Technical Standard for Sewerage System ≤10,000 PE

TS(T-P) 0103-1:2018

Technical Standard for Sewage Treatment Plant for Liquid Stream (Solid-Liquid Separation) - Part 1: Secondary Clarifier
Contents

Foreword ........................................................................................................................................ 2
Committee Representation .................................................................................................................. 3
1.0 Introduction .................................................................................................................................. 4
2.0 Scope ............................................................................................................................................ 4
3.0 Normative Reference ..................................................................................................................... 4
4.0 Abbreviation ................................................................................................................................. 7
5.0 Definition ...................................................................................................................................... 7
6.0 Secondary Clarifier ......................................................................................................................... 9
   6.1 Purpose of Secondary Clarifier .................................................................................................. 9
   6.2 Design Requirements ................................................................................................................ 9
      6.2.1 General ............................................................................................................................... 9
      6.2.2 Square Clarifiers ............................................................................................................... 11
      6.2.3 Rectangular Clarifiers ...................................................................................................... 12
      6.2.4 Circular Clarifiers ............................................................................................................. 12
      6.2.5 Weirs ............................................................................................................................... 12
      6.2.6 Process Control and Operation Regime .......................................................................... 13
7.0 Mechanical and Electrical Requirements ..................................................................................... 13
8.0 Other Amenities ........................................................................................................................... 13
9.0 Construction Requirements ........................................................................................................ 13
   9.1 General ....................................................................................................................................... 13
   9.2 Reinforced Concrete Structures ............................................................................................. 13
   9.3 Structural Steel ......................................................................................................................... 14
10.0 Health and Safety Requirements ............................................................................................... 15
Foreword
Committee Representation

This Technical Standard for Sewage Treatment Plant for Liquid Stream (Solid-Liquid Separation) - Part 1: Secondary Clarifier has been prepared by a Task Force and reviewed by Technical Working Group comprising of representatives from the following Government Agencies, Scientific and Professional bodies, Consultants, Supplier and Specialist Contractors.
1.0 **Introduction**

This technical standard sets out the requirements for a sewerage system to cater for a design population of 10,000 PE or less.

2.0 **Scope**

TS(T-P)0103-1:2018 shall cover the design and construction requirements of the secondary settling process in the sewage treatment plant to ensure that all settleable solids and sludge are effectively removed from the liquid.

3.0 **Normative Reference**

The normative references that are relevant to TS(T-P) 0103-1:2018 are as follows:

(a) Akta Bekalan Elektrik 1990 (Akta 448).

(b) Biological Wastewater Treatment Series – Sludge Treatment and Disposal, Volume Six, Cleverson Vitorio Andreaoli, Marcos von Sperling, Fernando Fernandes and Mariska Ronteltap.

(c) Environment Quality Act 1974.

(d) Factories and Machinery Act 1967.

(e) Occupational Safety and Health Act 1994.


(k) Malaysian Standards


(l) British Standards


(iii) BS 7079:2009 – General introduction to standards for preparation of steel substrates before application of paints and related product.


(viii) BS EN 10029:2010 – Hot-rolled steel plates 3 mm thick or above. Tolerances on dimensions and shape.


(xii) BS EN 10210-2:2006 – Hot finished structural hollow sections of non-alloy and fine grain steels. Tolerances, dimensions and sectional properties.


(m) Australian / New Zealand Standards


4.0 Abbreviation

FRP Fibre Reinforced Polyester
HRT Hydraulic Retention Time
IEC International Electrotechnical Commission
MLSS Mixed Liquor Suspended Solid
OSHA Occupational Safety and Health Administration
PE Population Equivalent
Q_{avg} Average Flow Rate
Q_{peak} Peak Flow Rate
RAS Returned Activated Sludge
RC Reinforced Concrete
Rpm Revolutions per minute
SPAN Suruhanjaya Perkhidmatan Air Negara (National Water Services Commission)
STP Sewage Treatment Plant
TWL Top Water Level
UV Ultraviolet
WAS Waste Activated Sludge

5.0 Definition

Activated Sludge - refers to the flocculant microbial mass, produced when sewage is continuously aerated.

