Sewage treatment and its essentials

This item was submitted to Loughborough University's Institutional Repository by the/an author.


Additional Information:

- This is a conference paper.

Metadata Record: https://dspace.lboro.ac.uk/2134/30538

Version: Published

Publisher: © WEDC, Loughborough University

Rights: This work is made available according to the conditions of the Creative Commons Attribution-NonCommercial-NoDerivatives 4.0 International (CC BY-NC-ND 4.0) licence. Full details of this licence are available at: https://creativecommons.org/licenses/by-nc-nd/4.0/

Please cite the published version.
SEWAGE TREATMENT AND ITS ESSENTIALS

by P S RAJVANSHY and S K MISHRA

Jaipur city, today envelopes about 10 lac souls. It is flanked by two major sewerage outfalls (North and South). During the past couple of years it became very essential to treat the sewage and consequently a fool proof sewage treatment plant was commissioned in the year 1979. This was implemented to remove risk to Public Health, to avoid foul smells and objectionable sights and to prevent the pollution of streams and wells.

In its conceptual design consideration for the first time the new water treatment facility, MEED Rajasthan incorporated several innovating features. One of these features was that biological treatment was used with aerobic diestore attached with sludge thickener. This treatment unit has been in full operation for approximately two years and this paper describes the facilities being used and discusses some of the design and basic mechanism involved in every treatment unit. Figure 1, shows the present plant layout, and reflects the complete sewage treatment and disposal cycle. The present design capacity in use is 3mgd with the total capacity for 6 mgd. Sewage receives primary treatment prior to biological treatment and the effluent is discharged to the Jalmahal lake. The excess sludge is thickened and digested to pass on to the drying beds for final disposal as manure.

Extended Aeration: Extended aeration, total oxidation or aerobic digestion is the system in which water borne wastes of domestic origin are aerated in the presence of flocculent cultures of micro-organisms, the so called activated sludge, to oxidize the organic compounds in the presence of molecular oxygen to carbon dioxide, water, and new cells. Flocculated mass can be separated by sedimentation. Quantities of the waste water then can further be added, and the procedure is repeated until a sufficient concentration of flocculent activated sludge has been built up to permit operation under continuous flow conditions. A high mixed liquor suspended solids (MLSS) concentration and extended period of the aeration are essentials of this process to seek a reduction of BOD over 98 percent. The essentials in this process are:

- Sludge Age (days): 10, Residence time (Hr.) 15-30; Removal efficiency (%): 85-98; Reactor solid concentration (Kg ML SS/l): 2500-5000; Recycle Ratio: 0.7-1.5; Lbd 800/ft cu.days: 0.025

Sewage purification and sewage works: Sewage is a water borne waste which contains enormous variety of waste products of human, animal, vegetable or mineral origin in dissolved and undissolved form. Efficient and successful sewage treatment involves the healthy and proper functioning of all operations. Each unit of treatment plant relies on the harmonious functioning of the previous one. Each unit differs in design, strength and quantity of sewage it receives and the period of contact.

Screening: The sewage from the half of the city Jaipur is led to this treatment plant by a 1200 mm dia. masonry sewer. The total quantity of the sewage received by the treatment plant is about 3 mgd with a maximum flow in the morning/evening hours. The first step is the removal of the objects by screens of size 3" and 3/4". The bar screen has been set with the bars, sloping in the direction of the flow, and the angle with the horizontal is 60°. Bar screens are cleaned by hand alternately, substituting another set of screen of the same size.

Grit Removal Unit: Removal of grit is based on the fact that grit is heavier than organic solids present in the sewage. The specific gravity of quartz material is about 2.65 and of organic matter ranges from 1.0 to 1.2. Practically, a detention period of 1 minute and a velocity of about 1 fps, have been found to be most effective in removal of grit. Theoretically, this unit should eliminate inorganic material larger than about 0.2 mm. The
removal is effected by means of a small settlement tank from which the grit is removed by pump. The four parabolic channels with a top width of 0.6m, bottom width, and 0.85m deep, also play vital role in removing the grit from sewage. This unit is equipped with mechanical device for washing and removing the grit. The grit unit makes use of small detention where after being washed, the grit is lifted out by a conveyor. The conveyed material is dumped into the trolley standing just below it for final disposal.

**Biological Reactor:** This sewage after grit removal is led through the channels to the surface aeration system. The system of aeration in this plant involves the latest technology. The mechanical aeration system introduces oxygen into the liquid and the activated sludge is kept in suspension by an agitator, rotating at or near the surface of the aeration tank. Aeration cone consists of an inverted rotating tunnel shaped agitator equipped with vanes on its upper surface, surmounting on masonry take tube, situated in the centre of each aeration pocket. Circulation and aeration are achieved by the aeration cone: drawing liquid from the draught tube and spraying over the tank surface, entraining and dis- solving oxygen in the process. The intensity of aeration can be controlled by varying either or both the rotation speed of the cone and its degree of immersion in the liquid. The rate of oxygen transfer is affected by the nature of aeration device, depth of submergence, temperature turbulence in the tank, depth of the tank and the chemical composition of the sewage. The MLSS has to be kept 3500-5000 mg/l and is so adjusted that dissolved oxygen remains 2-3 mg/l. The very important part of this unit is the maintenance of recirculation ratio, which is kept commonly in between 0.5 to 1.5 in treating domestic sewage but ratio upto 10 are employed in the strong industrial waste. The re-circulation is from the under-flow of the final settling tank.

