THE GLOBAL ENGINEERING CONFERENCE ON SUSTAINABLE DEVELOPMENT AND WORLD FEDERATION OF ENGINEERING ORGANISATIONS EXECUTIVE COMMITTEE MEETINGS.

15th - 18th October 2024, Kigali, Rwanda

Theme: Engineering Innovations for a Sustainable Future

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FAEO

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SEQUENCING BATCH REACTOR (SBR) TECHNOLOGY BIOLOGICAL WASTEWATER TREATMENT TOWARDS SDG 6 CLEAN WATER & SANITATION

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FAEO

PLENARY SESSION:
CLEAN WATER AND SANITATION (SDG6)

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(*WASTE WATER TREATMENT TECHNOLOGY SPECIALIST*)

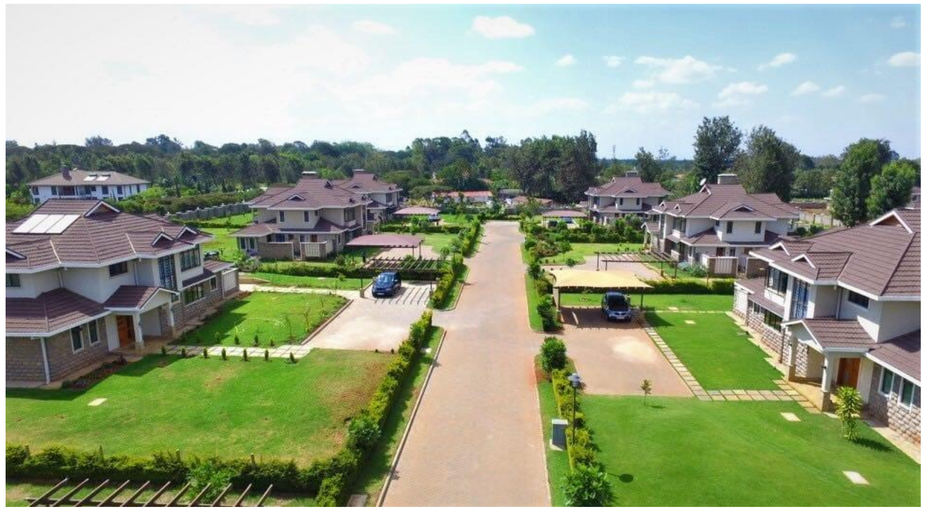
SEWAGE DISPOSAL CHALLENGES

Lack of Municipal Sewer, Failed Septic Tanks, Sewage Spills

SOLUTION TO SEWAGE DISPOSAL CHALLENGES

Sewage treatment to clean,safe reusable water.

- Discharge clean, safe recycled water
- Reuse recycled water
- Maintain green spaces 247
- No sewage spills



WHAT IS SBR SEWAGE TREATMENT?

The sequencing batch reactor (SBR) is a fill-and draw activated sludge system for wastewater treatment. In this system, wastewater is added to a single “batch” reactor, treated to remove undesirable components, and then discharged.

In a conventional activated sludge system, unit processes would be accomplished by using **separate tanks.** Sequential batch reactor is a modification of activated sludge. The difference between the two technologies is that the SBR performs equalization, biological treatment, and secondary clarification **in a single tank using a timed control sequence**.

Sequencing Batch Reactor (SBR) method is a highly efficient biological treatment process that removes organic and inorganic contaminants from wastewater.

WORKING PRINCIPLE OF SBR SEWAGE TREATMENT

The SBR sewage treatment process operates in a batch mode, encompassing distinct phases:

a) **Filling:** Wastewater is introduced into the reactor tank.

b) **Reacting:** The wastewater undergoes biological treatment, where microorganisms break down organic matter and nutrients.

c) **Settling:** After the reacting phase, the mixture is allowed to settle, and the solids separate from the treated water.

d) **Decanting:** The clear, treated water is decanted from the top of the tank, leaving the settled solids at the bottom.

e**) Idle:** The reactor remains idle before starting a new cycle.