Baffle - refers to the palate / structure that is installed or constructed in the process tank to promote uniform flow throughout the tank and to avoid short-circuiting.

Competent Person - refers to a person who is qualified to submit sewerage planning and design, supervise the construction, installation, testing and inspection of the sewerage works or septic tank works as particularly set out in the Schedule 1, Water Services Industry Act 2006 (Planning, Design and Construction of Sewerage System and Septic Tank) Rules 2013 [P.U.(A) 214].
Desludging - refers to the removal of the settled solids in the process tanks in the STP together with the liquid periodically when the settled solid has reached prescribed limit.

Effluent - refers to the treated fluid discharged from the sewage treatment plant.

Equipment - refers to any component which is installed in, mounted on, attached to, or operated on structures in the performance of their intended function.

Final Effluent - refers to the effluent discharged from a sewage treatment plant.

Freeboard - refers to the space between top water level and the top of the channel or process tank.

Mixed Liquor Suspended Solid (MLSS) - refers to the concentration of dry solids in mg/l of mixed liquor in the aeration tank or channel of an activated sludge plant.

Outlet Fitting - refers to the device that allows a connection to be made between the outlet of the tank and the drainage system that conducts the effluent or liquid away for further treatment.

Platform - refers to the raised level surface on which people or things can stand.

Population Equivalent (PE) - refers to the population equivalent in terms of fixed population of a varying or transient population for domestic wastes from sectors which include residential, commercial and industrial that contribute flow to the sewerage system.

Retention Time - refers to the average length of time the sewage is retained within the given process unit within in the sewerage system. It is also known as Residence Time.

Scum - refers to a layer of floating or buoyant materials on the surface of sewage treatment unit such as clarifiers, grease chamber, sludge treatment units.

Sewage - refers to any liquid discharges containing human excreta, animal or vegetable matters in suspensions or solution derived from domestic activities and being generated from household, commercial, institutional and industrial premises including liquid discharges from water closets, basins, sinks, bathrooms and other sanitary appliances but excluding rain water and prohibited effluent.
Sewage Sludge - refers to the residual mixture of solid and liquid produced during the partial or full treatment of sewage but does not include treated sewage effluent discharged through a disposal pipe.

Sewerage System - refers to a system incorporating sewers, disposal pipes, pumping stations or sewage treatment works or any combination thereof and all other structures, equipment and appurtenances (other than individual internal sewerage piping, common internal sewerage piping or septic tanks) used or intended to be used for the collection, conveyance, pumping or treatment of sewage and sewage sludge or the disposal of treated sewage effluent or sewage sludge.

Top Water Level (TWL) - refers to the maximum water level in a channel, process tank, an aeration tank, oxidation ditch or a sludge storage tank or any other sewage treatment structure.

6.0 Secondary Clarifier

6.1 Purpose of Secondary Clarifier

(a) The treated liquid (also known as mixed liquor suspended solids or MLSS) from the biological processes contains high concentration of biomass and large population of micro-organisms. Secondary clarifiers provided allow the solids to settle from the liquid. The clarified liquid is then disinfected before being discharged to the environment.

(b) The solids and biomass settle down in the secondary clarifier are returned (return activated sludge) to the biological treatment system to maintain the MLSS concentration; whereas excess biomass and microorganisms (waste activated sludge) are pumped to the sludge treatment facility.

6.2 Design Requirements

6.2.1 General

(a) Open tanks preferably made of grade 35A reinforced concrete complete with 20 mm thick high alumina cement lining internally. The corners shall be chamfered.

(b) At least two (2) identical tanks to ensure sufficient redundancy, catering for shut-down of any one unit for maintenance.

(c) Proper scum skimmer to remove scum from the surface. The scum collected must be disposed. The air supply pipe to the scum skimmer shall be tapped from the sludge holding tank’s air blower with proper isolation valve and timer.

(d) Appropriate feed and outlet pipes shall be provided with hydraulic consideration.
(e) Proper access for the operations and maintenance of all components of the clarifier. The maintenance platform width shall be 1 m minimum, made of reinforced concrete grade 35A or other non-corrosive material.

(f) Proper lifting facility to remove the Returned Activated Sludge (RAS) and Waste Activated Sludge (WAS) pumps and other equipment.

