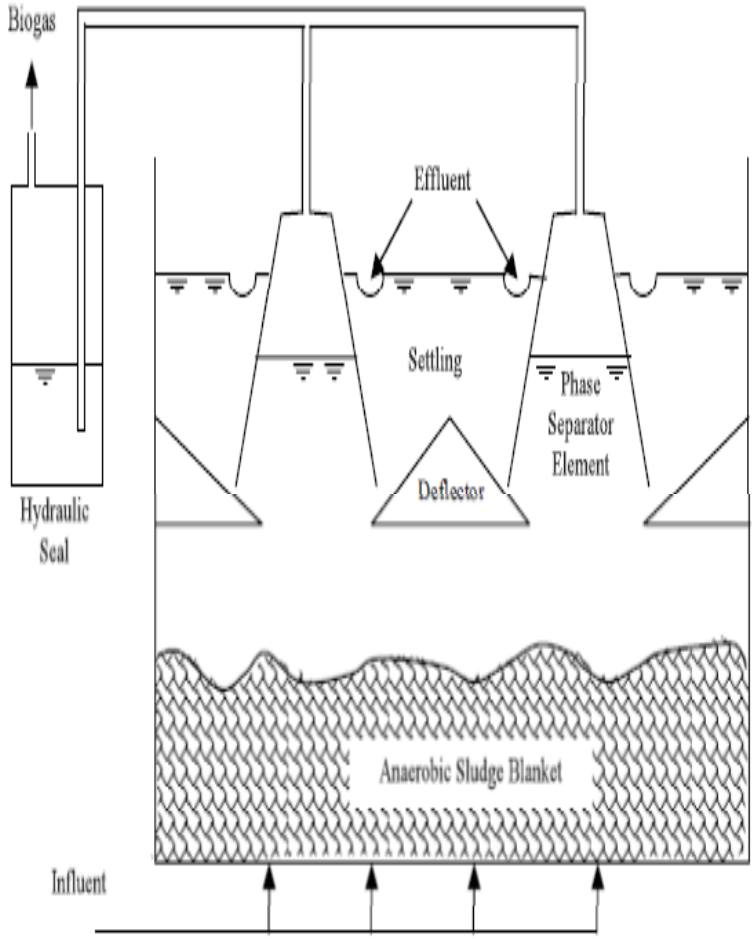
- Essentially a trickling filter with enhanced oxygen supply through submerged aeration.
- Unconventional plastic media with high void ratio and specific surface area.
- High BOD removal with 98% efficiency with effluent BOD concentration less than 10 mg/l.
- High Suspended solids removal with effluent concentration of 20 mg/l.
- Faecal coliforms removal of the order of 2-3 on log scale at SAFF 2 Stage.

Cyclic Activated Sludge Process (CASP)



- Essentially activated sludge process operated in batches through auto-control.
- Aeration and settling in one tank leading to lower plant foot print.
- Uninterrupted power supply is a must as the whole process is auto controlled.
- High BOD removal with effluent concentration less than 10 mg/l
- High Suspended solids removal with effluent concentration less than 20 mg/l
- Faecal coliforms removal of the order of 2-3 on log scale.

Upflow Anaerobic Sludge Blanket Process (UASB)



- Process not vulnerable to power cuts.
- Recovery of gas with high calorific value.
- Low sludge production.
- No primary treatment, suspended solids in the waste water acts as carrier material for microbial attachment.
- Recovery of gas with high calorific value.
- Low sludge production.
- Post treatment of UASB is invariably required.

Land Area Requirement for Different STPs

Sl. No.	STP Process	Land Area, hectare /MLD	Advantage	Disadvantages	Applicability
1	Waste Stabilisation Pond System (WSPS)	0.80 to 1.5	i) The inherent simplicity of construction offers low cost technology option ii) High quality effluent at least operating costs iii) Low skill requirement for operation of the plant. Iv) Fish yield from aquaculture ponds around 4 - 7 MT/ha/year	i) Large land requirement ii) High cost of lining iii) Risk of odour nuisance and mosquito breeding iv Risk of groundwater contamination in porous and fractured strata	i) Suitable under warm Indian climatic conditions ii) For areas with easy availability of land iii) In areas with social preference for aquaculture iv) In areas with low, unreliable or expensive power supply.
2	Duckweed Pond System (DPS)	1.5 to 2.0	i) Less sensitive to low temperature, high nutrient levels, pH fluctuations, pests and diseases compared to other aquatic plants ii) Simultaneous significant nutrient removal iii) Yield of highly protein containing vegetative material (35 - 45%) as animal feed iv) Duckweed as an excellent feed for poultry v) Realization of tangible economic returns from sale of raw or processed weed or fish	i) Low pathogen removal due to reduced light penetration ii) Duckweed die off in cold weather conditions	i) Low strength domestic wastewater or after primary sedimentation with influent BOD < 80 mg/L ii) In combination with existing WSP iii) Rural and semi urban settlements with easy land availability iv) As a polishing pond for an existing activated sludge plant or other technology based STPs

