8th WEDC Conference: Water and waste-engineering in Asia: MADRAS: 1982

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 waste water treatment facility, PHED Rajasthan incorporated several inovating features. One of these features was that biological treatment was used with aerobic digester attached with sludged thickner. 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. Flocculeted 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 aerations 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 (Hrs.): 15-30; Removal efficiency (%): 85-98; Reactor solid concentration (Mg ML SS/1): 3500-5000; Recycle Ratio: 0.7-1.5; Lb BOD/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 harmoneous functioning of the previous one. Every unit differs in design, strength and quantity of sewage it receives and the time period of contact.

Screening: The sewage from the half of the city Jaipur is led to this treatment plant by a 1200 mm dia. masonary 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 alternatively, 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. Theoritically this unit should eliminate inorganic material large 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 2.286 meter top width, 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 a use of small detention where after being washed, the grit is lifted out by a conveyor. The conveyed material is dumped into the trolly 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 funnel shapped agitator equipped with vanes on its upper surface, surmounting on masonary uptake tube, situated in the centre of each aeration pocket. Circulation and aeration are produced by the aeration cones drawing liquid from the draught tube and spraying over the tank surface, entraining and dissolving 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 imersion in the liquid. The rate of oxygen transfer is affected by the nature of aeration device, depth of submergence, temperature turbulance in the tank, depth of the tank and the chemical character of the sewage. The MLSS has to be kept 3500-5000 mg/1.and is so adjusted that dissolved oxygen remains 2-3 mg/1. 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 to 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 Thickener: Twenty percent of the settled sludge is pumped to a gravitional thickner 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. Here 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 disgester.

Aerobic digesters: Waste biological sludge so produced is stabilished 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. Stabilization process has a very mixed, varied complete food chain which results into non-fragile 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 6-12" from which water drains out 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_5 removal is to the extent of 95 to 98%. The effluent is more than of excellent quality with a minimum and maximum BOD_5, 7 and 15

respectively. Though design requirement is 10 against the influent BOD_5 450 mg/1. The sewage sludge contains substances of considerable fertilizing value such as nitrogen (3-4%); phosphorous (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/-

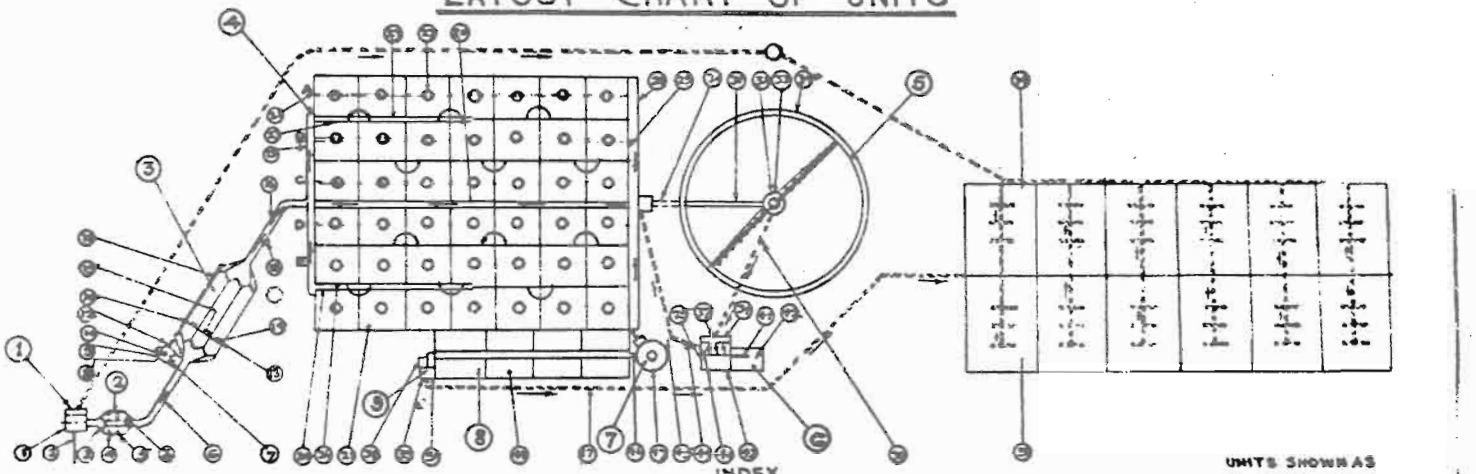
Revenue Return of sewage sludge has been evaluated not only to give a coverage to the expenses incurred in maintaining the plant but proves to be of an asset to the income. Annually the production of sewage sludge is about 10,000 cum which (@ Rs.80 per cum) yields Rs.8,00,000/- annually. 2.9 mgd effluent 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 mgd. 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/1, BOD_5. 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 Inlet Chamber:	Out fall sewer 1200 mm dia. with capacity of 12 mgd.
Unit : 2 Screen Chamber:	Two chambers of 6 mgd capacity. Velocity of flow: Max. 0.76 mt/Sec. at peak flow. Screen size: Coarse screen 3" opening, Fine Screen 3/4" opening.
Unit : 3 Grit Removal:	Capacity : Ultimate 6 mg. Velo. of flow: 0.772 mt/Sec. Size of grit settling: 0.2mm settling time: 65 Sec.
Unit: 4 Aeration Tank: (42)	Detention time in the tank: 13.28 Hrs. Proposed MLVSS concentration: 2520 Proposed MLSS:" 4200 Oxy.capacity:1.15 Kg/Kg of BOD_5. Capacity of aeration tank: 15.08 Million Lit. (358660 x 42). Proposed SVI: 50-100 Volume of surplus sludge:2250 Kg./day Proposed F/M: 0.1485 Proposed SRT: 525 Kg/ 1000 cum. Aeration tanks:10.36x 10.36x2.47 Mt. Hopper bottom tanks: 10.36x10.36x5.56x1M Aeration concs:1.8 mt.dia.
Unit: 5 Final Settling tank:	Surface overflow rate: 53750 lit/day/sq.mt. Detention period:2½ Hr. Total capacity:5.675M.Lt.
Unit: 6 Return Sludge Pump House:	Pumping capacity:6 mgd. with 2 mgd stand-by.
Unit: 7 Sludge Thickner:	Capacity: 186140 lit. Size: RCC 6.1 circular tank with 3.96 meter depth with hopper bottom. Inlet:200mm dia.C.I.Pipe Outlet: -do-
Unit: 8 Aerobic disgestors:	Detension time: 12 days Oxy.capacity:0.08 Kg.of Oxy. per Kg. of BOD removed.
Unit: 9 Secondary Sludge Pump House:	Pump capacity: 27.2cum/hr.
Unit: 10 Sludge drying beds:	Area: 4366 sqm. Drying time 10 days. 12 Nos. Sludge drying beds. Size: 22.87x17.62 meter (each).

