

Fig. Function decomposition of design

**Calc.**

|  |  |  |  |
| --- | --- | --- | --- |
| **a.** | **Analytical and Numerical Model Solutions** |  |  |
|  |  |  |  |
|  | Total Population = | 500 |  |
|  | **Water Consumed =** | **90000** | **LPCD** |
|  |  | 90 | KLD |
|  |  | 0.09 | MLD |
|  |  | 90 | m3/day |
|  |  |  |  |
|  | Average Sewage generated = | **76.5** | **KLD** |
|  | Average Sewage per hour = | **3.1875** | **m3/hour** |
|  |  |  |  |
|  | Peak Factor = | 3 |  |
|  | **Design Flow Capacity =** | **9.5625** | **m3/hour** |
|  |  | **0.0027** | **m3/sec** |
|  |  |  |  |
| **b.** | **Sizing Calculation for Collection Pit** |  |  |
|  |  |  |  |
|  | Retention time required = | 4 | hr |
|  | Average Design flow = | 3.1875 | m3/hour |
|  | Capacity of collection sump = | 12.75 | m3 |
|  | Assume liquid depth = | 5 | m |
|  | Area, required for collection pit = | 2.55 | m2 |
|  |  |  |  |
|  | Let us consider it to be a circular tank |  |  |
|  | Now, |  |  |
|  | r = | 0.9 | m |
|  |  |  |  |
| **c.** | **Design of Sewer Chamber** |  |  |
|  | Qmax | 0.0027 | m3/sec |
|  | Assumption, |  |  |
|  | Shape of Bar | MS FLAT |  |
|  | Size | 10 | mm |
|  |  | 50 | mm |
|  | Clear Spacing between the bars = | 20 | mm |
|  | Inclination of bars | 80 | deg |
|  |  | 1.4 | radian |
|  | Sin 80 | 0.98544973 |  |
|  | Assume avg. velocity to sewer | 0.8 | m/sec |
|  | At peak flow, net inclined area required = | 0.003375 | m2 |
|  | Gross inclined area | 0.00405 | m2 |
|  | Gross vertical area required | 0.003991071 | m2 |
|  | Provide submergence depth | 0.3 | m |
|  | Width of channel | 0.013303571 | m |
|  | **Assumed Width of channel** | **0.3** | **m** |
|  |  |  |  |
| **d.** | **Design of Grit Chamber** |  |  |
|  | Design Flow | 0.225 | MLD |
|  |  | 225 | m3/day |
|  | Surface Loading | 1100 | m3/m2/day |
|  | To account for turbulence and short circuiting, |  |  |
|  | Reduced surface loading | 770 | m3/m2/day |
|  |  |  |  |
|  | Area required | 0.292207792 | m2 |
|  | Assumed area required | 0.3 | m2 |
|  | Provide 0.3 m dia. Chamber (Circular) |  |  |
|  | detention time | 60 | sec |
|  | Volume | 0.15625 | m3 |
|  | Liquid Depth | 0.53 | m |
|  | **Free Board** | **0.6** | **m** |
|  | **Size of grit chamber** | **0.3 X [0.53 + 0.6]** |  |
|  |  | **0.3 X 1.13 m** |  |
|  | **Dia** | **0.3** | **m** |
|  |  |  |  |
| **e.** | **Check for horizontal velocity** |  |  |
|  | Cross sectional area of grit chamber | 0.159 | m2 |
|  | Velocity | 0.02 | m/sec |
|  |  | 2 | cm/sec |
|  | Check if velocity less than 18 cm/sec | OK |  |
|  | Grit generation assumed | 0.05 | m3 |
|  |  | per |  |
|  |  | 1000 | m3 |
|  |  | of sewage flow | |
|  | Storage volume required | 0.0051 | m3 |
|  | Grit storage area | 3.14 | m2 |
|  | Grit storage depth | 0.0016 | m |
|  | Total liquid depth | 0.53 | m |
|  | **Provide grit chamber of size** | **2 m X 0.28 m** |  |
|  |  |  |  |
| **f.** | **Design of Primary Sedimentation Tank** |  |  |
|  | Detention time | 2 | hour |
|  | Volume of Sewage | 1.59 | m3 |
|  | Provide depth | 1 | m |
|  | Surface Area | = Volume/Depth | |
|  |  | 1.59 | m2 |
|  | d2 | 2.02 | m |
|  | **d** | **1.42** | **m** |
|  |  |  |  |
| **g.** | **Design of Aeration Tank** |  |  |
|  | No. of Tanks | 2 |  |
|  | Avg. Flow to each tank | 0.1125 | MLD |