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Sl. No.	STP Process	Land Area, hectare /MLD	Advantage	Disadvantages	Applicability
3	Facultative Aerated Lagoon (FAL)	0.27 to 0.4	i) Simple operation of the plant requiring lower skilled manpower ii) Minimum civil, electrical and mechanical installation iii) Lower energy costs compared to other aerobic processes iv) Lower O&M cost	i) Possibility of groundwater contamination in porous and fractured strata ii) High cost of lining	i) Stand alone system for sewage treatment ii) As an upgradation option for overload WSPs
4	Trickling Filter (TF)	0.25 to 0.50	i) Simple operation of the plant requiring lower skilled manpower ii) Rugged system, less prone to hydraulic and organic over loading iii) Reduced requirement for process monitoring iv) Sludge with better settling characteristics	i)Blockage of ports in distribution arm. ii)Blockage of bio - filter due to excess biomass growth or floating matter iii) Risk of odour and filter fly	i) In combination with ASP for good and consistent performance
5	Activated Sludge Process (ASP)	0.15 to 0.25	i) Performance is not significantly affected due to normal variations in wastewater characteristics and seasonal changes	i) Performance is adversely affected due to interruption in power supply even for a short period ii) Foaming problem may occur iii) Requires elaborate sludge digestion/drying/disposal arrangement	The most widely used option for treatment of domestic wastewater for medium to large towns where land is scarce

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Sl. No.	STP Process	Land Area, hectare /MLD	Advantage	Disadvantages	Applicability
6	BIOFOR Technology (Biological Filtration and Oxygenated Reactor)	0.08	i) Higher aeration efficiency through co - current diffused aeration system ii) Able to withstand fluctuations in flow rate and organic loads iii) Compliance with stricter discharge standards iv) Effluent suitable for UV disinfection without filtration v) Absence of aerosol and odour nuisance in the working area vi) Absence of corrosive gases in the area	i) Continuous and high chemical dosing in primary clarification ii) Undigested sludge from primary clarification requiring post treatment	
7	High Rate Activated Sludge Biofor Technology	0.10	i) Higher aeration efficiency through diffused and tapered aeration system ii) Compliance with stricter discharge standards iii) Stable digester performance and consistent gas production	None, except high high cost	
8	Fluidized Aerated Bed (FAB)	0.06	i) Deep reactors enabling small space requirements ii) Elimination of the need for sludge recirculation and monitoring of MLSS in the reactor iii) Capacity to handle shock loads iv) Low & stabilised sludge production eliminating the need for sludge digestion	i) Reliance on patented filter media ii) Reliance on flocculants, polyelectrolyte and chemical disinfectant (optional) iii) Requires skilled manpower	The FAB technology based system is particularly applicable for: i) small to medium flows in congested locations ii) Sensitive locations iii) decentralised approach iv) Reliving existing overloaded STPs