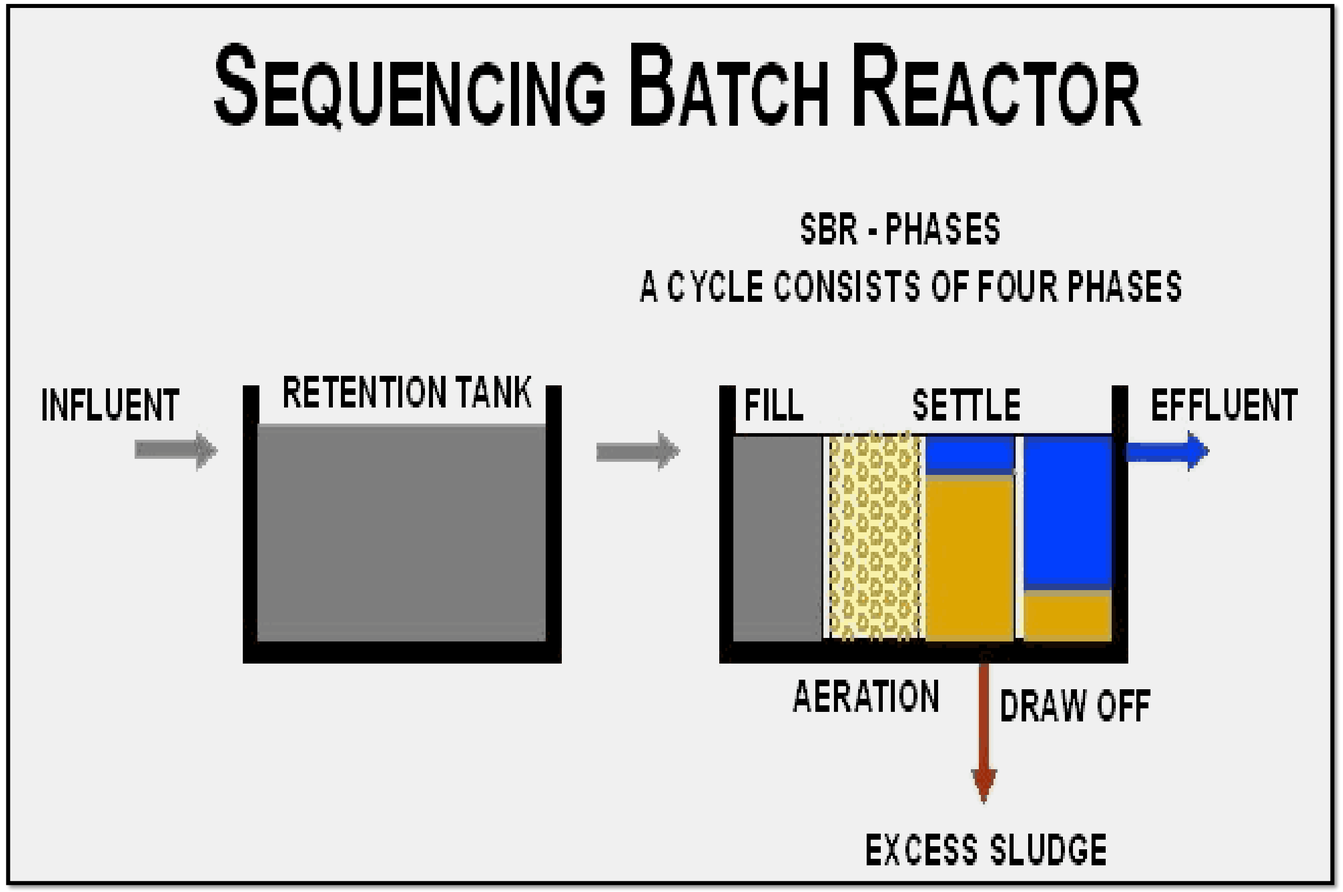
SBR PROCESS - STEP-BY-STEP

1. Filling Phase
- Description of the filling process
- Importance of controlled inflow

