Saraswati 2.0

Identifying the best available technologies for decentralized wastewater treatment and resource recovery for India

D2.2 Pilot 2 implementation report

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1. Context information and overview of the pilot plant

A pilot plant for biological treatment of sewage using a Sequencing batch reactor technology comprised of Zone 1: Selector and Zone 2: Main Aeration Chamber was installed. The proposed pilot-scale SBR was installed at the 27 MLD sewage treatment plant premises in Jagjeetpur, Haridwar, Uttarakhand (India). The purpose is to do the complete performance evaluation and optimize the treatment process of the plant in treating sewage in terms of organic matter removal, biological nutrient removal (Nitrogen and Phosphorus), suspended solids removal, and pathogens removal in consecutive phases of aeration/ fill, settle and decant and record the biological sludge production. The pilot plant treats typical Indian sewage coming from domestic households and drains of nearby local areas, including mainly raw sewage accompanied by storm-water inclusions.

The operation can be conducted at varying temperatures, cycle times, DO/ OUR control, and the system's anaerobic (selector) HRT. The system is designed such that the sludge return rate causes approximate daily cycling of the total biomass through the selector zone. The mechanism in the selector zone and the internal sludge transfer eliminate the requirement for separate fill-ratio selectivity, anoxic, and anaerobic mixing periods that are necessary for the older generic SBR configurations. The process prevents solids washout during peak or wet weather hydraulic surges that are not possible in conventionally designed clarifier-activated sludge plants. The aeration zone has a controlled DO/ OUR operation that helps to promote nitrification, SND, and excess phosphorus uptake processes, and then the system proceeds to settle and decant.

2. Changes in the technology compared to the DOA

The scope/design has not changed.

3. Detailed design and project report (task a)

The sewage treated per day will be the maximum of up to 100m^3 per day. The sewage comes to the equalization tank and then after the preliminary treatment, it moves to the biological treatment process. As shown in figure 1, the central reaction basin is the SBR reactor which is an improved version of conventional SBR. It incorporates an initial multi-cell selector zone within the tank to effectively control filamentous sludge bulking. Each reactor basin is divided by baffle walls into two sections (Zone 1-Selector, Zone 2- Main Aeration chamber). The multi-cell selector is having three compartments to mix the raw sewage and return activated sludge and remain in contact as per the designed selector's HRT (anoxic/ anaerobic phase) contributing to excellent flocculation of sludge, denitrification, and EBPR.