(g) The pipe size of RAS and WAS pump shall be minimum 80 mm. The pipe shall be designed with gradient to avoid clogging inside the pipe.

(h) Air lift pump is not permitted.

(i) For PE less than or equal to 1,000 a single clarifier is acceptable.

(j) Minimum 1 m side water depth shall be provided.

(k) RAS / WAS Pump shall be equipped with manual valve for isolation and the operation shall be by timer. (Applicable for PE ≤ 5,000).

(l) For 1,000 < PE ≤ 5,000 PE, if 2 nos. of clarifier, 1 duty and 1 standby per tank; if 4 nos. of clarifier, 1 duty per tank and 1 cold standby pump per system shall be provided.

(m) The capacity of standby pump shall be equivalent to the larger capacity of duty pump. All pumps shall be interconnected complete with proper isolation valve.

(n) The requirements of the secondary clarifier are summarised in Table 4.1 and as follows:

**Table 4.1: Requirements of the Secondary Clarifier**

<table>
<thead>
<tr>
<th>Description</th>
<th>Design Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>PE ≤ 5,000</td>
</tr>
<tr>
<td>1. Minimum number of tanks</td>
<td></td>
</tr>
<tr>
<td>2. Tank configuration</td>
<td>Square</td>
</tr>
<tr>
<td>3. Size of square tanks</td>
<td></td>
</tr>
<tr>
<td>• Length: Width</td>
<td>1 : 1</td>
</tr>
<tr>
<td>• Maximum water depth</td>
<td>5 m</td>
</tr>
<tr>
<td>• Floor slope</td>
<td>60° to horizontal</td>
</tr>
<tr>
<td>4. Size of rectangular tanks</td>
<td></td>
</tr>
<tr>
<td>• Length: Width</td>
<td></td>
</tr>
<tr>
<td>• Minimum water depth</td>
<td></td>
</tr>
<tr>
<td>• Width: Depth</td>
<td></td>
</tr>
</tbody>
</table>
### Description

<table>
<thead>
<tr>
<th></th>
<th>Design Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>( \text{PE} \leq 5,000 )</td>
</tr>
<tr>
<td>• Floor slope</td>
<td></td>
</tr>
<tr>
<td>5. Size of circular tanks</td>
<td></td>
</tr>
<tr>
<td>• Minimum water depth</td>
<td>3 m</td>
</tr>
<tr>
<td>• Floor slope</td>
<td>1 : 12</td>
</tr>
<tr>
<td>6. Minimum freeboard</td>
<td>500 mm</td>
</tr>
<tr>
<td>7. Minimum hydraulic retention time (HRT) at ( Q_{\text{peak}} )</td>
<td>2 hours</td>
</tr>
<tr>
<td>8. Surface overflow rate at ( Q_{\text{peak}} )</td>
<td>( \leq 30 \text{ m}^3 / \text{d/m}^2 )</td>
</tr>
<tr>
<td>9. Solids loading rate at ( Q_{\text{peak}} )</td>
<td>( &lt; 150 \text{ kg} / \text{d/m}^2 )</td>
</tr>
<tr>
<td>10. Solids loading rate at ( Q_{\text{avg}} )</td>
<td>( &lt; 50 \text{ kg} / \text{d/m}^2 )</td>
</tr>
<tr>
<td>11. Weir loading rate at ( Q_{\text{peak}} )</td>
<td>( &lt; 180 \text{ m}^3 / \text{day/m} )</td>
</tr>
<tr>
<td>12. RAS / WAS pump per tank</td>
<td>2 units</td>
</tr>
<tr>
<td></td>
<td>(1 duty and 1 standby)</td>
</tr>
<tr>
<td>13. Guide rail for lifting of the RAS / WAS pumps</td>
<td>Double</td>
</tr>
<tr>
<td>14. RAS pumping rate</td>
<td>Continuous</td>
</tr>
<tr>
<td>15. WAS pumping rate</td>
<td>Batch</td>
</tr>
</tbody>
</table>

