17. OTHER PRIMARY TREATMENT SYSTEMS

Other pretreatment operation such as equalization, skimming tanks, flocculation and pre-aeration are used sometimes. However, for sewage treatment, equalization, flocculation and pre-aeration are generally not used, but these can be used in case of industrial wastewater treatment.

17.1 EQUALIZATION

For sewage treatment plant of large capacity the variation in the sewage flow received at sewage treatment plant of centralized system is not that pronounced and equalization may not be required in this case. However, for sewage treatment plant of small community, where wastewater flow rate considerably vary with time, and for industrial wastewater treatment plants, where wastewater flow and characteristic varies with time, equalization becomes essential to obtain proper performance of the treatment plant by avoiding shock loading (hydraulic and organic) to the systems. Due to possibility of variation in flow rate received at treatment plant, there may be deterioration in performance of the treatment plant than the optimum value. To facilitate maintenance of uniform flow rate in the treatment units, flow equalization is used. This helps in overcoming the operational problems caused by flow variation and improves performance of the treatment plant. Flow equalization is provided for dampening of flow rate variations so that a constant or nearly constant flow rate is achieved.
The equalization can also be provided for dampening the fluctuation in pollutant concentration in the incoming wastewater to avoid shock loading on the treatment system; to provide continuous feeding to the treatment system when the wastewater generation is intermittent; to control pH fluctuations or to control toxic concentration in the feed to the biological reactor; and this can also be used to control the discharge of industrial effluent in to the sanitary sewers.

Equalization can be of ***two types:***

a) Inline: Where all flow passes through equalization basin
b) Off-line: In this, the flow above average daily flow is diverted to equalization basin. The pumping is minimized in this case but amount of pollutant concentration damping is considerably reduced.

Location of Equalization: Location of equalization basin after primary treatment and before biological treatment is appropriate. This arrangement considerably reduces problem of sludge and scum in the equalization basin. If the equalization basin is placed before primary treatment, it must be provided with sufficient mixing to prevent solids deposition and concentration variations, and aeration to prevent odour problem. Most commonly submerged or surface aerators with power level of approximately 0.003 to 0.004 KW/m^3 are used. In diffused air mixing, air requirement of 3.74 m^3/m^3 (air flow rate to water flow rate) is used (Eckenfelder, 2000).

Volume requirement: The volume required for the equalization tank can be worked out using an inflow mass diagram in which cumulative inflow volume is plotted versus the time of day.

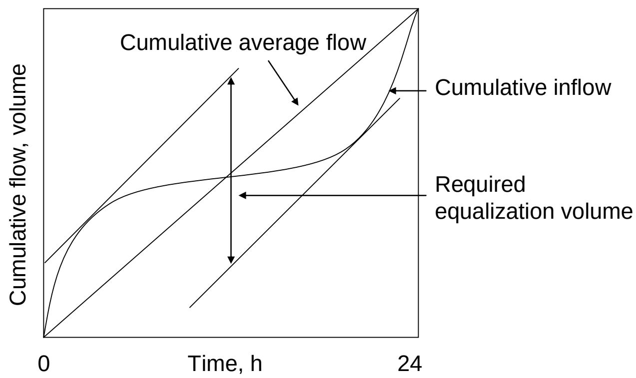

Figure 17.1 Inflow mass diagram for determination of required equalization basin volume.

In practice, the volume of tank is kept 10 to 20% greater than the theoretical volume. This additional volume is provided for the following:

- Not to allow complete drawdown to operate continuous mixing or aeration (e.g. floating aerators)
- Some volume must be provided to accommodate concentrated stream to get diluted wastewater.
- Safety for unforeseen changes in flow.

Example:1

Determine the volume required for the equalization tank for the following flow rate given in Table 17.1.

Solution

Average pumping = 193.3 m^3/24 h = 8.054 m^3/h, hence in three hours pumping = 24.1625 m^3

From the table after calculating maximum cumulative deficit and surplus, the volume of equalization basin required = 42.1875 + 1.86 = 44.047 m^3

Provide 20% extra volume, hence volume of the tank = 53 m^3

Provide mixer of capacity 0.004 KW/ m^3

Therefore, power required for mixer = 53.2 x 4 = 212.8 W

Hence provide mixer of about 250 W to impart mixing in the equalization basin.

Provide depth of the basin = 3.5 m, hence are required = 15.14 m^2
Provide suitable square or circular tank.