A

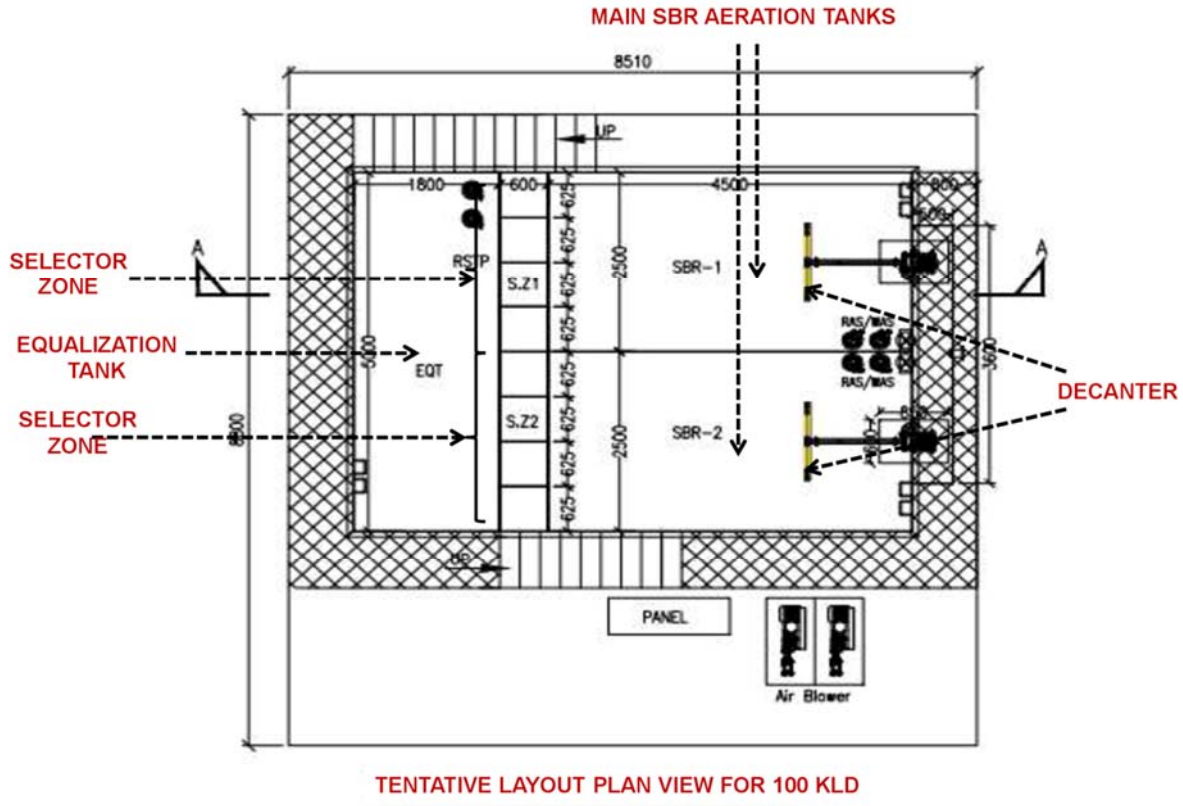


Figure 1a: Typical design of pilot-scale SBR installed at Jagjeetpur, Haridwar (Plan View).

B

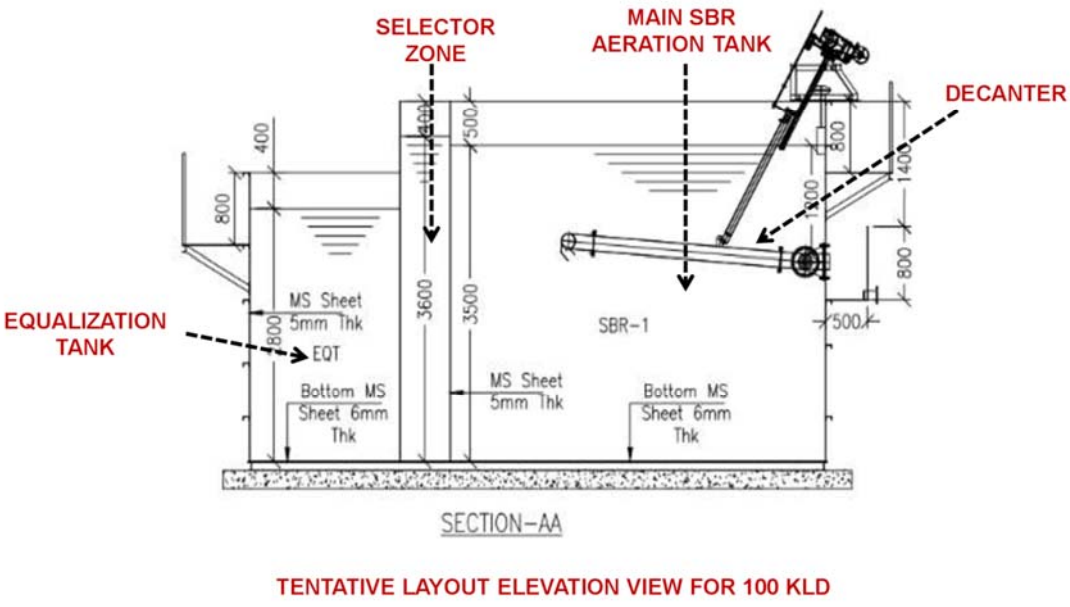


Figure 1b: Typical design of pilot-scale SBR installed at Jagjeetpur, Haridwar (Side view)

A sufficient amount of mixed liquor returns from Zone 2, i.e.,the aeration basin to the Zone 1 i.e., bio-selector to remove the readily degradable soluble organics from the sewage and favor the growth of the floc-forming microorganisms and well-settling biomass of low sludge volume index resulting from the suppression of the filamentous growth. The selector is self-regulating for all loadings and operates under anoxic conditions during aerobic sequencing and anaerobic reaction conditions during non-aerated periods. De-nitrification and enzymatic transfer of available substrate during enhanced biological phosphorus removal (EBPR) are also achieved in the selector zone. The selector zone is capable of benefitting these systems in suppressing the filamentous bacterial growth and enhancing the flocculation of sludge which ultimately improves the sludge settling characteristics i.e., prevents bulking and reduces SVIs, and allows simultaneous nitrification and denitrification (SND) to occur in large flocs. The complete-mix nature of the main reactor provides flow and load balancing and tolerance to shock or toxic loading. The sewage then moves to an aeration chamber with controlled DO/ OUR operation contributing to biological nutrient removal (nitrification, SND, and excess phosphorus uptake process), and then settling and decanting occur consecutively for the next half of the cycle time. The treated water is analyzed both for water quality and microbiological parameters. The analysis of the reactor comprises biochemical processes taking place in the main aeration chamber and bio-selectors, stage-wise/ phase-wise analysis as well as qualitative and quantitative microbiological studies (light microscopic studies, and advanced molecular biological analysis for microbial community dynamics).

