Generic Brochure Of

Econo Services For

STPs (Sewage Treatment Plant)

For Good Quality Treatment

Submitted by:

Econo Services (India) Private Limited,

Chennai, India

Benefits of this Technology

1. The system **can be designed to conform to very rigorous Client specifications, or to minimum specifications at low cost**.
2. It is **cost effective compared to other technologies**, taking into account Total Cost of Ownership (sum of Investment, and on-going Operating Cost and Maintenance Cost), as the Operation and Maintenance Costs with our technology are low.
3. It can be designed to **use minimal space**, even odd-shaped space, making huge savings, in view of the possibility of commercial use of the space saved.
4. Being a Closed system, it **doesn't generate foul smell, and it won't breed mosquitoes and insects** unlike conventional technologies.
5. It is **easy to operate**; an STP using this technology is being maintained successfully by Polytechnic students in a hostel in Chennai, India, for several years. Even unskilled workers can be trained to operate it.
6. It **can be designed to digest organic sludge, which is difficult to dispose**. So, there is no need to transport and dispose sludge.
7. It **doesn't consume chemicals** in its processes, except for optional Chlorination.
8. The system **won't degrade in performance even over years**, unlike conventional technologies, since it doesn't use electromechanical equipment other than pumps and air blowers; the blowers are not for conventional aeration, but only in fluidized bed and fixed bed reactors.
9. It **can be switched off when not required**, with minimal air flow, saving power, unlike conventional technologies which require the STP to be running all the time.
10. It **can withstand even long power cuts**, as long as effluent flow can be managed.
11. If the Client so desires, **we can enter into an AMC** (Annual Maintenance Contract) and ensure that the system is maintained well over the years.
12. It **deploys an advanced technology**, developed by an Environment Technology Research Lab of the Government of India, and commercialized by us outside India. Hence the technology comes **with guarantee from this Govt of India Lab**.

In sum, this STP itself can become a talking point in the community.

About Econo Services (India) Private Limited

Econo Services (India) Private Limited is a 14 year old Company, promoted and run by Mr. Subramanian Ganesan, a Post-graduate in Technology and a Consultant with 40 years of experience with keen interest in promoting modern and cost-effective technologies worldwide, also having served Indian Prime Minister's Task Force in the past.

Working in close association with some of the latest technology researchers and leaders in this field in India, Econo Services seeks to provide the right kind of solution that meets the technical and environmental requirements of its clients, economically.

Econo Services promotes worldwide, the AICR (Advanced Immobilized Cell Reactor) technology, one of the latest and best of technologies in Wastewater Treatment, and more particularly in Sewage Treatment. This technology has been developed and patented by a reputed Environment Technology Research Lab of the Govt of India. Any client implementing an STP or ETP would get the added benefit of guarantee for the technology and project from the Environment Technology Research Lab of the Govt of India.

Econo Services promotes the modern concept of decentralized STPs, which reduces the cost of underground sewerage substantially, besides being able to deliver treated water of any level of purity for local re-use. AICR being a modular and scalable technology, it is eminently suited for implementing STPs in a decentralized form. Since developed countries have already invested heavily in centralized STPs, particularly in the form of huge underground sewerage lines, the ideal market for decentralized STPs is the developing countries.

Econo Services has associates working in many countries promoting the AICR technology. A 1,200 m3/day STP in Kumasi and a 1,500 m3/day ETP for treating tuna fish processing plant in Tema are in different stages of execution in Ghana. Several projects are in various stages of discussions in Colombia, Ecuador, Canada, Ghana, Nigeria, etc.

Econo Services had the fortune of having been asked to author an eBook on “All About Wastewater Treatment: A Comprehensive Guide”, by ‘Geostar Publishing & Services LLC, USA’. This is the world's first eBook on this subject. The staff of Econo Services undertook the assignment and the eBook was published in 2005. Thousands of copies of this eBook have been sold worldwide.

In addition, with the free technical assistance of Econo Services, Geostar has been educating academics, professionals, corporates and Municipalities about Wastewater Treatment processes and technologies through their FREE Newsletters, which have over 10,000 subscribers worldwide. The subscribers have been immensely pleased with this free effort of social service.

Soft Loan from Government of India: The world over, Governments (including State Governments and municipalities, even in developed countries, but more so in developing countries) face serious shortage of financial resources to execute infrastructural projects like Wastewater Treatment. When they run out of ideas to mobilize finance, they resort to the PPP (Public Private Partnership) mode, using the popular BOT (Build, Operate & Transfer) model.