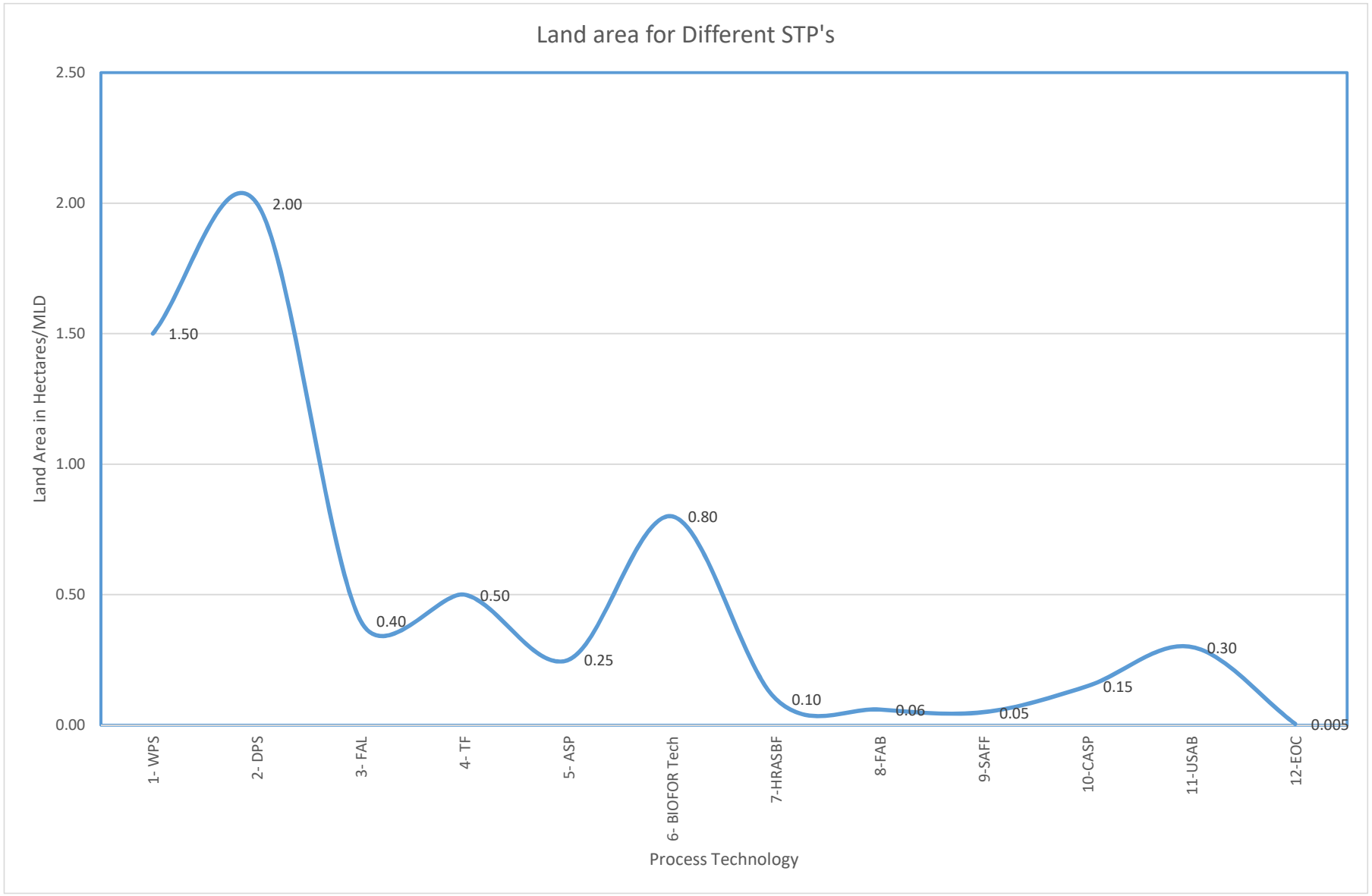
Sl. No.	STP Process	Land Area, hectare/MLD	Advantage	Disadvantages	Applicability Contd..
9	Submerged Aeration Fixed Film (SAFF) Technology	0.05	i) Deep reactors enabling small space requirements ii) Ability to effectively treat dilute domestic wastewaters iii) Low & stabilized sludge production eliminating the need for sludge digestion	i) Clogging of reactor due to absence of primary sedimentation ii) Reliance on proprietary filter media iii) High reliance on external energy input iv) Requires skilled manpower	The SAFF technology based system is particularly applicable for : i)Small to medium flows in congested locations ii) Sensitive locations iii) Decentralized approach iv) Reliving existing overloaded trickling filters
10	Cyclic Activated Sludge Process (CASP)	0.12 -0.15	i) Can be designed to remove N and P along with carbon removal	i) No provision for sludge management ii) No provision of primary treatment iii) High reliance on external energy input iv) Requires skilled manpower	The Cyclic Activated Sludge Process (CASP) may be applicable for: i) small to medium flows in congested locations ii) Sensitive locations iii) decentralised approach iv) reliving existing overloaded trickling filters
11	Upflow Anaerobic Sludge Blanket (UASB) Process	0.2 - 0.3	i) Sludge handling is minimized ii) Power supply interruptions have minimal effect on plant performance iii) Can absorb hydraulic and organic shock loading	i) In general can not meet the desired effluent discharge standard unless proper post treatment is adopted, which in turn may make the treatment scheme energy intensive or may require large land area ii) Effluent is anoxic and invariably exerts substantial initial/instantaneous oxygen demand which may have adverse impact on receiving inland water bodies or when used for irrigation	The suitability of this technology may be doubtful as a stand - alone secondary treatment option

