DESIGN OF SEWAGE TREATMENT PLANT BY USING SBR TECHNLOGIES IN NARAYANA ENGINEERING COLLEGE

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ABSTRACT

The dirty water that comes from homes and business as a result of laundry, using the bathroom, and all the soapy water that comes from washing dishes as like in the kitchens is what we call sewage or wastewater. Rainwater entering drains and industrial wastes also appear to fit under this category.

Sewage is treated by a variety of methods to make it suitable for its intended us, be it for spraying onto irrigation fields (for watering crops) or be it for human consumption. Sewage treatment mainly takes place in two main stages: Primary and Secondary treatment. In arid areas, where there is not enough water, sewage also undergoes a tertiary treatment to meet the demands of the drinking water supply.

During, primary treatment, the suspended solids are separated from the water and the BOD (Biological Oxygen Demand) of the water is reduced, preparing it for the next stage in wastewater treatment. Secondary treatment can be accomplished by a wide variety of means. However, in our project and poster. We will only be concentrating on two of the most commonly used methods: the trickling filter and activate sludge. The activated sludge method uses air and a biological floc that is comprised of bacteria (mainly Zoogloea) and protozoans. This “Aeration “continues for 4-6 hours, after which it is stopped and the contents moved to a settling tank. In the settling tank, the floc settles out and removes much of the organic material with it. This process removes 75-95% of the BOB.

In the trickling filter, sewage is passed (as a fine spray) over a bed of rocks or moulded plastic, over which a biofilm or aerobic microorganisms grow. This method removes 80-85% of BOD. The water is then is infected, mostly by chlorination and released into flowing streams or oceans.

1. INTRODUCTION

Sewage is the term used for wastewater that often contains faces, urine and laundry waste. It also carried in solution or suspension that is intended to be removed from a community. Also known as domestic and industrial waste water, It is more than 99.9% liquid waste and 0.1% solid waste is characterized by volume or rate of flow, physical conditions, chemical and toxic constituents, and its bacteriologic status. It consists mostly of grey water, black water, soaps, detergents and toilet paper and also contains surface runoff depends on the sewer system. It is generated by residential, institutional, commercial

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and industrial establishments. It includes household waste liquid from toilet, baths, showers, kitchens and sinks draining into sewers. In many areas, sewage also includes liquid waste from industry and commercial places. Sewage is composed of many materials that are broken down into three general areas. These areas are the physical, chemical, and biological characteristics of waste water. The physical characteristics of waste water includes those items that can be detected using physical senses. They are temperature, colour, odour, and solids. The chemical characteristics of sewage helps in indicates the stage of sewage decomposition, its strength, extent and type of treatment required for making its safe, they include solids are present may be four types suspended solids, dissolved solids, colloidal solids, settable solids, pH, nitrogen contents, chloride content, DO. The biological characteristics of sewage contains many microorganisms like bacteria, algae, fungi, protozoa, etc. Bacteria being most predominant **(1)** The resulting water pollution causes the quality of the water to deteriorate and affects ecosystems.

1.2 NECESSITY OF SEWAGE TREATMENT:

- Sewage treatment plant plays an important role for the mankind.
- The main function of these plant is to make the water of the sewage clean that comes from home, commercial and industrial sectors.
- The treatment of sewage water has become the need of the hour as its stops spreading the diseases and illness caused by the sewage water.
- It helps society in making the water as well as environment clean.
- The sewage treatment plant works composed of 3. The three stages of these plants include the primary stage, the secondary stage and the tertiary stage.
- In the primary stage, the contaminates that are easy to eliminate are taken out from the waste water. This substance may include oils, grease and fats that can be easily removed from the surface area. The solids thing like grits, stones, rocks, etc., are strained.
- At the secondary stage, the removal of biological contaminants in waste water takes place.

