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Advances in ZLD Technologies

Abstract: *India is lagging several countries in treating its wastewater. Whilst there is a big push from the Government and willingness from the people, it is mired with several bottlenecks. Choosing the right technology has always been a challenge. The market is driven by sale rather than solutions.*

My Paper deals with a host of technologies from inventors across Europe and USA, either being manufactured or in the process of being manufactured in India. Some of these technologies are as follows:

Treatment Technologies:

On the Aerobic side, I will be discussing various technologies such as MBR (Membrane Bio Reactor), (AMBR) Advanced Membrane Bio Reactor, MBBR Moving Bed Bio Film Reactor, AGTR (Aerobic Granular Sludge Technology), SBR (Sequential Batch Reactors), ASBR (Advanced Sequential Batch Reactors), MABR (Membrane Aerated Bio Film Rector)

On the Anaerobic side I will be discussing the technologies such as AMBBR (Anaerobic Moving Bed Bio Film Reactor) and Granulated Sludge based Anaerobic Reactor.

I will also be discussing technologies on product level as follows:

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1. Micro STP's - For flows as low as 1 KLD.
2. Intelligent Evaporators.
3. Solar Sludge Drying systems.
4. Vacuum Distillation.
5. Sludge Densification Systems.
6. Heavy Metals Removal.
7. High end filtration at low Capex & Opex replaces PSF and UF in one go.
8. Instant Drinking water
9. Nano Gas Technology.
10. Dissolved Air Floatation.
11. Multistage RO for recovery above 90%
12. Captive Deionisation
13. Multiple effect Flash Desalination
14. Bacteria for plant performance enhancement.
15. Tailored Chemicals of optimisation and thereby cost saving.

Keywords: 1. Modern Technologies, 2 Developed in Europe and USA,3 Made in India

1. Treatment Technologies

1.1 MBR

Known as Membra Bio Rector has been gaining popularity for its simplicity in the design. The Aeration, settling all happens in one reactor. It occupies very less space and gives potable quality output. The out water is 100% free of bacteria and 67% of viruses are eliminated. Just a disinfection stage is required, and the water is good for potable use. On the downside, the UF membranes must be maintained well and have a maximum shelf life of 5 years or less and must be replaced after that.

1.2 AMBR

Known as advanced Membrane Bio Reactor. It is very similar to the above but some with some innovative features. It saves on power as there is no need for air scouring, the scouring happens due to oscillation rather than blower power. It also offers higher flux as there is no deposition due to oscillation. It has high peeling strength. Also, it has a very high tensile there by ensuring long life. Since no air is used for scouring, there is additional benefit of nitrification :

1.3 MBBR

Known as Moving Bed Bio Film Reactor. This technology is gaining a lot of popularity across Municipal and Industrial plants. They occupy very less space and are highly resilient to shock loads. They are well suited for retrofits and plant capacity enhancements and can double the flow within the existing infrastructure. An offshoot technology namely IFAS is pre-dominantly used in Municipal plants which harnesses the goodness of ASP and MBBR in one go.

1.4 AGTR

Known Aerobic Granular Sludge Technology. Aerobic granules are a type of sludge that can self-immobilize flocs and microorganisms into spherical and strong compact structures. The advantages of aerobic granular sludge are excellent settleability, high biomass retention, simultaneous nutrient removal and tolerance to toxicity. It reduces space required and is resilient to shock loads.

1.5 SBR

Very popular in India and is known as Sequential Batch Rector are well suited for Municipal Sewage. Here BOD, Phosphorus, Nutrient removal and clarification all happens in one tank. They need a higher level of automation and work in batch modes. They operate in 5 different steps namely, Fill, Mix, Anoxic, Aerate and Decant modes.

1.6 ASBR

Known as advanced sequential batch reactor, this technology operates with a single drive. One motor is used for aeration pumping and valve control. It also has a sludge densification system where the live biology is put back into the reactor and only the dead biology is wasted.

1.7 MABR

Known as Membrane Aerated Bio Film Reactor is also called a bubble less technology. Air is circulated through special membranes. These membranes diffuse oxygen and biology grows on these membranes. Due to direct utility of oxygen, the power requirement comes down substantially. The lean oxygen air is used for scouring. In this system nitrification and denitrification happens simultaneously. This is very ideal for existing plant enhancements.:

1.8 AMBBR

Knowns as Anaerobic Moving Bed Bio Film Rector. This technology uses the space saving advantage of MBBR and at the same time power saving advantage of Anaerobic mode. Anaerobic biology is grown on the media. The media is kept in motion using slow speed submerged mixers.

1.9 GBAR

Known as Granulated Biomass Anaerobic Reactor. In this system the granulated Biomass is planted into the reactor and will be about 80% of the reactor. The influent is fed into the system where it gets mixed with the biomass and rises. As it rises the organic load is converted into Biogas. The gas escapes to the topmost part of the reactor where it is harnessed. The water enters the 2-stage separation chamber where the biomass is separated, and the treated water is harnessed. The Second stage separated Biomass is mixed with the incoming influent.

2. Technologies at Product Level

2.1 Micro STP's - For flows as low as 1 KLD.

Although this is a technology by itself, I have put it under the product category as this operates with a single drive and is fully automated. There is no human intervention required and works well even when the flows are lean or absent for some time. It not only removes BOD but also treats nutrients as well.