That is, they invite private sector to invest in such BOT projects, on the premise of recovering their investment over a few years (say 5 to15 years) in the form of EMI (Equated Monthly Installments). Typically, private sector works on a 25% RoI (Return on Investment) basis for such financing. At 25% interest, the loan recipient Government's monthly payout to the private player on 1 M US $ investment by the private player works out to US $ 21,355.59.

Econo Services will try to secure for the Client, Government of India's soft loan funds at ~ 6% interest (diminishing balance) on a 15 year loan. The monthly payout in this case, on 1 M US $ is just US $ 8,438.57, just about 40% of what the private players charge. Indian Government would seek, for any such loans, a Sovereign Guarantee from the recipient Central Government.

So, any Government availing such a loan would cut the payout by a whopping 60% compared to PPP (BOT) model. That is, a Government that will pay US $21,355.59 p.m. through PPP, would have to pay only US $8,438.57 p.m. through Indian Government soft loan at 6% interest. This means the project cost would be only 40% for the loan recipient Government.

About Advanced Immobilized Cell Reactor Technology

This technology is extremely efficient compared with other technologies in terms of the capital cost of building the Plant, cost of operation & maintenance, quantity of sludge generated, odor level, and availability of space.

Conventional biological sewage treatment systems consume enormous electrical power and need vast land areas, apart from involving huge investment in the form of electro-mechanical equipment. Thus, the Total Cost of Ownership (i.e., the cost of setting up and operating a modern Sewage Treatment Plant) that meets the demanding Pollution Control norms works out to be exorbitant.

Moreover, the various equipment units used in treatment operations are subjected to wear and tear; consequently, the aerobic biological diversities are deprived of oxygen, thereby leading to their retarded performance. Thus, Effluent Treatment Plants and Sewage Treatment Plants degrade in performance over time, and they fail to deliver as per the discharge standards for treated wastewater, as prescribed by the local pollution control authorities, and as delivered at the time of commissioning. Imagine installing a Plant that performs well initially, but fails to perform as per specifications within a few years (if not a few months), thereby attracting the penalty of the pollution control authorities!

There has been a constant search for cost effective treatment systems that would solve te above problems and also accommodate shock load applications, and be extremely flexible in its operation.

Advanced Immobilized Cell Reactor technology has been developed specifically to address all these issues. Additionally, a few other patented technologies (like FAICR and EICR) have been developed after extensive research to address diverse sewage and industrial effluent treatment challenges.

Why Advanced Immobilized Cell Reactor Technology Is Truly GREEN!

A Green Technology is one that uses naturally occurring conditions and organisms along with other resources from nature, in a way that does not harm the environment, while serving the desired purpose. Such solutions should conform to the conditions associated with the term "Sustainable Development" which involves being environmentally sound, socially equitable, and economically viable, all at the same time.

Green technologies include Emerging Technologies that are nature friendly, Environmental Remediation that protects the environment by removing pollutants & contaminants that are of chemical and biological origin, Renewable Energy that is produced by using natural objects like sunlight, wind, or water, and last but not the least, Waste Management involving eco-friendly treatment, purification, re-use (wherever possible) and disposal of solid and liquid waste.

To be considered Green, a wastewater treatment technology should:

- Consume low energy during the treatment process,
- Use only biological processes, and no chemical processes, and
- Restore water through re-usability.

The Advanced Immobilized Cell Reactor technology completely eliminates the need for chemicals and does not involve electricity consumption (except outside of the process when water needs to be pumped), facilitates re-use of water, and is one of the Greenest Technologies that meets all of the above parameters with ease!

Why Housing Estates Choose AICR Technology

The Advanced Immobilized Cell Reactor technology, besides being **Green**, promises benefits that include:

- Significantly lower plant cost
- Up to 50% savings in operating costs
- Up to 50% savings in maintenance costs
- Up to 90% less sludge production
- Accomplishment of any high purity level of treated water is possible, like:
  - (i) BOD (Biological Oxygen Demand): < 3 mg/Liter,
  - (ii) COD (Chemical Oxygen Demand): < 25 mg/Liter
  - (iii) TSS (Total Suspended Solids): < 20 mg/Liter

Additional Merits of This Technology:

