Primary Treatment
Technical Note for urbanised Areas in India

Technology description

Primary treatment is the first "line of defence", it reduces the suspended solids and biochemical oxygen demand (BOD) of raw wastewater on downstream treatment processes. Suspended particles are heavier than water; this treatment harnesses the natural ability of these particles to settle by gravity under quiescent conditions. This enhances soluble substrate removal during secondary treatment and reduces the volume of sludge that is generated. Primary treatment equalizes raw wastewater quality and flow to a limited degree, thereby protecting downstream unit processes from unexpected surge in flow. The most common form of primary treatment is plain quiescent settling with skimming, collection, and removal of settled primary sludge, floating debris, and grease.

Figure 1. shows the schematics of a primary clarifier with centre feed arrangement designed for 100 m^3/d flow with a detention time of 3 hours. It has a diameter of 3.25 m with a bottom slope 1in12 with a centrally driven mechanism consisting of stationary bridge, motor cum planetary gear arrangement and scraper mechanism with rotation at 2-3 RPH for removing sludge. Influent feeding is in a feed well of 1.0 m diameter attached to the bridge. This clarifier has been commissioned in November 2015 at Ordnance Factory Township, Nagpur site under NaWaTech project (Figure 2).

Figure 1.Schematic diagram of Primary Clarifier

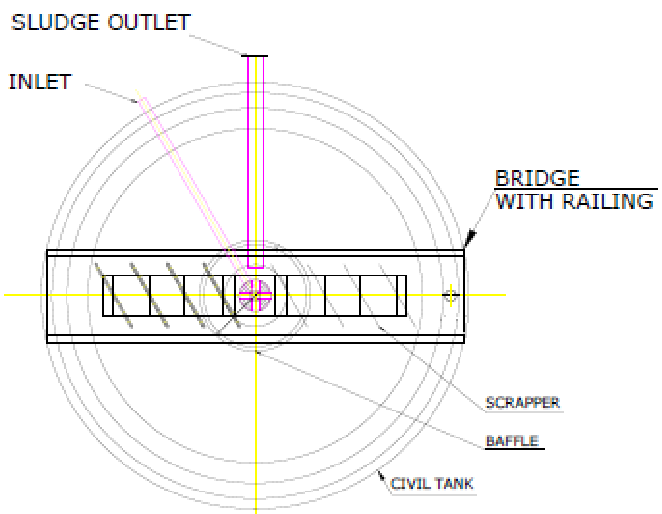

Figure 2. Primary Clarifier at Ordnance Factory Township, Nagpur

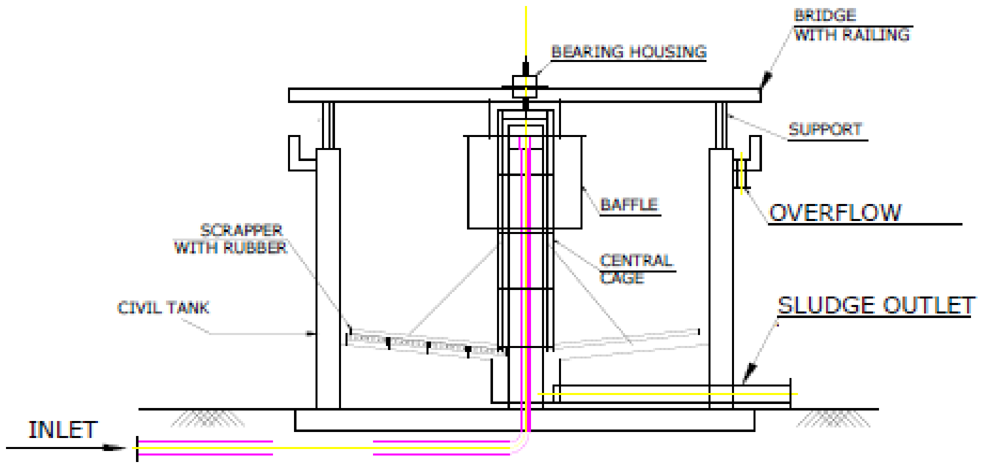

Figure 3. Typical energy dissipating and flow distribution inlet for a central feed tank. The inner ring is used to create a tangential flow pattern (Vertical Section)