1.3 IMPORTANCE OF MANAGING SEWAGE:

➢ The scope of sewage management has involved throughout history with changes in sociometric conditions, city structures and the environment. today, sewage infrastructure that is well planned and operated supports urban sanitation and related activities. effective sewage management is essential for nutrients cycling and for maintaining ecosystem integrity. It is also important for:

1. Improving the environment through proper drainage and disposal of wastewater;
2. Preventing floods through removal of rainwater;
3. Preserving receiving waste quality

➢ The sewage treatment process facilitates the achievements of water quality objectives.in addition to nutrient recycling, advanced treatment of wastewater often includes associated unit processes which support the optimization of resource use. Some of these unit processes includes conversion of sludge into various benefits biproducts and the process of extracting thermal energy from sewage and wastewater.in addition, the sewage collection system can be used as a conduit for optical fibre cables and other communication infrastructure.

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1.4 COMPOSITION OF SEWAGE:

- Soluble inorganic material such as ammonia, road-salt, sea-salt, cyanide, hydrogen sulphide, thiocyanates, thiosulphates, etc.,
- Animal such as protozoa, insects, anthropods,small fish, etc.,
- macro-solids such as sanitary napkins,nappies/diapers, condoms, needles, children's toys, dead animals or plants etc.,
- gases such as hydrogen sulphide, carbondioxide ,methane etc.,
- emulsions such as paints adhesives ,mayonnaise,hair colorants ,emulsified oils,etc.,
- toxins such as pesticides,poisons,herbicides etc., pharmaceuticals and hormones.

1.5 OBJECTIVES OF STUDY:

- To study the problem related to the conventional methods of treatment of wastewater.
- To find the best alternative technology possible.
- To study the treatment of dairy wastewater using SBR technology by obtaining COD, TSS, Ph, TKN.

1.6 ADVANTAGES OF SBR:

- Equalization, primary clarification, biological treatment and secondary clarification can be achieved in a single reactor vessel.
- SBR requires small space.
- SBR has controllable react time and quiescent settling.
- Minimal footprint.
- High nutrient removal capabilities.
- The BOD removal efficiency is generally 85 to 90%
- Filamentous growth elimination.
- Consistent good quality treated water for reuse applications (BOD < 15). Handle varying flow and organic loadings.
- No need of Settling Tank.
- No need of Sludge Recycling system. Less Foot Print.
- Low Sludge production. Retrofits on Existing Tanks.

1.7 LIMITATIONS OF SBR:

- A higher level of sophistication is required especially for larger systems, of timing units and controls.
- Higher level of maintenance associated with more sophisticated controls, automated switches, and automated valves.
- Potential plugging of aeration devices during selected operating cycles, depending on the aeration system used by the manufacturer.
- FBBR enables better removal of biological nutrients without excessive usage of chemicals. SBR also uses coagulants (generally lime or alum) to remove phosphate from sewage which

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potentially increases the sludge volume.

2. WASTEWATER TREATMENT

Wastewater is any water that has been affected by human use. Wastewater or sewage is the by-product of many uses of water. When water is used by our society, the water becomes contaminated with pollutants. Most human activities that use water produce wastewater. As the overall demand for water grows, the quantity of produced wastewater and its overall pollution load are continuously increasing worldwide.

2.1 MUNICIPAL WASTEWATR TREATMENT SYSTEM:

Preliminary treatment (removes materials that can cause operational problems, equalization basins are optional)

- Primary treatment (remove ~60% of solids and ~35% of BOD)
- Secondary treatment (remove ~85% of BOD and solids)
- Advanced treatment (varies: 95+ % of BOD and solids, N, P)
- Final Treatment (disinfection)
- Solids Processing (sludge management)

2.2 WASTEWATER TREATMENT :

a) Preliminary Treatment (screening)
b) Primary Treatment (primary settling)
c) Secondary Treatment (e.g. activated sludge)
d) Advanced Treatment (e.g. P removal)
e) Final Treatment (disinfection)
f) Solids Processing (sludge treatment)

2.3 PRELIMINARY TREATMENT:

Upon arrival via the sewer system, the wastewater is sent through a bar screen, which removes large solid objects such as sticks and rags.

Leaving the bar screen, the wastewater flow is slowed down entering the grit tank, to allow sand, gravel and other heavy material that was small enough not to be caught by the bar screen to settle to the bottom. All the collected debris from the grit tank and bar screen is disposed of at a sanitary landfill.

