SCREENING

A screen is a device with openings for removing bigger suspended or floating matter in sewage which would otherwise damage equipment or interfere with satisfactory operation of treatment units.

Types of Screens

**Coarse Screens:** Coarse screens also called racks, are usually bar screens, composed of vertical or inclined bars spaced at equal intervals across a channel through which sewage flows. Bar screens with relatively large openings of 75 to 150 mm are provided ahead of pumps, while those ahead of sedimentation tanks have smaller openings of 50 mm.

Bar screens are usually hand cleaned and sometimes provided with mechanical devices. These cleaning devices are rakes which periodically sweep the entire screen removing the solids for further processing or disposal. Hand cleaned racks are set usually at an angle of 45° to the horizontal to increase the effective cleaning surface and also facilitate the raking operations. Mechanical cleaned racks are generally erected almost vertically. Such bar screens have openings 25% in excess of the cross section of the sewage channel.

**Medium Screens:** Medium screens have clear openings of 20 to 50 mm. Bars are usually 10 mm thick on the upstream side and taper slightly to the downstream side. The bars used for screens are rectangular in cross section usually about 10 x 50 mm, placed with larger dimension parallel to the flow.

**Fine Screens:** Fine screens are mechanically cleaned devices using perforated plates, woven wire cloth or very closely spaced bars with clear openings of less than 20 mm. Fine screens are not normally suitable for sewage because of clogging possibilities.

Velocity

The velocity of flow ahead of and through the screen varies and affects its operation. The lower the velocity through the screen, the greater is the amount of screenings that would be removed from sewage. However, the lower the velocity, the greater would be the amount of solids deposited in the channel. Hence, the design velocity should be such as to permit 100% removal of material of certain size without undue depositions. Velocities of **0.6 to 1.2 mps through the open area for the peak flows** have been used satisfactorily. Further, the velocity at low flows in the approach channel should **not be less than 0.3 mps** to avoid deposition of solids.

Head loss

Head loss varies with the quantity and nature of screenings allowed to accumulate between cleanings. The head loss created by a clean screen may be calculated by considering the flow and the effective areas of screen openings, the latter being the sum of the vertical projections of the openings. The head loss through clean flat bar screens is calculated from the following formula:

\[ h = 0.0729 \ (V^2 - v^2) \]

where, \( h \) = head loss in m

\( V \) = velocity through the screen in mps

\( v \) = velocity before the screen in mps
SCREENING

Another formula often used to determine the head loss through a bar rack is Kirschmer's equation:

\[ h = b \left( \frac{W}{b} \right)^{4/3} h_v \sin q \]

where \( h \) = head loss, m

\( b \) = bar shape factor (2.42 for sharp edge rectangular bar, 1.83 for rectangular bar with semicircle upstream, 1.79 for circular bar and 1.67 for rectangular bar with both u/s and d/s face as semicircular).

\( W \) = maximum width of bar u/s of flow, m

\( b \) = minimum clear spacing between bars, m

\( h_v \) = velocity head of flow approaching rack, \( m = \frac{v^2}{2g} \)

\( q \) = angle of inclination of rack with horizontal

The head loss through fine screen is given by

\[ h = \left( \frac{1}{2g} \right) \left( \frac{Q}{CA} \right) \]

where, \( h \) = head loss, m

\( Q \) = discharge, m\(^3\)/s

\( C \) = coefficient of discharge (typical value 0.6)

\( A \) = effective submerged open area, m\(^2\)

The quantity of screenings depends on the nature of the wastewater and the screen openings.

**Equalization Tanks**

The equalization tanks are provided (i) to balance fluctuating flows or concentrations, (ii) to assist self neutralization, or (iii) to even out the effect of a periodic “slug” discharge from a batch process.

**Types of Equalization Tanks**

Equalization tanks are generally of three types:

1. Flow through type
2. Intermittent flow type
3. Variable inflow/constant discharge type

The simple flow through type equalization tank is mainly useful in assisting self neutralization or evening out of fluctuating concentrations, not for balancing of flows since a flow through type tank once filled, gives output equal to input.

Flow balancing and self-neutralization are both achieved by using two tanks, intermittently one after another. One tank is allowed to fill up after which it is checked for pH (or any other parameter) and then allowed to empty out. The
SCREENING

second tank goes through a similar routine. *Intermittent flow type* tanks are economic for small flows from industries.

When flows are large an equalization tank of such a size may have to be provided that *inflow can be variable while outflow is at a constant rate*, generally by a pump. The capacity required is determined from a plot of the cumulative inflow and a plot of the constant rate outflow and measuring the gaps between the two plots. A factor of safety may be applied if desired.

Generally, *detention time* vary from 2 to 8 hours but may be even 12 hours or more in some cases. When larger detention times are required, the equalization unit is sometimes provided in the form of facultative aerated lagoon.