4. Detailed engineering design and construction (task b)

The detailed engineering design and construction have been conducted by the contractor winning the tender procedure (Premier Tech Brisanzia Pvt Lyd.). Figure 2 shows pictures of the pilot plant construction stage.

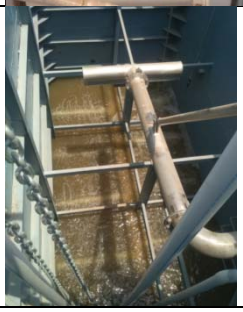
Figure 2 – Construction and installation of pilot-scale SBR

5. Commissioning and start of operation (Task C)

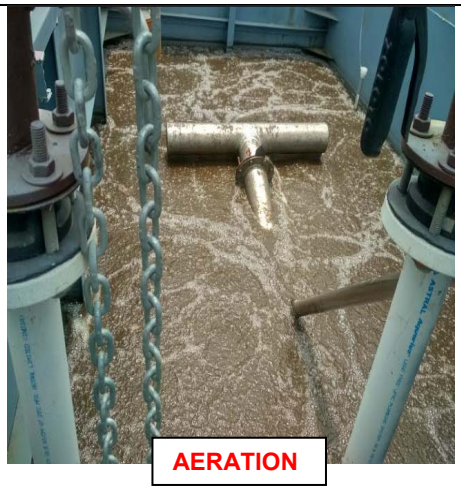
The pilot was commissioned in the first week of July 2022 and operation was started after 8th July 2022. Activities that were carried out during the commissioning:

- Commissioning instruction was provided by the Contractor (Premier Tech Brisanzia).
- The sewage was collected from the main pumping station and sewer lines were covering the residential areas of Jagjeetpur, Haridwar.
- The physical-chemical parameters including pH, dissolved oxygen (DO), oxidation reduction potential (ORP), temperature and operational parameters comprising mixed liquor suspended solids (MLSS), mixed liquor volatile suspended solids (MLVSS), sludge volume index (SV_{30}), sludge retention time (SRT), and Oxygen uptake rates (OUR) have been monitored regularly to realize the plant's performance since 8th July 2022.
- While commissioning the pilot, all the steps were followed as instructed by the Contractor (Brisanzia) and mentioned in the operation and maintenance manual.
- All necessary precautions were taken care of as discussed during the commissioning.
- After commissioning, basic parameters (BOD, sBOD, TCOD, sCOD, TSS, VSS, NH_4-N, TKN, PO_4-P, TP, and Alkalinity) of raw sewage and treated effluent were studied to check the performance of the pilot SBR system.

Table 1. Construction and commissioning phases of the plant (April 2022-present)

S. No.	Different Phase	Pictures	Date	Remarks
1.	The initial construction phase (infrastructure along with wall paintings) was completed.		20th May 2022	-
2.	In all the types of equipment, holding water, i.e., SBR tanks, pipe fittings, and valve- leakage checks were performed and finished. However, the plant is under observation till yet.		28th May 2022	-
3.	Introduction and fitting of the gate valves and a micro-controller in the SBR.	 	6th June 2022	-
4.	First filling of sewage (before grit removal) - including grits and plastic packets in the Equalization tank that deteriorated the quality.	 	7th June 2022	-

				
5.	Pipe fittings were over for taking sewage after grit removal (provided after getting orders by IIT Roorkee)		1st July 2022	-
6.	Second filling of sewage (after grit removal)		4th July 2022	-
7.	Mixed Liquor Suspended Solids (biomass) pumped in the pilot SBR tanks, obtained from 27 MLD SBR plant, and the plant was in the process from then. Officially, the commissioning of the plant was over. However, the plant is working under observation till now for continuous checking of any loopholes.		6th July 2022	

8.	Regular monitoring and continuous sampling in the plant were performed. Moreover, several issues occurred meanwhile the sampling duration, but they were fixed by the mid of July 2022.	 AERATION  DECANTATION	8th July 2022-present	Some issues were observed and fixed. Now, the plant is working fine in auto mode.