2.4 PRIMARY TREATMENT:

Primary treatment is the second step in wastewater treatment. It allows for the physical separation of solids and greases from the wastewater. The screened wastewater flows into a primary settling tank where it is held for several hours allowing solid particles to settle to the bottom of the tank and oils and greases to float to the top.

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2.5 SECONDARY TREATMENT:

1. -Biological treatment process that removes dissolved organic material from wastewater. The partially treated wastewater from the settling tank flows by gravity into an aeration tank.

2. -Mixing of water to solids containing that use oxygen to consume the remaining organic matter in the wastewater as their food supply (use of air bubble for mixing and oxygen supply)
3. -Liquid mixture (i.e., solids with micro-organisms and water) is sent to the final clarifier.

4. -In clarifier, solids settle out to the bottom where some of the material is sent to the solids handling process and some is recycled back to replenish the population of micro-organisms in the aeration tank to treat incoming wastewater.

2.6 FINAL TREATMENT:

Treated water is disinfected and then it is sent out for wastewater reuse activities or for discharging in river/streams. mostly chlorination and/or ultra violet irradiation is used for disinfection purposes.

2.7 SOLIDS PROCESSING:

a) The primary solids from the primary settling tank and the secondary solids from the clarifier are sent to a digester. Micro-organisms use the organic material present in the solids as a food source and convert it to by-products such as methane gas and water.
b) Digestion results in a 90% reduction in pathogens and the production of a wet soil-like material called "biosolids" that contain 95-97% water.
c) In order to remove some of this water, mechanical equipment such as filter presses or centrifuges are used to squeeze water from the biosolids to reduce the volume prior to being sent to landfill, incinerated or beneficially used as a fertilizer or soil amendment.

3. METHODOLOGY OF SEQUENTIAL BATCH REACTOR

3.1 ABOUT 3R TECHNOLOGY:

- 3R stands for RECOVERY, RECYCLE and REUSE units and systems.
- 3R TECHNOLOGY offers solution for optimum utilization of raw materials and energy with minimum waste or Zero Discharge through Recovery and Recycle/Reuse systems.
- This has been termed under Cleaner Technology of UN Resolution for sustainable business development. 3R Technology acknowledges the facts of Cleaner Technology.

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3.2 SBR HISTORY:

- During the early development of the activated sludge process in the United Kingdom by Ardern and Lockett around 1914, plants were operated using fill-and-draw or batch feed methods. .
- Around 1956, development of oxidation ditch technology.
- By the late 1970s, the sequencing batch reactor (SBR) was well established and many small plants were in operation.

  Recent developments in technology made SBRs a more viable option for small to medium size facilities.
- Sequencing batch reactor (SBR) is a fill-and-draw activated sludge system for wastewater treatment. It operates in a true batch mode with aeration and sludge settlement both occurring in the same tank. SBR systems have been successfully used to treat both municipal and industrial wastewater.
- According to a 1999 U.S. EPA report, an SBR is no more than an activated- sludge plant that operates in time rather than space.

3.3 PLANNING FOR SBR:

- Get accurate flow monitoring data
- Inflow/Infiltration considerations
- Wastewater Characteristics
- Community Growth Patterns
- Site Adaptation/Selection
- Access to skilled operator

3.4 SBR SELECTION:

Different configurations of the SBR

- Equalization/non-Equalization
- Two Cell/Four Cell Design
- Fill cycle variations
- Different Aeration systems
- Decanter designs
- Sludge wasting mechanisms
- Controls and Automation

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- Configuration to site.

3.5 ADVANCED SBR APPLICATION:

- Sewage Treatment for Reuse Applications like
- Toilet Flush, Landscape, Car Wash, Construction, Gardening etc. (Below and Above Ground)
- Apartment Buildings
- IT Parks
- All Commercial Establishments such as Hospital
- Hotels
- Educational Institutions, etc
- Decentralized STP in remote and hilly terrains.

4 STANDARDS OF SBR

4.1 QUALITY REQURIMENT FOR IRRIGATION WATER:

Irrigation water should perform its function without any adverse effects on the fertility of the soil or on the proper growth of plants.