- Less Overall Space Requirement
- Lower Requirement For Electrical And Mechanical Equipment
- Lower Detention Period
- Lower Power Consumption (About 30% Of The Conventional)
- No Need For Aeration Tank
- No Foaming Problem
- No Addition Of Micro /Macro Nutrients
- No Biomass Production
- No Secondary Settling
- No Need For Any Other Tertiary Treatment Except For Primary Re-use
- Complete Removal Of Color And Odor
- Possibilities For Reusing The Treated Effluent For Almost Any Application
- Scalability: Provision To Handle Any Volume Of Additional Load By Adding More Modules
- Need Not Force Operation On Holidays
- Low Pay Back Period Due To Huge Saving On Electricity & Chemical/ Other Consumables

- Non-requirement of Continuous Power Availability
- Low Capacity DG Set As Power Back Up, If At All Required
- Ability To Work In All Climatic Conditions With Proper Design
- Very Little Of Imports, Thereby Reducing The Costs Of Transportation, Taxes, Duties & Overheads
- Most Of The Investment On Local Material & Labor, Thus Helping The Local Economy

In the Advanced Immobilized Cell Reactor technology, integrated biological and chemical oxidation happens in a single reactor.

Sewage water treated through the Advanced Immobilized Cell Reactor system has been found to eliminate sulfide, odor and color by almost 100%.

Obviously, specifications have cost implications. Hence, based on the client specifications, some or all of the above features and benefits can be built into any Plant.

Two Advanced Immobilized Reactor Technology

Based Sewage Treatment Plants

In Chennai, India

Total Cost of Ownership: The Decisive Edge Of Advanced Immobilized Cell Reactor Technology

As investment in sewage treatment is a long term investment, and since Governments are likely to be more and more stringent in respect of the quality of treated water produced, you will be protecting your investment for 20 years or more by going in for this latest technology.

Total Cost of Ownership (TCO) = Initial Investment + Ongoing Operating Costs + Maintenance Costs.

Though most of the capital decisions are taken based on initial investment, it has been found in practice that the ongoing operating costs work out to be much more.

So, when you want to invest in a new Sewage Treatment Plant, you have to additionally take into account the on-going cost of repairs & maintenance, the salary costs of operations crew, the cost of consumables, and the cost of electricity.

All of these add up to what we call as TCO (Total Cost of Ownership).

There are no chemicals/ consumables in our system, and electricity & staff costs are very low too. **So, this technology is not only superior in performance, but also has the lowest TCO.**

So, when you invest in Advanced Immobilized Cell Reactor Technology, you are protecting your investment for the long term, taking the best decision in terms of modernity of technology, performance, and cost.

Advanced Immobilized Reactor Technology Based Sewage Treatment Plant (50 $M^{3/}$Day) Installed In The Basement Of A Software Park, In Bangalore, India

A Pilot Plant To Demonstrate The Technology

Partial View Of 1,500 M3/Day Fish Processing Etp (Effluent Treatment Plant) At Tema, Ghana – Structures Are Of Steel

Visual Comparison of Fish Processing Effluent And Treated Water

Comparison With Other Technologies

(The other technologies are either variants of these technologies or not as popular. So, the comparison still holds.)

S. No	Factor Of Comparison	MBR	Activated Sludge Method	SAFF Method	Advanced Immobilized Cell Reactor Method
1	Area & Height	Area= Smallest Height= Smallest	Area=Largest Height=Smaller	Area=Medium, Height=Smaller	Area=Smallest, Height=Larger
2	Manpower requirement	High	High	High	Low
3	Manpower Skill requirement	High	High	High	Low
4	Frequent Materials Replacement	Membrane	Diffuser membrane	SAFF film	No replacement of catalyst
5	Need for Continuous Operation	Necessary. 24 hours/day; 365 days/year	Necessary. 24 hours/day; 365 days/year	Necessary. 24 hours/day; 365 days/year	Not Necessary. Operates only when required.
6	Chemical treatment	Periodic Cleaning Required	Desirable for high kitchen load	Desirable for high kitchen load	Not required
7	Energy recovery	Not possible	Not possible	Not possible	Possible
8	Sludge Generation	Very High	Very High	Very High	Very Low
9	Sludge Disposal mode	Allowed after treatment	Allowed after treatment	Allowed after treatment	Allowed without treatment
10	Treated Water Quality (With BOD: 400 ppm, COD: 800 ppm, TSS: 450 mg/l)	BOD <10 ppm COD<50 ppm Pathogen >10^3 CFU/ml	BOD <30 ppm COD<250 ppm Pathogen >10^6 CFU/ml	BOD <30 ppm COD<250 ppm Pathogen >10^6 CFU/ml	BOD <10 ppm COD<50 ppm Pathogen >10^3 CFU/ml
11	Appearance of treated water	Colorless	Tinted yellow in color	Tinted yellow in color	Colorless
12	Water Odor	Low	Very High	Moderate	Very Low
13	Ventilation requirement	Low	High	Low	Very low
14	Response to Power failure	Moderate (Max: 2-4 hrs)	Sensitive (Max: 1.5 hr)	Moderate (Max: 2-4 hrs)	Almost Nil. No upsets on power failure
15	Response to shock loads	No deterioration in efficiency	Plant upsets	Plant upsets	No deterioration in efficiency
16	Degradation of performance over time	High	High	High	Almost Nil
17	Stabilizing Time at Commissioning	Requires a few days	25-40 days	25-30 days	Stabilizes instantly
18	Minimum Load required for commissioning	25%	25%	25%	No such constraints
19	Flexibility for future expansion	Easy & Modular. Modules can be added any time	Not Easy. New Civil & electro-mechanical items required	Not Easy. New Civil & electro-mechanical items required	Easy & Modular. Modules of reactors can be added any time
20	Investment cost	Highest	Higher	Moderate	Lower
21	Operating Cost (Chemicals, Power, Consumables & Labor)	Highest	Very High	Moderate	Low