2.2 Intelligent Evaporators.

This is another revolutionary technology. Here using an artificial intelligence system, a fan blows through the mist and sends it into the air. This is specifically used where RO rejects are to be dealt in small capacities of up to 10 KLD. If the effluent has BOD and COD, this does not fit as foul smell may emanate. It operates on very low power and does not require any steam. The salts are collected on the pans and can be bagged.

2.3 Solar Sludge Drying systems

This is another state-of-the-art technology where Solar Power is used to dry the sludge there by reducing the quantity to be handled. The Concentrated Solar Thermal Generator heats up the water up to 80 degrees centigrade and is circulated through the GI pipes in shallow beds of 150 mm. Sludge is poured over this up to 50 mm thick. The sludge that comes with 20% or less consistency can be dried up to 90% plus consistency. A ton of sludge can be reduced to just 250 kgs. The sludge bed needs to be covered to protected from the rain.

2.4 Vacuum Distillation

This is another technology that is taking the market by storm. Here a compressor is used to generate heat by creating vacuum. The steam is circulated to the vessel holding the influent there by transferring the heat. The saturated steam comes out as pure distillate. The residue at the bottom of the vessel is taken out as concentrate. 95% comes out as distillate and 5% comes out as concentrate.The salts that come out are around 20% consistency and can be dried further. The supernatant is fed back into the system along with the influent. There is no usage of steam and it is completely automatic including the CIP.

2.5 Sludge Densification Systems

This is a boon for plants operating on Activated Sludge Process. Basically, it is a cyclone adapted on the return activated sludge line. It segregates dense sludge which is live biology and sends it into the Reactor and the rest is wasted. This enables higher MLSS and better performance of the plant.

2.6 Heavy Metals Removal

This is a technology developed with a membrane that is an extract of milk protein. This is so revolutionary that it absorbs almost anything. It is very useful for effluents containing Heavy Metals, Radioactive Metals, Arsenic, Fluoride and even can be used for disinfection. And the membrane can be replenished by certain procedure. Further this is also adopted for precious metal recovery.

2.7 High end filtration at low Capex & Opex replaces PSF and UF in one go.

This is a direct replacement for Pressure Sand Filter and Ultra Filtration in one go. It has a better output quality than Ultra Filtration. It needs back-wash once in 24 hours and is low on Capex and Opex. It can handle TSS up to 50 ppm. It has a long lifecycle and needs media top up once in 2 years with anthracite which is cheap and locally available.

2.8 Instant Drinking water

This is a portable unit which can generate water literally from any source. It does not matter if the water is contaminated or has high salts like the sea water. It just gives pure drinking water from any source. This is used by the US Military and was widely deployed during Haiti Crisis.

2.9 Nano Gas Technology

The Nano Gas technology generates bubbles which are less than 400 nm. This enables the air with oxygen to stay in the water for long periods and does not escape. The oxygen in the air start the treatment. This can be used in Municipal Plants to reduce the power consumption. This is predominantly used with difficult to treat effluents which have high COD and TDS etc.:

2.10 DAF Dissolved Air Flotation

With more than 2,000 installations across the world, now this product is made in India. The biggest Skid mounted 50 MLD DAF was delivered to a steel plant in Karnataka. A 25 MLD PP DAF was exported from India as well. This is based on unique Cross Flow Design&Progressive Water Extraction. It is available in PP and SS configuration. It occupies very less space and gives a very high-quality output.

2.11 Multistage RO for recovery above 90%.

A combination of RO systems ensures permeate of 90% and above. This is boon for ZLD as the handling of reject waster is minimised.

2.12 Captive Deionisation

This technology uses electrostatically charged ionic membranes to desalinate or treat high TDS water. Operates on 30% to 50% less energy compared to RO. For lower TDS the energy consumption also drops proportionately. Is a good option for Fluoride removal as well. It requires minimal Pre-Filtration. The CIP js based on Non-invasive chemical cleaning. An occasional flush with mild ascetic acid is done whilst continuous flow is maintained

2.13 Multiple Effect Flash Desalination.

In this system a Concentrated solar thermal generator is used to make steam from sea water.A relatively small amount of steam, from the 1st Effect is leveraged to produce many times more steam than provided by the 1st Effect.The energy available to cause evaporation is 4,625 Btu/hr. in the 2nd Effect. In the 18th Effect 20,894 Btu/hr is available.The product are distillate and salt and hence no brine. It consumes minimal power and operates at very low Opex.

2.14 Bacteria for plant performance enhancement.

These are specially developed bacteria that aid in better treatment of difficult effluent and there by bringing down the sludge quantity by better di-gestion. These are also used in lake cleaning and shrimp farming.

2.15 Optimized Chemicals

A new approach in designing tailor made chemicals and poly electrolytes has ensured optimal usage and thereby saving on chemical costs.

The above is what I have gained as practical knowledge over my three decades executing several projects worldwide. I have tried my level best to touch upon some of the modern technologies that are slowly penetrating the market. It is important to choose the right technology based on the nature of the effluent.

Conclusion

Many a times the Industry looks for technologies that are tried and tested by other industries. My effort has been to put some light on the various technologies that are available in the market that contribute to lower Opex and Capex. Whilst adopting new technologies the carbon foot print also gets a boost. The latest technologies uses less power, are easy to maintain and have long shelf lives. All the technologies that have been explained have been in practice overseas and are not able to find acceptability in the Indian Market. My take away would be "please do due diligence on the new technologies but give them a chance instead of taking the beaten path."