The suitability or otherwise of water for irrigation purposes is determined on the following considerations.

1. The total soluble salt concentration of the water as it effects crop yield through osmotic effects.
2. The concentration of specific ions that may be toxic to plants or that have unfavorable effect on crop quality.
3. The concentration of cations that can cause deflocculation of the clay in the soil and resulting damage to soil structure and declines infiltration rate.
4. Nature of soil to be irrigated. 5.Type of crop grown.

Table -1: STANDARDS FOR IRREGATION WATER

S.NO	PARAMETERS	TOLERABLE CONCENTRATION
1	pH	6.5-8.5
2	BOD	<10
3	COD	<50
4	TDS	200-500
5	TSS	<10

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6	DO	1-3
7	TN	<10
8	TP	<2
9	CHLORIDE	355
10	FLUORIDE	1
12	IRON	1

4.2 DRINKING WATER STANARDS:

Water supplied to the consumer should not have any impurities which cause taste and odour, colour, toxicity, and injurious substances to human health. The different impurities in water which cause undesirable effects may be classified into physical, chemical, bacteriological and radiological parameters.

The standards prescribed for potable water supplies by different authorities usually give two types of norms e.g. PEMISSIBLE and TOLERABLE concentration for the different impurities. Indian Council of Medical Research (ICMR), Bureau of Indian Standards have published standards for potable waters. Different countries have published similar standards which can be used for all. Table gives these standards for the different impurities.

Table -2 :Drinking Water Standards

S. N O	PARAMETERS	INDIAN STANDARDS		WHO	
1	Physical	(P)	(E)	(P)	(E)
	Colour (units)	10	50	5	50
	Taste and odour	unobjectionable		unobjectionable	
	Turbidity (units)	10	25	5	25
2	Chemical	(P)	(E)	(P)	(E)
	pH	6.5 – 8.5	6.5 – 9.2	7- 8.5	6.5-9.2
	Total solids	-	-	500	1500
	Iron	0.3	1.0	0.3	1.0
	Chlorides	250	1000	200	600

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	Fluoride	**0.6-1.2**	**0.5**	**1.0- 1.5**
	Sulphates	**150**	**200**	**400**
	Total hardness	**300** **600**	**-**	**-**

4.3 QUALITY STANDARDS FOR WATER IN CONCRETE USAGE:

Cement needs less than 0.3 times its weight of water for chemical action, but some more is required for proper workability of concrete . Water used for making and curing of concrete should be free from injurious substances such as oils, acids, alkalis, salts, sugar, organic materials or other elements that may be deleterious to concrete or steel.

A popular yard-stick to the suitability of water for mixing concrete is that if water for making concrete. This does not appear to be a true statement for all conditions .Some waters containing a small amount of sugar would be suitable for drinking , but not for mixing concrete.

Setting time is likely to be effected by the presence of sugar, carbonates and bicarbonates of sodium and potassium. Excessive salts of manganese, tin, copper, and lead cause marked reduction in attainment of strength of concrete.

Sodium iodide, sodium phosphate and sodium borate reduce the initial strength of concrete to an extra-ordinary high degree. Salts and suspended particles are undesirable as they interfere with setting, hardening and formation of bonds. The presence of mineral or humic acids or carbonic acid can retard the hardening of low calcium cements by reacting with calcium before setting begins.

Table -3: Tolerable Concentration Of Impurities In Mixing Of Water Of Concrete

S.NO	PARAMETER	TOLERABLE CONCENTRATION (Mg/l)
1	pH	6 – 8 (no units)
2	Acidity	50
3	Alkalinity	250
4	Sulphates	500
5	Chlorides	2000 – PCC, 3000 – RCC
6	Organic solids	200
7	Inorganic solids	3000
8	Suspended matter	2000
9	Carbonates & bicarbonates	100

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4.4 QUALITY REQUIREMENTS FOR BATHING WATERS:

Bathing waters should be free from:

1. Materials which impart colour , taste or turbidity (e.g. oil, grease, phenols etc.);
2. Substances which may settle to form objectionable deposits or float on the surface as debris, oil and scum;
3. Toxic substances including radio nuclides, physiologically harmful to man, fish or other aquatic plants or animals; and
4. Substances which are likely to result in promoting the growth of undesirable aquatic life.