Select List of Clients Using Advanced Immobilized Cell Reactor Technology

S.No	Name of the Industry	Nature of the Industry	Type of waste	Vol. of discharge
1	Macro Marvel Housing Project, Chennai, India	Sewage Treatment Plant	DWW	120 m^3 / day
2	TCL Industries, (MALAYSIA) SDN, BHD, Kemman, Terengganu, Malaysia	Liquefaction of organic rich solid waste	SRW	2 kg/day
3	Paradise Toys, Colombo, Sri Lanka	Sewage treatment Plant	DWW	120 m3/day
4	Sri Chamundi Leather, Chennai-48, India	Garment leather manufacturing	IWW	75 m^3 / day
5	Shameel Tanners, Warangal (A.P), India	Upper leather manufacturing	IWW	25 m^3 / day
6	Shuttle Weaves Color (P)Ltd, Karur, India	Textile Dyeing	IWW	150 m^3 / day
7	Jaya Murugan Sago Factory, Salem, India	Starch powder manufacturing	IWW	250 m^3 / day
8	ARG Raja Sago factory, Salem, India	Sago manufacturing	IWW	450 m^3 / day
9	India Dyeing (P) Ltd, Erode, India	Textile dyeing	IWW	150 m^3 / day
10	Celebrity Fashion (P) Ltd, Chennai, India	Textile Dyeing	IWW	150 m^3 / day
11	Orchid Chemicals& Pharmaceuticals, India	Drug R&D unit	LWW & DWW	15 m^3 / day
12	Pure Enviro Engg (P) Ltd, Chennai, India	Sewage Treatment Plant	DWW	10 m^3 / day
13	LLC Industrial Chemicals, Dubai	Resin manufacturing	IWW	35 m^3 / day
14	United Bleachers, Mettupalayam, India	Textile Dyeing	IWW	700 m^3 / day
15	Shiva Oils &Fats, Sipcot, Ranipet, India	Edible Oil Manufacturing	IWW	20 m^3 / day
16	M/s Shanmugam Tannery, Pammal, Chennai, India	Leather Manufacturing	High TDS Water	10 m3/day
17	ASTRA ZENECA, Tesla technologies Oxidation, Bangalore, India	Pharmaceutical R & D	LWW & DWW	50 m^3 / day
18	Heritage Property Devopment, Chennai, India	Sewage Treatment Plant	DWW	350 m3 / day
19	Chempure Technologies, Chennai, India	Sewage Treatment Plant	DWW	350 m3 / day