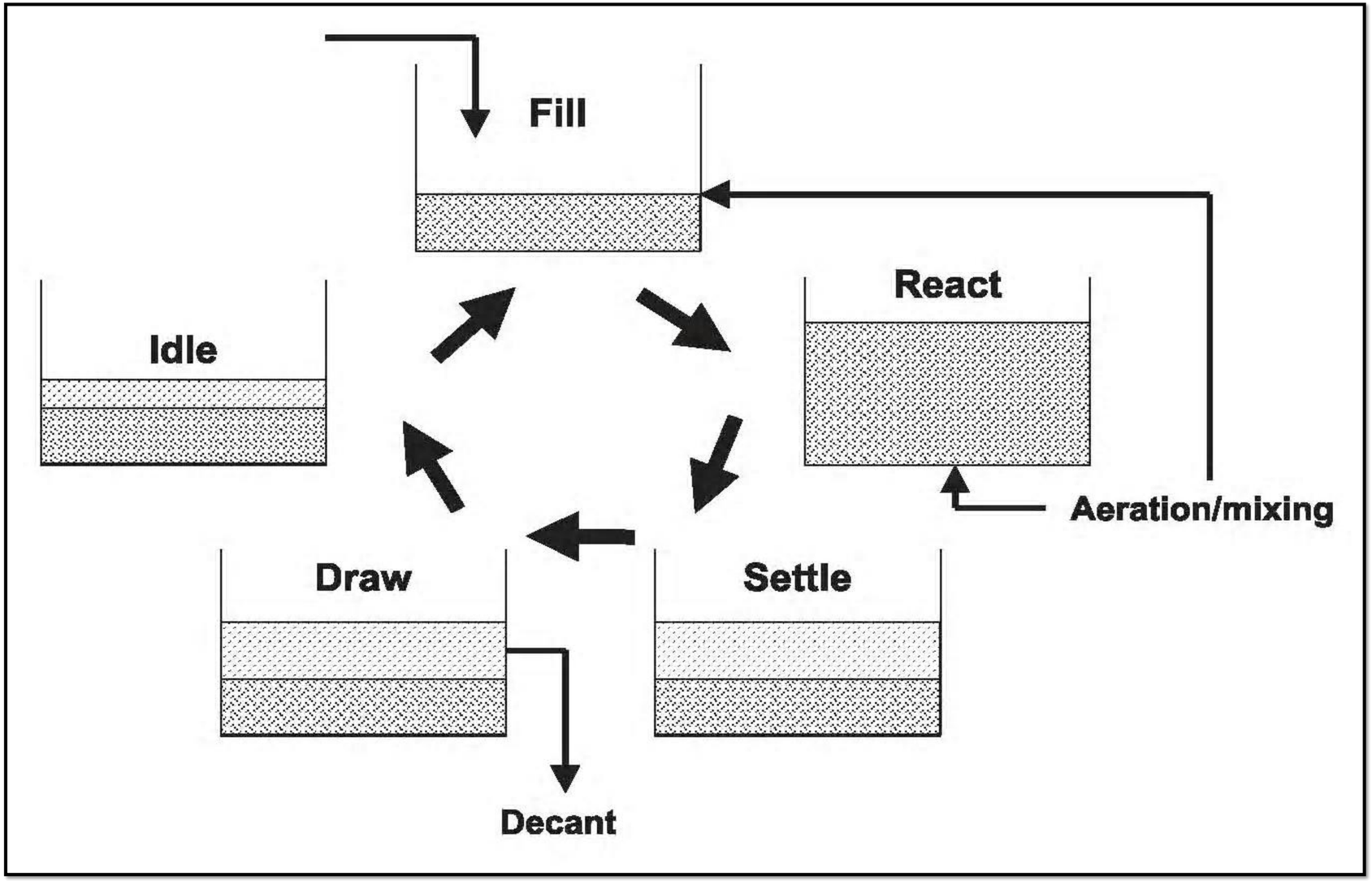
2. React Phase
- Biological treatment of sewage
- Aeration and mixing in the reactor