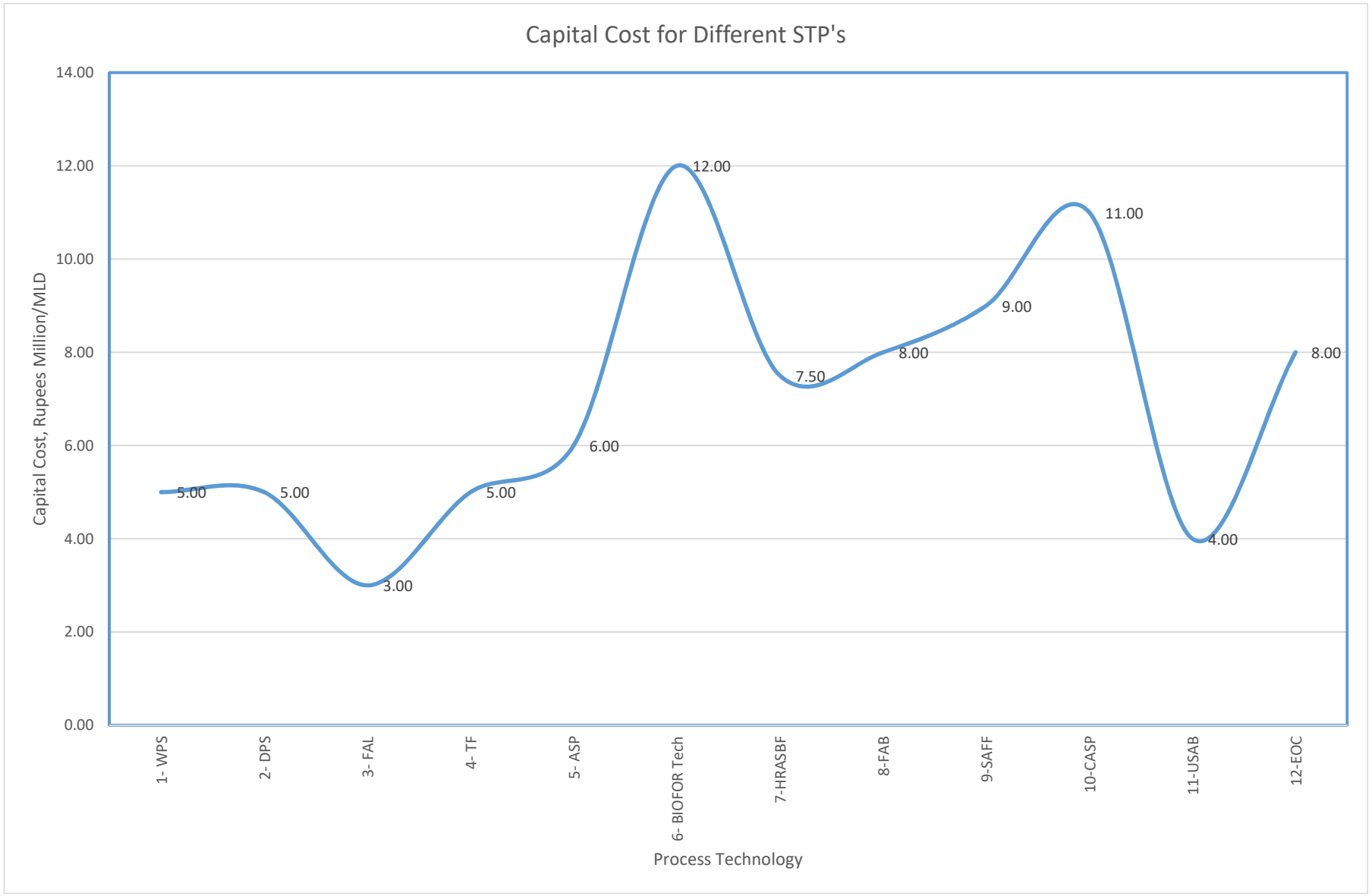
12	**Electro Oxy Coagulation**	**0.004 -0.005**	**i) low sludge formation II) all heavy metals removed iii) On/Off Type iv) No Chemicals/Non-Microbial v) Small Pumps, DC powered vi) Can take organic shock**	**i) Electrode replacement periodically**	**i) Applicable for any type of Sewage**