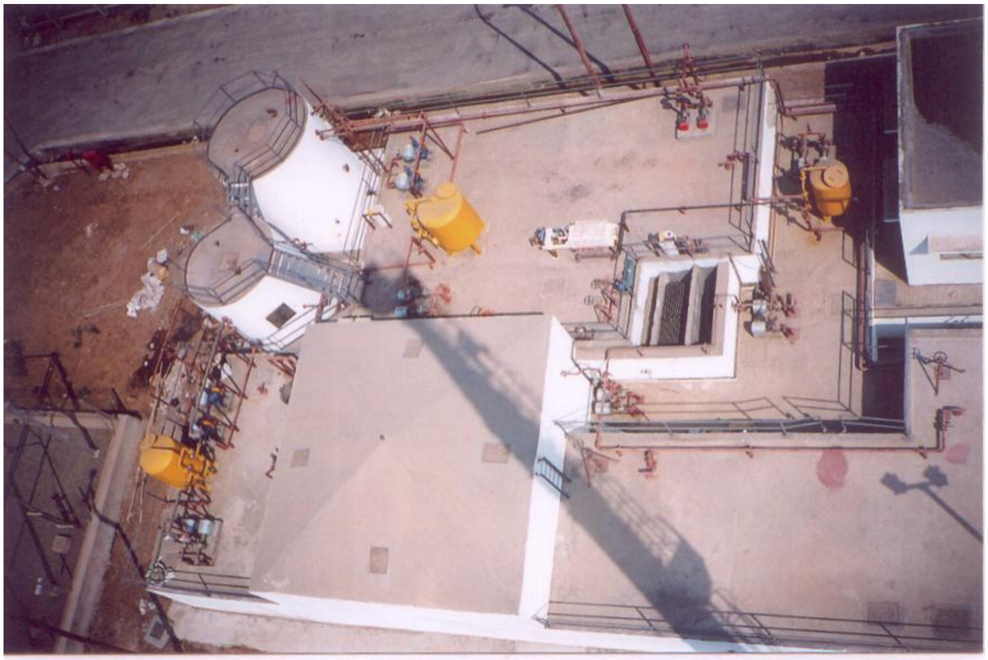
20	Stallaion, Tiruppur, India	Textile Effluent	IWW	1000 m3 / day
21	IVRC, Hyderabad, India	Sewage Treatment Plant	DWW	200 m3/day
22	Danube, Bombay, India	Textile Effluent	IWW	700 m3/day
23	DART, Hyderabad, India	Sewage Treatment Plant	DWW	30 m3/day
24	Jain Constructions, Chennai, India	Sewage Treatment Plant	DWW	120 m3/day
25	Greaves Ltd., Ranipet, India	Sewage Treatment Plant	DWW	75 m3/day
26	Reliance , Bombay, India	Laboratory Effluent	LWW & DWW	225 m3/day
27	Infosys , Chennai, India	Sewage Treatment Plant	DWW	250 m3/day
28	Infosys, Pune, India	Sewage Treatment Plant	DWW	250 m3/day
29	Huntsman, Chennai, India	Bisphenol Resin Manufacturing	IWW	120 m3/day
30	Ramco Cements, Karaikudi, India	Sewage Treatment plant	DWW	75 m3/day
31	Rajarajeswari Dental College, Bangalore, India	Sewage Treatment Plant	DWW	120 m3/day
32	Standard Chartered Bank, Chennai, India	Sewage Treatment plant	DWW	75 m3/day
33	South City, Calcutta, India	Sewage Treatment Plant	DWW	2,050 m3/day
34	Reliance (Dhirubhai Ambani Knowledge Centre), Mumbai, India	Sewage Treatment plant	DWW	2,500 m3/day
35	Tamil Nadu Newsprint Limited, Chennai, India	Sewage Treatment Plant	DWW	1,000 m3/day
36	Anatech, Namibia	Sewage Treatment Plant	IWW	12 m3/day
37	Cosmo Seafoods, Tema, Ghana	Fish Processing Effluent Treatment Plant	IWW	1,500 m3/day