3. Settle Phase
- Separation of treated water from sludge
- Importance of settling time

4. Decant Phase
- Treated water removal process
- Sludge return to the reactor



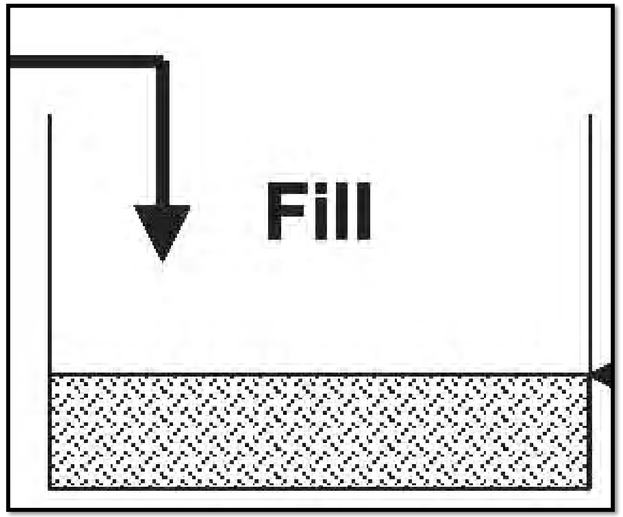
VARIOUS PHASES IN A TYPICAL SBR PROCESS



SOURCE: *biodos.org*

FILL PHASE

- During the fill phase, the basin receives influent wastewater. The influent brings food to the microbes in the activated sludge, creating an environment for biochemical reactions to take place.
- In order to maintain suitable F/M (food to microorganism) ratios, the wastewater should be admitted into the tank in a rapid, controlled manner. This method encourages the growth of certain microorganisms with better settling characteristics.



REACT/AERATION PHASE

- No wastewater enters the basin and the mechanical mixing and aeration units are on. This phase allows for further reduction of wastewater parameters.

- It involves the utilization of biochemical oxygen demand (BOD) and ammonia nitrogen, where applicable, by microorganisms.

- The length of the aeration period and the sludge mass determines the degree of treatment. The length of the aeration period depends on the strength of the wastewater and the degree of nitrification (conversion of the ammonia to a less toxic form of nitrate or nitrite) provided for in the treatment

SETTLE / SEDIMENTATION PHASE

- During this phase, activated sludge is allowed to settle under quiescent condition.The activated sludge tends to settle as a flocculent mass.

- Aeration is stopped and the sludge settles leaving clear, treated effluent above the sludge blanket. Duration for settling varies from 45 to 75 minutes depending on the number of cycles per day.

DECANT / DISCHARGE PHASE

- Clarified treated effluent (supernatant) is removed from the tank through the decanter, without disturbing the settled sludge.

- No surface foam or scum is decanted.

Stage 5: Idling

The SBR Tank waits idle until it is time to commence a new cycle with the filling stage.

EXCESS SLUDGE WASTING PHASE

- Activated sludge is wasted periodically during the SBR operation. As with any activated sludge treatment process, **sludge wasting is the main control of the effluent quality** and microorganismpopulation size.

KEY ADVANTAGES OF SBR SEWAGE TREATMENT METHOD

a) **Flexibility and Adaptability:** SBR technology can be easily adapted to treat varying inflow rates and pollutant loads, making it ideal for different applications and industries.

b) High-Quality Effluent: The process consistently produces high-quality treated water, meeting stringent environmental standards and regulations.

c) Reduced Footprint: SBR systems often require less space compared to traditional wastewater treatment methods, making them suitable for areas with limited land availability.

d) Energy Efficiency: The intermittent aeration and idle periods in SBR systems lead to energy savings compared to continuous-flow systems.

e) Nutrient Removal: SBR sewage treatment can efficiently remove nutrients like nitrogen and phosphorus, addressing eutrophication concerns in water bodies.