### 6.2.2 Square Clarifiers

- (a) Total number of tanks shall be even numbers.
- (b) The base of clarifier shall be hopper type with a maximum 1.5 m width.
- (c) Slide gates shall be used at the feed to isolate each tank.
- (d) The feeder pipe to each tank shall be at the centre.
- (e) Stilling box shall be provided at the centre of the clarifier. The material shall be non-corrosive metal or Fibre Reinforced Polyester (FRP) with minimum 10 mm thickness. The box shall be extended to the top of the clarifier and the bottom clearance shall be at maximum of 1.5 m from the base of the clarifier. Minimum width shall be 1 m.
- (f) Minimum number of scum skimmers per tank shall be 2.
(g) Effluent channels shall be provided for all sides.

6.2.3 Rectangular Clarifiers

(a) Flow distribution channel / chamber shall be provided for flow isolation or to equalise the flow distribution.

(b) The minimum settling tank length shall be 3 m.

(c) Maximum width of each tank shall be 6 m.

(d) Baffled inlet with minimum 600 mm immersion shall be provided.

(e) Slide gates shall be used at the feed to isolate each tank.

(f) Rectangular clarifier tanks shall be equipped with travelling scraper combined with scum removal and desludging devices.

(g) Scraper travelling speed shall be between 0.3 – 0.6 m/min. The scraper mechanism comprises a transverse bridge that automatically travels back and forth.

6.2.4 Circular Clarifiers

(a) Flow distribution channel / chamber shall be provided for flow isolation or to equalise the flow distribution.

(b) Circular clarifier shall be equipped with automatic scraping and desludging devices.

(c) The rotation of the scraper shall not exceed 0.03 rpm. A multiple stage reduction unit shall be incorporated to achieve such rotation. The scraper tip travelling speed shall be less than 1.8 m/min.

(d) The type of drive unit for the scraper shall be peripheral drive only. The scraper blades shall be arranged in a volute pattern, designed to transport settled sludge to the central hopper in a single rotation.

(e) Scum baffles preceding the peripheral weir shall be required. Provisions shall be made for scum removal within the drum.

(f) Circular stilling box shall be provided at the centre of the clarifier. The material shall be non-corrosive metal or FRP with minimum 10 mm thickness. Minimum diameter shall be 1 m.

6.2.5 Weirs

(a) The overflow weirs shall be arranged to prevent hydraulic short circuiting, based on hydraulic calculation.

(b) The effluent discharge channel shall be provided with cascading V-notch weirs. Broad crested weirs are not permitted.

(c) The weir shall be provided with slots to allow for level adjustment when required.

(d) All parts of the weirs must be visible and accessible for regular cleaning.

(e) Material for the weirs shall be Ultraviolet (UV) resistant FRP.
6.2.6 Process Control and Operation Regime

(a) The return rates for the RAS pumps shall be capable of returning the critical underflow rate for tanks and provide enough flexibility to operate at flowrates to satisfy the minimum process design requirements.

(b) Secondary sludge wasting from biological suspended growth process shall be initiated on a time basis. Provision shall be made within the control system for operator intervention to adjust the time clock settings for both the frequency and duration of the wasting cycle. A manual override of the timed cycle shall also be provided for maintenance purposes.

7.0 Mechanical and Electrical Requirements

Refer to TS(CT) 03-1:2018 for the mechanical and electrical requirements.

8.0 Other Amenities

Refer to TS(CT) 04-1:2018 for the other amenities requirements.

9.0 Construction Requirements

9.1 General

All construction method shall comply with the relevant Occupational Safety and Health Act (OSHA) requirements for safety.

9.2 Reinforced Concrete Structures

(a) The design of all reinforced concrete structures shall be designed by competent person.

(b) Concrete structures shall be designed in accordance with MS 1195:1991, except that concrete structures for retaining sewage and other aqueous liquids shall be designed in accordance with BS EN 1992-3:2006. Unless otherwise stated elsewhere, the design working life of all reinforced concrete structures shall be 50 years.

(c) The foundation for all concrete structures in the STP shall be designed to withstand uneven settlement when the structures are loaded, as well as buoyancy due to high water table.

(d) Concrete for structures retaining sewage shall have a strength grade not less than grade C35A. Strength grades higher than C35A may be required as design by the competent person.