IWW Industrial Wastewater

SRW Solid Refractory Waste

DWW Domestic Wastewater

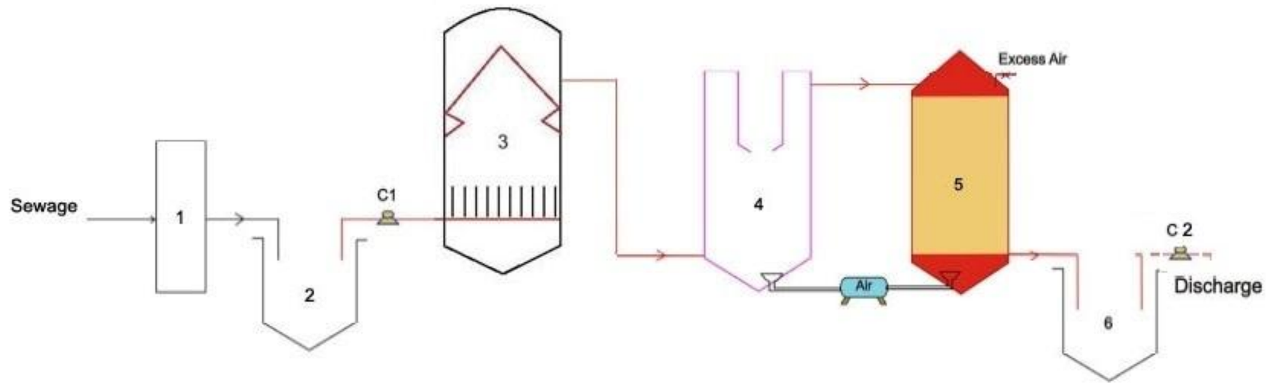
LWW Laboratory Wastewater



BIRD'S EYE VIEW OF A PLANT USING
ADVANCED IMMOBILIZED CELL REACTOR TECHNOLOGY AT RELIANCE, MUMBAI

PERSPECTIVE VIEW OF A PLANT USING
ADVANCED IMMOBILIZED CELL REACTOR TECHNOLOGY AT TIRUPPUR, INDIA

Schematic Flow Diagram



Primary Treatment

1. Screen
2. Collection Tank

Secondary Treatment

3. Anaerobic Reactor
4. FICCO Reactor
5. AICR Reactor
6. Treated Water Tank

C1, C2 - Pumps

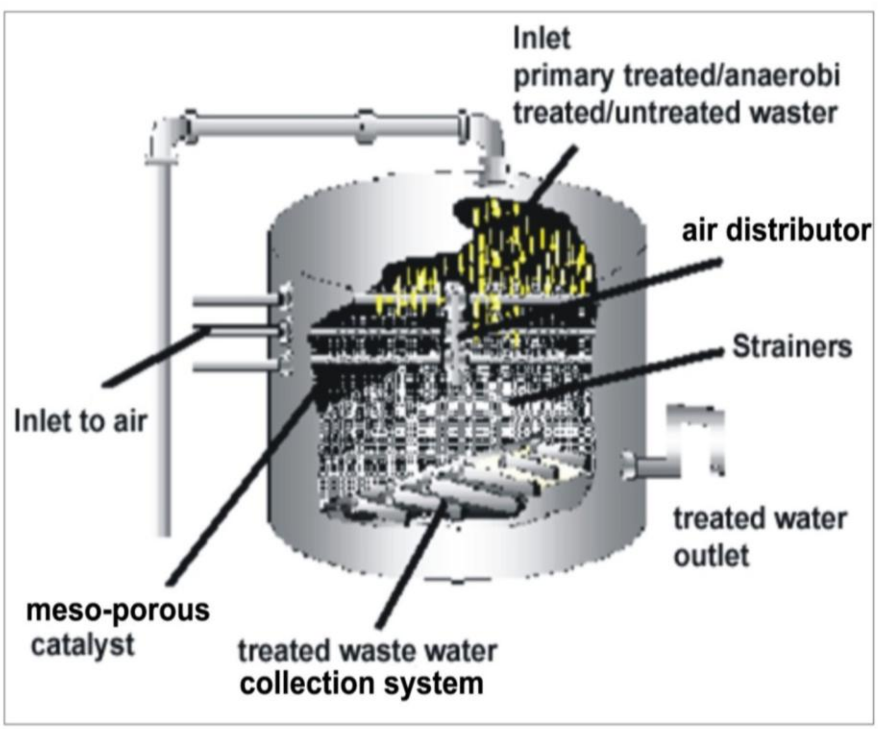


Figure: Inside An Advanced 'Immobilized Cell Reactor'

Description of the Schematic Flow Diagram

Pre-settling Collection Tank/ Sump collects sewage, passed through a Screen and removes floating solids in the sewage before the Reactors.

Anaerobic Reactor (Digester) is a closed reactor. Here, bacteria act upon the organic waste and release plenty of carbon dioxide and methane. The microbial community has only obligate anaerobic and facultative bacteria. Initially the macromolecules are hydrolyzed. These products are then converted to volatile fatty acids (mainly acetic acid), and alcohols. The organisms responsible for these reactions are popularly called acid formers. They obtain energy through oxidation of organic compounds, but do not use oxygen as electron acceptor. Instead, another fragment of the substrate is reduced to anaerobic acids and alcohols. These are then metabolized by a second group of obligate anaerobic bacteria (the methane formers), and converted to methane. The activities of the methane and acid producing groups of bacteria must be balanced as the former is sensitive to pH changes and works best in pH range 6.8 to 7.5.