|  | **Q** | **112.5** | **m3/day** |
|  | Total BOD entering STP | 295 | mg/L |
|  | The BOD of sewage coming to aeration tank, Y0 | 295 | mg/L |
|  | BOD left in the effluent, YE | 20 | mg/L |
|  | BOD removed in the activated plant | 275 | mg/L |
|  | Minimum efficiency required in the activated pant | 93 | % |
|  |  | **OK** | |
|  |  |  |  |
|  | Volume of aeration tank can be designed by assuming a suitable value for MLSS and "qC" (or F/M ratio). MLSS should be between 3000 - 3500 mg/L and F/M ratio should be between 0.18 - 0.10. | | |
|  | Assuming, |  |  |
|  | MLSS, XT | 3000 | mg/L |
|  | F/M ratio, "qC" | 0.1 |  |
|  | **F/M = (Q/V) X (Y0 / XT)** | |  |
|  | We have, Q = | 112.5 | m3/day |
|  | Y0 = | 295 | mg/L |
|  | XT = | 3000 | mg/L |
|  | F/M ratio, "qC" = | 0.1 |  |
|  |  |  |  |
|  | Therefore, |  |  |
|  | V = | (Q x Y0)/ (qC x XT) | |
|  | **Hence, V =** | **110.625** | **m3** |
|  |  |  |  |
|  | Let us adopt an aeration tank of following dimensions |  |  |
|  | B = | 5 | m |
|  | D = | 2 | m |
|  | H = V/(BxD) | 11.0625 | m |
|  | Hence, H = | 12 | m |
|  | Volume Provided = | 120 | **m3** |
|  | Since, Volume provided > Required Volume, | | |
|  | Hence, the adopted tank size is OK. | | |
|  | **So, the adopted tank size is (5 + 0.6)m X 2m X 12m .** | | |
|  |  |  |  |
| **h.** | **Design of Secondary Clarifiers** |  |  |
|  | No. of Clarifiers = | 1 | no. |
|  | Avg. Flow = | 76.5 | m3/day |
|  | Reduced flow, say 50 % = | 112.5 | m3/day |
|  | Total Inflow = | 189 | m3/day |
|  | Provide hydraulic detention time = | 2 | hrs |
|  | Volume of tank = | 15.75 | m3 |
|  | **Assume liquid depth =** | **3.5** | **m** |
|  | Area = | 4.5 | m2 |
|  |  |  |  |
|  | Surface loading area of avg. flow = | 15 | m3/m2/day |
|  | Surface area to be provided = | 5.1 | m2 |
|  | Provide area greater of the two. | | |
|  | Hence, Provided Area = | 5.1 | m2 |
|  | Dia. of circular tank (d) = | 2.547726259 | m |
|  | **Provided diameter =** | **3** | **m** |
|  |  |  |  |
|  | **Hence, provide a clarifier of 10 m dia. Having liquid depth as 3.5 m.** | | |
|  |  |  |  |
| **i.** | **Return Sludge Pump House** |  |  |
|  | Total return flow = | 112.5 | m3/day |
|  |  | 4.6875 | m3/hour |
|  |  | 0.0781 | m3/min |
|  | Detention time = | 15 | min |
|  | Volume of wet well = | 1.1715 | m3 |
|  | Provide wet well = | 2.5m x 1.5m x 1.8m |  |
|  | Provide dry well = | 2.5m x 2.5m |  |
|  | Size of annexe control room = | 2.5m x 2.5m |  |
|  | **Provide 2nos pumps each of 0.112 MLD capacity in the dry well for returning the sludge to aeration tank. The return sludge pipe line should be 150 mm F .** | | |
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|  |  |  |  |
| **j.** | **Design of sludge drying beds** |  |  |
|  | Sludge applied for drying beds @100 Kg/MLD |  |  |
|  | Sludge applied = | 125 | Kg/day |
|  | Specific gravity = | 1.015 |  |
|  | Solid Contents = | 1.5 | % |
|  | Volume of sludge = | 8.21 | m3/day |
|  | Considering monsoon, etc., total no. of cycle in 1 year = | 33 |  |
|  | Period of each cycle = | 11 | days |
|  | Volume of sludge = | 90.31 | m3 |
|  | Spreading a layer of 0.3 m per cycle area of beds required = | 302 |  |
|  | **Provide 4 beds of 1.2 m X 7 m,** |  |  |
|  | **Thus provided area =** | **336** | **m2** |