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.
- Enables better removal of biological nutrients without excessive usage of chemicals. SBR May use coagulants (generally lime or alum) to remove phosphate from sewage which potentially increases the sludge volume.

DIFFERENCES IN CONVENTIONAL ACTIVATED SLUDGE PROCESSES (ASP) & SBR

- SBR system has **oxygen dissolving capacity** higher than ASP.
- SBR provides Higher **Fecal coliform removal** efficiencies with less cost and space.
- As the **effluent quality is be**tter in case of SBR system than in ASP system, it helps in maintaining quality of water body in which its effluent is being disposed.
- SBR system is **flexible in nature**, it can be expanded in future while in ASP its not an easy task.

TREATMENT EFFICIENCY

The avg. performance data values(CPHEEO manual)

Parameters	SBR	ASP
BOD	89-98%	85-95%
TSS	85-97%	85-90%
Total Nitrogen Removal	>75%	No treatment
Phosphorus removal	57-69%	No treatment
Total Coliforms	99%	90-96%

TREATED WATER COMPLIANCE WITH ENVIRONMENTAL MANAGEMENT AUTHORITY STANDARDS

R-Raw sewage in 1st chamber.

A-Water in the SBR after treatment

C-Treated clean water (Last chamber)

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Quality Parameter	Sample "R"	Sample "A"	Sample "C"	NEMA Limit
Color Hazen Units	14	8	7	**15**
COD(ppm)	199.6	53.76	34.56	**50**
BOD (ppm)	70.5	26.00	13.50	**30**
TSS (ppm)	14.8	7.6	4.8	**30**
Ecoliforms (count/100ml)	4	Nil	Nil	**Nil**

EXPECTED OUTCOMES OF SBR

- The pollutant removal efficiency of SBR system is higher for nitrogen and phosphate.
- SBRs combine all of the treatment steps and processes it will result in low land area requirement.
- High Biological oxygen demand (BOD) removal efficiency is expected.
- It can also remove heavy metal such as Zinc (Zn), Copper (Cu), Lead(Pb).

BENEFITS TO SOCIETY

- Highly efficient and economic technology in comparison to present conventional methods of treatment (ASP).
- As nitrogen removal is also possible, it will help against Blue baby syndrome.
- As Nutrient removal is possible nitrogen & phosphorous (N&P), it will help against Algal bloom maintaining quality of water body in which its effluent is being disposed

SAMPLE PROJECTS EXECUTION

500PE (75M^3 PER DAY) ; US EMBASSY,DIPLOMATIC HOUSING3 (DH3) COMPLEX, KENYA

Phased / Modularised tank construction, 2x250PE)

500PE (75m^3 PER DAY) ; US EMBASSY, DIPLOMATIC HOUSING3 (DH3) COMPLEX, KENYA

System Finished & Landscaped Top slab used as Dog Play area.

10PE (1.5M^3 PER DAY); RESIDENTIAL HOME SYSTEM

Tank Top Slab formwork & Manholes

10PE (1.5m^3 PER DAY); RESIDENTIAL HOME SYSTEM

Systems component installation

10PE (1.5M^3 PER DAY); RESIDENTIAL HOME SYSTEM

Complete system, manholes covers & landscaped top slab.

CONCLUSION

- SBR technology can be easily adapted to treat varying inflow rates and pollutant loads.
- Sequencing batch reactors (SBR) are useful for areas where the available land is limited.
- Equalization, primary clarification, biological treatment and secondary clarification can be achieved in a single reactor vessel.
- SBRs are a variation of the activated-sludge process. They differ from activated-sludge plants because they combine all of the treatment steps and processes into a single basin whereas conventional facilities rely on multiple basins.
- The pollutant removal efficiency of SBR system is higher for nitrogen and phosphate.

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