Table 17.1 Variation in the flow rate of the wastewater

Time Period	Volume of wastewater, m^3	Cumulative volume, m^3	Cumulative pumping, m^3	Cumulative surplus, m^3	Cumulative deficit, m^3
8 – 11	22.3	22.3	24.162		**1.86**
11 – 14	43.2	65.5	48.325	17.175	
14 – 17	16.8	82.3	72.49	9.81	
17 – 20	41.1	123.4	96.65	26.75	
20 – 23	39.6	163	120.812	**42.187**	
23 – 2	11.1	174.1	144.975	29.125	
2 – 5	11.1	185.2	169.137	16.063	
5 – 8	8.1	**193.3**	193.3	0	

17.2 SKIMMING TANKS

It is a chamber so arranged that floating matter rises and remains on the surface of wastewater until removed, while liquid flows out continuously through deep outlets or under partition or deep scum board. This may be accomplished in separate tank or combined with primary sedimentation. In conventional sewage treatment plants separate skimming tanks are not used, unless specifically required, and this is achieved by providing baffle ahead of effluent weir in primary sedimentation tank. Skimming tanks are used to remove lighter, floating substances, including oil, grease, soap, pieces of cork and wood, vegetable debris, and fruit skins. Tank can be rectangular or circular, designed for detention period of 1 to 15 minutes. Typical detention time of about 5 min is adopted in design (Metcalf and Eddy, 2003). The submerged outlet is opposite the inlet and at lower elevation to assist in flotation and remove any solids that may settle.

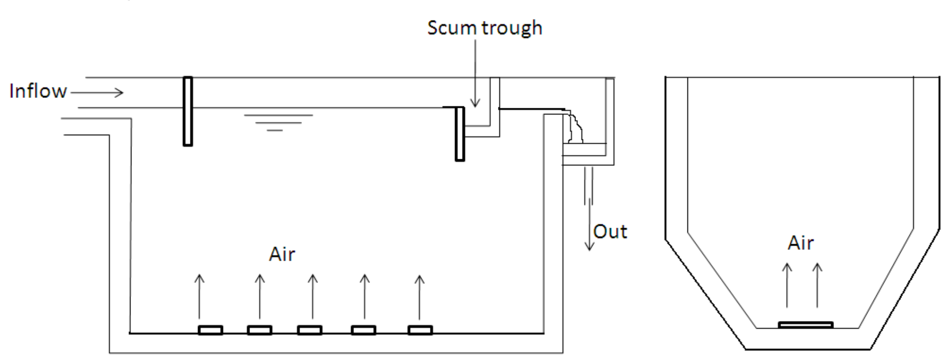

Figure 17.2 Skimming tank

17.3 FLOCCULATION

Flocculation is not commonly used for sewage treatment; however, it may be required in treatment of industrial wastewater where organic matter is present in high concentration in colloidal form. Presence of such solids will increase the oxygen demand in aerobic wastewater treatment system, and may disturb the performance of anaerobic reactor like UASB reactor, due to presence of finely divided suspended solids which may not settle well in the reactor to undergo digestion. If flocculation is used it is provided before the primary sedimentation tank.

Flocculation is provided with the objective to form flocs from the finely divided matter. It can be mechanical or air agitation without any chemical addition. Provision of flocculation can increase removal of SS and BOD in primary sedimentation tank and help in increasing efficiency of secondary sedimentation tank after biological treatment. It can be accomplished in separate tank or in conduits connecting the treatment units or combination of flocculator and clarifiers. In mechanical or air agitation flocculation systems it is common practice to taper the energy input so that the flocs formed will not be broken as they leave the flocculator. Detention time of 20 to 60 min (typical 30 min) is used in design of the flocculator (Metcalf and Eddy, 2003). In case of mechanical mixing, maximum speed at periphery for the paddles induced flocculation with adjustable speed is 0.4 – 1.0 m/sec (typical 0.6 m/sec). For air agitation flocculation with tube diffusers air supply is generally in the range of 0.6 – 1.2 m^3/ ML.

17.4 PRE-AERATION

Pre-aeration is sometimes used prior to primary sedimentation to improve treatability, to provide grease separation, odour control, grit removal, flocculation and more importantly to promote uniform distribution of suspended solids. This can be achieved by increasing detention time in aerated grit chamber (d.t. = 3 to 5 min) instead of separate tank. Using aerated channels for wastewater distribution to primary sedimentation tank can help uniform distribution of solids and also keeping solids in suspension at all flow rates. Air requirement for pre-aeration varies from 0.02 to 0.05 m^3/min.m length of channel (Metcalf and Eddy, 2003). When separate pre-aeration basin is used, detention time of 10 to 40 min and tank depth of 3 to 5 m can be adopted. The air requirement for the pre-aeration basin will be 0.75 – 3.0 m^3/ m^3.

Questions

1. Describe equalization. Under what circumstances this is provided? How the volume of the equalization basin is estimated?
2. What will be ideal location for the equalization basin in wastewater treatment plant? Give justification for suggested location.
3. Draw schematic of the skimming tank and explain the purpose of providing it and how removal of such pollutant occurs in this tank.
4. What are the advantages of providing flocculation and preaeration to wastewater?