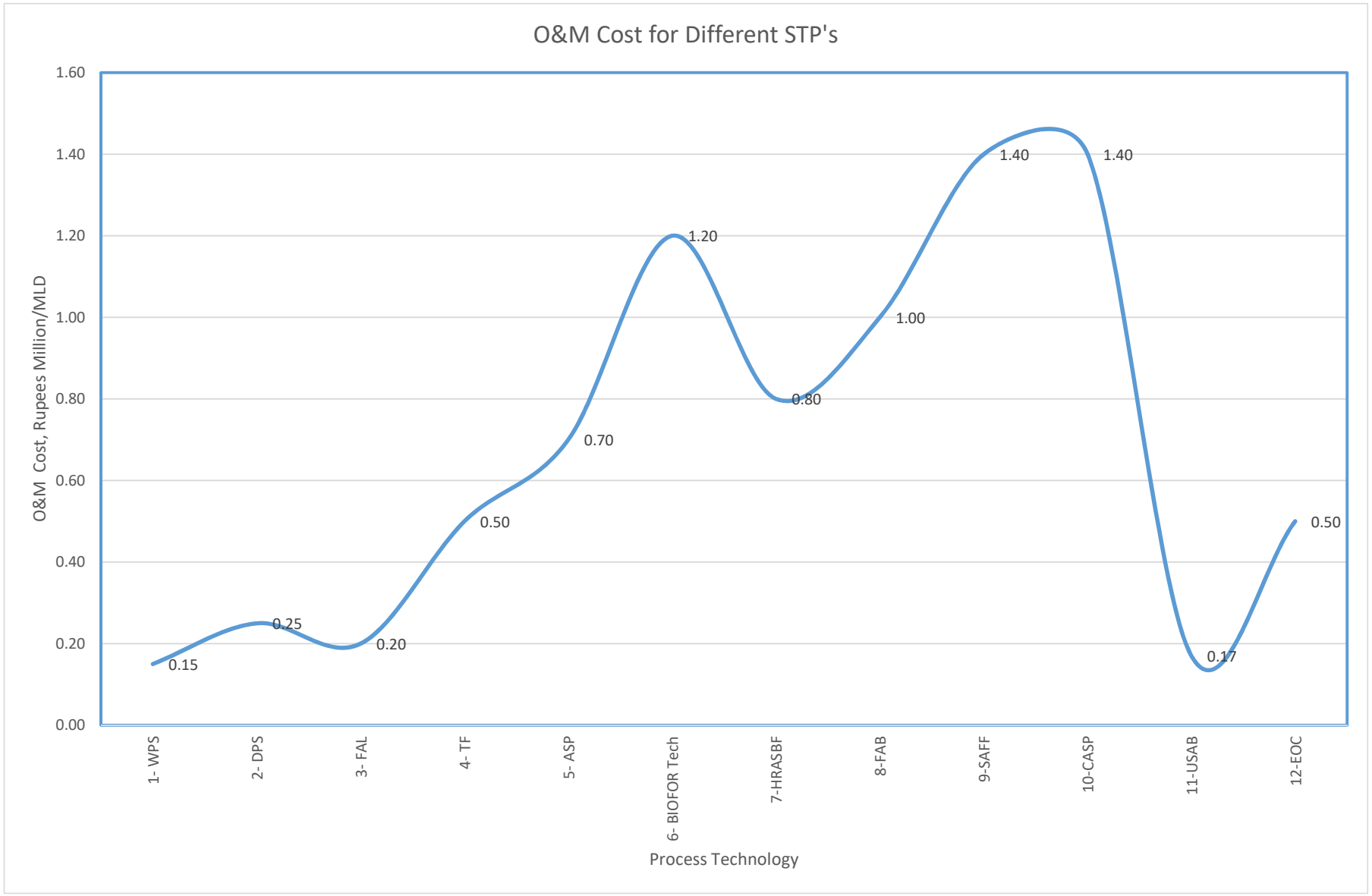
Capital and O&M Cost for Different STPs

Sl. No.	STP Process	Energy Requirement	Capital Cost, Rs. Million/MLD	O&M Cost, million/year/MLD
1	Waste Stabilisation Pond System (WSPS)	Negligible.	Rs. 2.5 - 5.0 Million/MLD	Rs. 0.09-0.15 million/ year/MLD Rs. 0.25-0.41/m^3
2	Duckweed Pond System (DPS)	Negligible.	Rs. 2.5 - 5.0 Million/MLD	Rs. 0.25 million/MLD/year. Rs. 0.68 /m^3
3	Facultative Aerated Lagoon (FAL)	18 KWh/ML	Rs. 2.2 to 3.0 Million/MLD	0.15 to 0.2 million/ MLD/yr. Rs. 0.41 to 0.55/m^3
4	Trickling Filter (TF)	180 KWh/ML	Rs. 4 to 5 Million/MLD	Rs. 0.5 million/MLD/year. Rs. 1.40/m^3
5	Activated Sludge Process (ASP)	180 - 225 KWh/ML	Rs. 5 to 6 Million /MLD	Rs. 0.5 to 0.7 million/MLD/Year Rs. 1.40 to 1.92/m^3
6	BIOFOR Technology (Biological Filtration and Oxygenated Reactor)	220 - 335 kWh/ML	Rs. 10 to 12 Million/MLD	RS 1.2 million/mld/Year Rs. 3.30/m^3
7	High Rate Activated Sludge Biofor - F Technology	180 kWh/ML	Rs. 7.5 Million / MLD	Rs. 0.80 million/ MLD /Year Rs.2.20/m^3
8	Fluidized Aerated Bed (FAB)	99 to 170 kWh/ML	Rs 6 to 8 Million/MLD	Rs. 0.9 to 1.0 million/MLD/year Rs. 2.47 to 2.74/m^3
9	Submerged Aeration Fixed Film (SAFF) Technology	390 kWh/ML	Rs. 9 Million/MLD	Rs. 1.4 million/MLD/year Rs. 3.84 /m^3