LAYOUT CHART OF UNITS



UNITS SHOWN AS

INDEX

1	ILC	INLET CHAMBER	18	FM	FLOW METER	35	STOC	SETTLING TANK OUTLET CHANNEL
2	OFB	OUTFALL SEWER	19	ATIC	AERATION TANK INLET CHANNEL	36	SSP	SLUDGE SUCTION PIPE
3	G	GETE	20	CMDC	CENTRAL MAIN DISTRIBUTION CHANNEL	37	SSPV	SLUDGE SUCTION PIPE VALVE
4	CS	COURSE SCREEN	21	AT	AERATION TANK	38	WS	WET SUMP
5	FS	FINE SCREEN	22	ABCDEF	AERATION TANK ROWS	39	DS	DRY SUMP
6	CCI	COLLECTING CHANNEL IN LET	23	WDC	WEST DISTRIBUTION CHANNEL	40	PS	PUMP SET
7	VS	VORTEX SEPARATOR	24	EDC	EAST DISTRIBUTION CHANNEL	41	MCP	MAIN CONTROL PANEL
8	VSP	VORTEX SEPARATOR PIPE	25	WSG	WEST SIDE GATE	42	OCP	OPERATOR CONTROL ROOM
9	VSC	VORTEX SEPARATOR CHAMBER	26	ESG	EAST SIDE GATE	43	MSPH	MAIN SLUDGE PUMP HOUSE
10	GE	GRIT ELEVATOR	27	AC	AERATION CONE	44	MSDP	MAIN SLUDGE DELIVERY PIPE
11	GL	GRIT LAUNDER	28	ATOC	AERATION TANK OVERFLOW CHANNEL	45	STIP	SLUDGE THICKNER INLET PIPE
12	GLP	GRIT LAUNDER PIPE	29	WP	WIER PLATE	46	STDP	SLUDGE THICKNER DELIVERY PIPE
13	GPB	GRIT PUMP BRIDGE	30	FP	FEEDING PIPE	47	ST	SLUDGE THICKNER
14	GP	GRIT PUMP	31	WWB	WALK WAY BRIDGE	48	SSPH	AEROBIC DIGESTORS
15	GVP	GRIT VACUUM PUMP	32	CP	CONCRETE PIER	49	SSPH	SECONDARY SLUDGE PUMP HOUSE
16	MC	MEASURING CHANNEL	33	SP	SCRAPER PIER	50	FR	FLOW RECORDER
17	SRM	SLUDGE RISING MAIN	34	WEDB	WEST SIDE DRYING BED	51	ESDB	EAST SIDE DRYING BED

Figure-1

TRACED BY 3/11