**Final Settling Tank:** From the aeration tank the sewage flows to a final circular settling tank whose storage capacity is 5675000 lit. The detention time allowed is 2.3 hours. The aerated sewage enters at the centre and flows to the periphery to form a sort of influent well at the centre by means of a pipe through the body of the tank or more appropriately it is more or less an upward flow through a central riser from a pipe entering under the tank. A circular baffle provides a satisfactory distribution of the flow. The baffle is perforated. Scraper has been provided to remove and concentrate the sludge to hopper, which is removed from the tank by pumping.

**Sludge Thickenner:** Twenty percent of the settled sludge is pumped to a gravitational thickener while about eighty percent of the same meets the sewage entering aeration tanks. The feed solids entering in the middle are distributed radially and the sludge solids are collected as underflow. By thickening the volume of sludge going to the aerobic digester is reduced and the thickner over flow is returned to the f s t inlet. More thickening means solid concentration to less than 15 percent, but practically to produce the sludge with 6 to 10 percent of solids. This sludge is then onwards passed on to the aerobic digester.

**Aerobic digesters:** Waste biological sludge so produced is stabilised by simply reserving aeration in four aeration basins. The basic reaction of the aerobic sludge stabilisation is conversion of complex organics into carbon dioxide and water by action of aerobic organisms. Stabilisation process has a very mixed, varied complete food chain which results into non-freahle ecology. Unit has been designed to eliminate all sludge disposal problems and to allow only inert solids to escape over the drying beds. Dewaterability is tremendously effected by it.

**Drying Beds:** The digested sludge is pumped on to twelve beds at a depth of 0.17"" cone which water drains into the sand and accumulates into the drains to out. A considerable fraction of the water is drained by settling of the solids and general compaction, followed by the formation of channels that further the process of dewatering. Further dewatering occurs by evaporation. Beds consist simply of shallow ponds with sand bottoms and tile drains. The time required for the sludge to dewater to a liftable consistency ranges from 10-15 days.

The plant has been in operation since September, 1979. On the basis of the operating experience today, it is interesting to note that the obtained results confirm the design specifications. BOD removal is to the extent of 95 to 96%. The effluent is more than of excellent quality with a minimum and maximum 50D, 7 and 15
respectively. Though design requirement is 10 against the influent BOD, 450 mg/l. The sewage sludge contains substances of considerable fertilizing value such as nitrogen (3-4%); phosphorus (1.5 to 2.5%); potassium (0.3-0.6%); humus, and organic growth producing substances. It is a soil conditioner and can be used as a filler for true fertilizer.

Maintenance Cost and Revenue Return:
The expenses incurred annually in the maintenance of sewage treatment plant are given herein as under:

Electricity Charges: Rs.4,80,000/-
Labour Salary & Wages: Rs.3,00,000/-
Miscellaneous expenses: Rs. 60,000/-
Total annual maintenance cost: Rs. 8,40,000/-

Revenue Return of sewage sludge has been evaluated not only to give a coverage to the expenses incurred in maintaining the plant but proved to be of an asset to the income. Annually the production of sewage sludge is about 10,000 cum which (at 80 percent) yields Rs.8,00,000/- annually. 2.9 m³ of effluent which is passed on to Jalmahal amounts to Rs.96,000 per annum. Therefore, Rs.8,96,000/- is the estimated revenue return against the maintenance cost shown. The revenue returns are furthered if the plant runs to 6 m³.

The economics enough cannot be compared with the invaluable efforts to safeguard the public health but conversely for a state which is already under so many economic strains, this facility with returns is of vital importance and considerations.

Conclusion: The system to date has been capable of meeting a process effluent guarantee of 10 mg/l. BOD₅. There was no evidence of filamentous growth and associated problems and no major system design problem could be noticed. Efficiency determining factors have revealed that there is no undue economic penalty and rather number of benefits can be ascribed to the aeration of this plant.

Details of Design Specifications of the Plant:

Unit 1: Out fall sewer 1200 mm dia, with capacity of 12 m³/d.

Unit 2: Two chambers of 6 m³ capacity. Velocity of flow: Max. 0.76 m/sec. at peak flow. Screen size: Coarse screen 3" opening, Fine Screen 3/4" opening.

Unit 3: Grit Removal: 6 m³. Velo. of flow: 0.772 m³/sec. Size of grit settling: 0.2 mm. Settling time: 65 Sec.

Capacity: Ultimate 2520
MLSS: 4200
Oxy.capacity: 1.15 Kg/Kg of BOD.
Volume of surplus sludge: 2250 kg./day
Oxy. capacity: 0.1485
Proposed SRT: 525 Kg/
Aeration tanks: 10.36 x 10.36 x 2.47 M.
Volume of clarification: 56.56 x 10.36
Aeration pond: 1.8 m dia.
Surface overflow rate: 63750 lit/day/sq.mtr.
Detention period: 2.5 hrs.
Total capacity: 5,675 M.Ltr.
Pumping capacity: 6 m³ with 2 m³ stand-by.

Unit 5: Final Settling Tank.

Unit 6: Return Sludge Pump House.

Unit 7: Sludge Thickener.

Unit 8: Aerobic Digestors.

Unit 9: Secondary Sludge Pump House.

Unit 10: Sludge drying beds.

Capacity: 186140 lit.
Size: RCC 6.1 circular tank with 3.96 m³ depth with hopper bottom. Inlet: 200mm dia. C.I. Pipe.
Outlet: 300 mm.
Detention time: 12 days
Oxy. capacity: 0.08 Kg of Oxy. per Kg. of BOD removed.

Pump capacity: 27.2 cum/hr.

Area: 4366 sq.m.
Drying time: 10 days.
12 Nos. Sludge drying beds.
Size: 22.87 x 17.62 meter (each).