Table -4 : Bathing Waters Quality Standards Are Given In Table.

S.NO	PARAMETERS	PERMISSIBLE LIMITS
1	**pH**	6-9
2	**Colour**	No abnormal change
3	**Mineral oil (mg/l)**	< 0.1
4	**Transprancy (m)**	2
5	**Dissolved oxygen (mg/l)**	3
6	**Phenol index**	0.005
7	**Free residual chlorine (mg/l)**	0.4

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1. CONCLUSION

- Sequencing batch reactor are useful for areas where the available land is limited. Equlization, Primariry clarification, biological treatment and secondary clarification can be achieved in a single vessel.
- SBR are a variation of the activated sludge process .they differ from activated sludge plants because they combine all treatment steps and processes in to single basin where as conventional facilities rely on multiple basins.
- The pollutant removal efficiency of SBR system is higher for nitrogen and phosphate.
- he SBR system can remove heavy metal such as Zn, Cu, Pb with organic pollutant and nitrogen
- The selection of the hydro-mechanical equipment for wastewater treatment plants, especially for smaller ones, often is left to the producer or to the equipment supplier, and the selection is mad without preliminary hydraulic calculations.
- Commonly, this problem is not treated as it deserves resulting into inadequate choice of hydro- mechanical equipment, especially for the pumps. In the most cases, the choice is: equipment with higher performance than needed once. Certainly, this equipment will provide correct operation of the plant, but, on the other hand, the electricity consumption and expenses will be much higher.
- The aim of this presentation is to point out the significance of correct engineering approach to hydro-mechanical equipment selection, which should be based on appropriate hydraulic calculations.
- Experimental results of STPs based on SBR Technology indicate that BOD, COD &Total Suspended Solids (TSS), Phosphate, and Total Kjeldahl Nitrogen (TN) removal efficiencies were calculated to be 97.88%, 996.62%, 97.40%, 98.87%, 84.50% respectively.
- According to Environmental protection rules 1986 [Schedule vi] published in CPCB report August 2013, treated effluent is safe against disposal on land and used in irrigation
- . Discharge of the final effluent from the Sewage Treatment Plant may not cause health risks or any major environmental problems.
- Total daily Power requirement (avg.) 172.5 kWh/d/MLD less than MBR and ASP technology while area requirement is 400 m 2 /MLD same as MBBR technology, double of MBR technology, and half of ASP technology Study of performance evaluation of STP based on SBR technology shows that BOD and COD removal efficiencies of plant are 97.88%, 96.22%, which is satisfactory. BOD removal depends on aeration time provided.
- Aeration times vary according to the plant size and the composition/quantity of the incoming sewage, but are typically 60 – 90 minutes.
- TKN concentrations in untreated wastewater are in the ranges 25.03- 70.9 mg/l and that in

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treated wastewater are in the range 6.21-9.40 mg/l.

- These concentrations are safe against disposal and reused. The addition of oxygen to the wastewater supports bacterial action and they consume the nutrients and supports nitrification process.
- Phosphate concentrations in untreated wastewater and treated effluent are in ranges 27.80-315.69 mg/l and 0.94-1.93 mg/l, respectively. To improve removal efficiency of phosphorus compounds from the wastewater aluminium sulphate (alum) is often added during this period.
- It reacts to form non-soluble compounds, which settle into the sludge in the next stage. The settling stage has usually the same length of time as the aeration.
- The pH value is 8.2-6.9 for untreated wastewater and same after treatment is 7.4(avg.), that is again within limits (6.5-8.5). The concentrations of TSS in untreated and treated wastewater are 470-258 mg/l and 9.68 – 8.68 mg/l, respectively which is good enough for safe disposals. Specialities of SBR- In built equalization, BOD/COD/SS removal, Settling, Decanting, Nitrification, Denitrification, Bio-P removal. All process are done in single stage.

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