Then it passes through FAICR (Fluidized Advanced Immobilized Cell Reactor), which consists of a reaction zone and a settling zone. The reaction zone is provided with mesoporous catalyst which has been immobilized with chemo autotrophic bacteria. The immobilized cell mesoporous activated carbon is fluidized using air at a pressure of 0.6 kg/cm2. The fluidized velocity of mesoporous carbon particles is fixed based on the influent wastewater flow velocity. The settling zone provided at the top is to settle the carbon particles and heterotrophic biomass developed during oxidation of organics in wastewater. The excess biomass buildup in the reactor will be periodically removed through sludge outlet. The COD in the reactor is removed by following first order kinetics.

The treated waste water from the FAICR Reactor is taken to the AICR Reactor (Advanced Immobilized Cell Reactor), a column of specially made activated carbon catalyst, which would remove substantial proportions of BOD and COD and almost all sulfides. The effluent from this unit is odorless.

The quality of water coming out will meet the specifications, and can be discharged/ re-used off as required.

A Chlorinator/ Ozonator can be added, if higher level of treatment is required by the Client.

The water so treated will be good enough for discharge to surface water bodies like rivers, or even for re-use for tertiary purposes like flushing in toilets, lawns, golf courses, and even for non-edible agriculture.

Known as "Advanced Immobilized Cell Reactor" technology, it is patented and is far superior to most of the other conventional technologies.

Note: FAICR and AICR technologies are patented based on years of research in a Government of India Environment Technology Research Lab, field trials and live plants They make use of patented proprietary catalysts which are not consumables but have lifespan of over 15 years. The schematic may be modified marginally to improve performance, based on continuous research being carried on in the Lab and in the field.

Contact Us

If you have any other questions about our wastewater treatment using the Advanced Immobilized Cell Reactor Technology, write to us.

Address your email to ceo@econoservices.com

We will be only too happy to answer any additional queries you may have about the Advanced Immobilized Cell Reactor Technology. Especially about how this technology can satisfy requirements specific to your needs, and how to set it up, either as a new plant, or as replacement for/ retrofit to an existing plant.

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ANNEXURES

How The Advanced Immobilized Cell Reactor Technology Works

A basic feature of this system is the immobilization of bacteria, in the pores or voids of the carbon matrix. These immobilized organisms are prevented from shock load applications as the diffusion of the pollutants from the bulk fluid phase to organisms follows Fick's law.

The reactor consists of a tall column packed with activated carbon. The activated carbon is immobilized with chemo autotrophs. Oxygen required for the oxidation of organics in wastewater is supplied in the form of compressed air from the bottom of the reactor. The countercurrent movement of the liquid and air streams enables the dissolved organics to undergo oxidation and desorb the converted products, so that the activated carbon maintains its activity throughout the operation.

In addition to having pores for the immobilization of organics, the system also brings the outer pore surface areas in contact with active sites of varying degrees of potential energy. These energetic active sites are engaged in adsorbing dissolved solutes in wastewater. The active sites are abundantly available for solute molecules leading to a condition in which the solute molecules wander freely over the outer pore surface area, and consequently, the entropy of the solute molecules tends to increase.

The enhanced entropy of the system will tend to lower the enthalpy of adsorption of the solute molecules for the fixed quantity of free energy of the system. The decrease in enthalpy of adsorption also favours desorption of the products formed. The oxygen molecules supplied for oxidation also adsorb at the activated sites. Oxidation of organic molecules is expected to be accompanied by the quenching of electrons released from them.

The electron-conducting carbon matrix has demonstrated a marked increase in its performance of oxidation of organics, expressed in terms of COD and BOD, in wastewater discharged from sewage and industries. The dissolved organics estimated as COD and BOD have been proven to be reduced to such a credible level as to allow the treated wastewater to be discharged onto open land surface areas.

The treated wastewater has been used for irrigation and the growth of vegetative plants, commercial crops and ornamental plants have been recorded. The treated wastewater has been tested for carcinogenity and the test results suggest that the treated wastewater can be safely handled by human beings.

Interestingly, biomass production was recorded to be so negligible that no clogging of the reactor was recorded even after continual operation for four years. The maintenance cost of sewage treatment using this system was estimated to be a mere 25% of the existing treatment system. The Advanced Immobilized Cell Reactor technology has been extended to treat wastewater from domestic & commercial sewage, besides leather, textile, sago & starch processing, and chemical & pharmaceutical industries.