Key design criteria: • Capacity: 100 m^3/d • TSS :150 mg/l • BOD :200 mg/l, COD : 350 mg/l • Surface Overflow Rate (SOR): 12 - 18 m^3/m^2/day • Hydraulic Retention Time (HRT): 3 hrs • Diameter:3.25 m, Side water depth (SWD): 2.00 m • Sludge Concentration : 5 – 7 g/L	**This technology allows to provide:** • Primary treatment **This technology needs to be combined with:** • Pre-treatment: Oil & Grease Trap, Screen Chamber • Post treatment: Suitable Secondary and Tertiary treatment • Sludge treatment: Sludge Drying Reed Beds (SDRB)
Implementation consideration: • Land requirement: low • Capital cost: medium • Maintenance burden: Medium	**Application and management level in the urban context:** • Highly suitable for application in the urban context.
Pollutant removal (%) TSS: 90% BOD: 30%	**Effluent suitable for:** • Secondary and Tertiary level treatments.

Design criteria for the Indian context

1. Suitability of the technology in urbanised areas in India

Primary clarifiers can be found in all types of conventional wastewater treatment plants in India. This treatment has wide applicability from small to large size communities. The treatment requires electricity to operate the scrapper attached at the bottom of the clarifier for the removal of settled sludge. The suspended particles are settled by gravity under quiescent conditions and then removed by the scrapper, so the whole process is temperature independent and thus it works in all variable climatic conditions.

2. Treatment performance expected under Indian conditions

Biochemical Oxygen Demand (BOD) removal of 30% and Total Suspended Solids (TSS) removal of 90% is expected.

3. Pre-treatment and post-treatment required considering typical Indian domestic influents and effluents

Screen bar chambers are required for removal of large floating particles like trunks, twigs, leaves, polybags etc., and oil and grease trap for removal of oil and grease matter. These floating matters, if not removed, may cause hindrance in the settling process. Post-treatment should consist of suitable secondary and tertiary treatments.

4. Construction materials and equipment availability in Indian urban areas

Plain cement concrete, reinforced cement concrete, steel reinforcement, masonry - stone or concrete blocks, cement plastering; Piping: HDPE drainage pipes; Electric motor & gear box, neoprene scraper, centrally driven bridge mechanism.

5. Sizing, site constrain and landscaping considerations

Rectangular and circular settling tanks are most commonly used in wastewater treatment. Rectangular settling tanks range from 15 to 90 m (50 to 300 ft) in length and 3 to 24 m (10 to 80 ft) in width. Depth should exceed 2 m (7ft). Circular settling tanks vary from small, 3 m (10 ft), to more than 90 m (300ft). Depths range between 2.4 and 4.0 m (8 to 13 ft) (WPCF, 1985). Circular settling tanks can use relatively trouble free circular primary sludge removal equipment (drive bearings are not under water). Walls of circular tanks act as tension rings, which permit thinner walls than those for rectangular tanks. Due to such advantages, circular tanks have a lower cost per unit surface area than rectangular tanks (unless the rectangular tanks use common wall construction).

Site constraints including land requirement, operational issues and necessity of sludge digestion call for attention while implementing primary clarifiers. Constraint of land area can be tackled by using either rectangular or circular tank depending upon the availability of space. Operational issues include sludge removal and frequent checking of electro-mechanical parts of sludge removal mechanism. Settled sludge exclusively needs to be digested either anaerobically or using sludge drying reed beds (SDRB). Another important constraint of primary clarifier is odour, since sewage is stored for 2 – 3 hours after initial hold-up in pre-treatment units, which may emanate bad odour.

6. Self-help compatibility for design and construction in Indian cities

Requires expert design, but can be constructed with locally available material.

Costs and maintenance

Range of Population Equivalent (p.e.)	Applicable for centralised and decentralised treatment systems
Expected life span (years)	15 – 20 years
Range of Implementation costs in India (investment and construction costs)	4000 - 5000 `/m3 400 –500 ` /p.e
Maintenance and operation costs from Maharashtra experiences (Rs./p.e.year)	Approx. Rs 70,000 -10,00,00 per annum for electricity and repairs for decentralised plants up to 1000 m^3/d

Total treated water costs (Rs./p.e.year) related to Indian context (including operation costs)	Not applicable
Required construction staffs and skills	Skilled staff required
Required operation and maintenance staffs and skills	Unskilled staff required
Energy requirements (kW/PE)	Less energy intensive

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References:

WPCF, Clarifier Design, Manual of Practice FD-8, Water Pollution Control Federation,Washington, DC, 1985.

Drawings, Photos and Data By:

CSIR-National Environmental Engineering Research Institute (CSIR-NEERI), Nagpur (Implementation of proposed treatment scheme of capacity 100 m3/day at Nagpur intervention site under NaWaTech project)