10	Cyclic Activated Sludge Process (CASP)	150 - 200 kWh/ML	Rs. 11 Million/MLD	Rs. 1.4 million/MLD/year
11	Upflow Anaerobic Sludge Blanket (UASB) Process	10 - 15 KWh/ML	Rs.3.0 to 4.0 Million/MLD	Rs. 0.12 to 0.17 million /MLD/Year Rs. 0.33 to 0.47 /m^3
12	Electro Oxy Coagulation Process	65-75 KWh/ML	Rs.5.0 to 8.0 Million/MLD	Rs. 0.3 to 0.5 million /MLD/Year


Land area for Different STP's
Land Area in Hectares/MLD
2.50
2.00
1.50
1.00
0.50
0.00
1.50
2.00
0.40
0.50
0.25
0.80
0.10
0.06
0.05
0.15
0.30
0.005
1- WPS
2- DPS
3- FAL
4- TF
5- ASP
6- BIOFOR Tech
7-HRASBF
8-FAB
9-SAFF
10-CASP
11-USAB
12-EOC
Process Technology


Capital Cost for Different STP's
Capital Cost, Rupees Million/MLD
14.00
12.00
10.00
8.00
6.00
4.00
2.00
0.00
5.00
5.00
3.00
5.00
6.00
12.00
7.50
8.00
9.00
11.00
4.00
8.00
1- WPS
2- DPS
3- FAL
4- TF
5- ASP
6- BIOFOR Tech
7-HRASBF
8-FAB
9-SAFF
10-CASP
11-USAB
12-EOC
Process Technology


O&M Cost for Different STP's
O&M Cost, Rupees Million/MLD
1.60
1.40
1.20
1.00
0.80
0.60
0.40
0.20
0.00
0.15
0.25
0.20
0.50
0.70
1.20
0.80
1.00
1.40
1.40
0.17
0.50
1- WPS
2- DPS
3- FAL
4- TF
5- ASP
6- BIOFOR Tech
7-HRASBF
8-FAB
9-SAFF
10-CASP
11-USAB
12-EOC
Process Technology