The system has been designed so as to integrate biological and chemical oxidations, in a single reactor. In the upper portion of the reactor, biological oxidation is performed by the immobilized organisms, while chemical oxidation takes place in the bottom portion of the reactor.

The oxygen required for the oxidation of organics is facilitated through compressed air sent from the bottom of the reactor. The wastewater to be treated is applied over the cross section of the reactor and therefore the oxidation of organics in wastewater is terminated while the fluid streams (air and wastewater) flow in the counter current direction.

The treated wastewater is collected from the bottom of the reactor. As Chemoautotrophs are used for the biodegradation of organics, whose yield coefficient is very low, biomass production is greatly reduced.

Hence, there is no need to have a secondary clarifier for the separation of secondary sludge, and consequently the problem of sludge disposal is also considerably eliminated.

However, this technology also has some limitations:

- Permeability index is less than that of sand filters

- Maximum organic loading rate allowed is limited
- Performance is limited by the presence of suspended solids in wastewater.
- Anaerobic treatment is an essential unit of operation before proceeding to the Advanced Immobilized Cell Reactor to reduce the viscosity of wastewater and eliminate colloidal solids.
- Multiple modules are required to handle huge volumes (as opposed to a single module with other technologies).

All in all, the Advanced Immobilized Cell Reactor technology can be applied across a wide spectrum of industries. As already stated, it has performed at a credible level in the removal of organics estimated as BOD and COD from sewage and wastewater generated from several industries.

Technical Aspects Of This Technology

Amongst technologies, the immobilized cell oxidation process has been used more successfully than others, for the treatment of wastewater. Immobilized cells have been defined as cells that are entrapped within or associated with an insoluble matrix.

Mattiasson discussed six general methods of immobilization: covalent coupling, adsorption, biospecific affinity, entrapment in a three dimensional polymer network, confinement in a liquid emulsion, and entrapment within a semi permeable membrane.

Under many conditions, immobilized cells have an advantage over either free cells or immobilized enzymes. By preventing washout, immobilization allows a high cell density to be maintained in a bioreactor at any flow rate. Catalytic stability is greater for immobilized cells and some immobilized microorganisms tolerate a higher concentration of toxic compounds than do their non-immobilized counterparts.

One partial disadvantage of immobilization is the increased resistance of substrates and products to diffusion through matrices used for immobilization. Owing to the low solubility of oxygen in water and the high local cell density, oxygen transfer often becomes the rate limiting factor in the performance of aerobic immobilized cell systems. Thus when aerobic cells are used, the aeration technique bears a very important consideration in bioreactor design technology.

Advanced Immobilized Cell Reactor technology for treatment of wastewater

This technology rests on the following concepts:

1. Immobilization of organisms in the carrier matrix will prevent the dissipation of oxygen.
2. Accessibility of enzymes to the substrate is increased by reducing the mean free path of the bio-catalyst to the substrate.
3. Cellular synthesis is reduced by using the organisms with low-yield coefficient.

In the Advanced Immobilized Cell Reactor technology, the carrier matrix used is activated carbon of low surface area.

The bacteria immobilized in anoxic zone can fragment the organics into simpler compounds and the bacteria in oxic zone perform oxidation of organics. In addition to bacterial oxidation, catalytic oxidation is also facilitated at the active sites of the carbon matrix. The heat of combustion of organics released at the active sites will be used for excitation of organic molecules to cross over the activation energy barrier, which normally determines the rate of any chemical reaction.

The freedom of movement of molecules is also restricted at the surface of the adsorbent as they are anchored at the sites. Thus energy expenditure towards translational motion, which is considered to be the major component in the orientation of molecule, is lowered to the maximum extent possible. The partially oxidized organic molecule is aerobically oxidized with low heat of combustion by aerobic organisms immobilized at the mouth of the pores. Thus, the energy available for cellular synthesis is decreased and consequently, biomass production is decreased. Since the organisms are in an immobilized state, the expenditure of energy towards diffusion of organic molecules and oxygen from the bulk liquid to cellular matrix is minimal compared with that in a suspended growth system.

Hence, the conservation of energy in the immobilized state enhances the rate of degradation of organics in wastewater to a much greater level than in a suspended growth system. The elimination of micropores in the carrier matrix avoids the loss of active sites by irreversible bonding with organic molecules in an aqueous environment. Therefore, the number of active sites available for oxidation of organic compounds remains a constant. Thus, the rate of removal of dissolved pollutants in wastewater is nearly constant.