(e) Concrete for purposes other than structures retaining sewage shall have a strength grade not less than grade C20 where unreinforced, and not less than grade C30 where reinforced.


(g) Cement used shall be resistant to sulphate attack.
9.3 Structural Steel

(a) Structural steel sections shall comply with BS EN 10365:2017 or otherwise with:
   (i) BS EN 10162:2003 for cold rolled steel sections.
   (ii) BS EN 10210:2006 for hot rolled steel sections.
   (iii) BS EN 10025:2004 for weldable structural steel.
   (iv) BS EN 10296-1:2003, BS EN 10297-1:2006 and BS EN 10305:2016 for steel tube.

(b) The use of structural steel in building shall be in accordance with MS 415: PART 1: 1976.

(c) Steelwork that may be in contact with sewage through immersion, splash or spray, or that is over tanks containing sewage, shall be protected against corrosion using one of the following coating systems:
   (i) high build tar epoxy system, complying with AS/NZS 3750.2:2008 and applied in two or more coats to give a total dry film thickness of not less than 200 µm.
   (ii) high build micaceous iron oxide pigmented epoxy system complying with AS/NZS 3750.12:1996(R2013) and applied in two or more coats to give a total dry film thickness of not less 200 µm.
   (iii) hot-dipped galvanised coating of 140 µm nominal thickness in accordance with MS 740:1981.
   (iv) sealed sprayed zinc coating of 150 µm nominal thickness in accordance with BS EN ISO 2063:2017.

(d) Steelwork that is exposed to the external atmosphere, except severe marine atmospheres, shall be protected against corrosion using one of the following coating systems:
   (i) a prime coat of a two packs polyamide cured epoxy zinc phosphate of dry film thickness 60 to 80 µm with a finishing coat of a high build micaceous iron oxide chlorinated rubber paint, spray applied to a dry film thickness of 60 to no more than 80 µm; or
   (ii) hot-dipped galvanised coating of 85 µm nominal thickness, in accordance with MS 740:1981.
   (iii) sealed sprayed zinc coating of 150 µm nominal thickness, in accordance with BS EN ISO 2063:2017.

(e) Steel substrates shall be prepared before application of coatings, in accordance with BS 7079:2009.

(f) Other corrosion protection coating systems for steelwork shall be determined using BS 5493:1977 or AS/NZS 2312:2014 for tropical atmospheres, to provide 20 or more years with low maintenance.
(g) Unprotected steelwork in contact with sewage shall be stainless steel grade 316S31 complying with BS EN 10088: Part 1 and 3:2014 or BS EN 10029:2010 and BS EN ISO 9445:2010.

(h) Successive coatings of the one component shall be tinted a different colour to facilitate overcoating and inspection.

(i) Bolts, nuts, screws and other fasteners shall have either:
   (i) Hot-dipped galvanised, in accordance with MS 739:1981.
   (ii) Sherardized zinc coating, in accordance with BS EN ISO 14713-3:2017.
   (iii) Electro plating.

(j) Washers and other small components shall have either:
   (i) Hot-dipped galvanised, in accordance with MS 740:1981.
   (ii) Sherardized zinc coating, in accordance with BS EN ISO 14713-3:2017.


(l) Fasteners of incompatible material to the component being fastened shall have suitable isolating washers and sleeves.

10.0 Health and Safety Requirements

The following shall be considered throughout the design, construction and installation:

(a) Provide safe ingress and egress.

(b) Provide safe working conditions for workers and operators.

(c) Protect the adjoining properties and the public.

(d) Compliance to Occupational Safety and Health Act 1994 and Factories and Machinery Act 1967 requirements.

(e) All Electrical works shall comply to Akta Bekalan Elektrik 1990 (Akta 448), Peraturan-Peraturan Elektrik 1994 and the relevant IEC Standards.

(f) The following shall be provided:
   (i) All moving parts shall be protected by suitable guards. Where inspection is required, an open mesh with frame and suitably supported maybe used. The maximum aperture of the mesh shall be 6 mm.
   (ii) All guards shall be readily removable and replaceable to the correct orientation only. However the guard shall be designed with features to prevent accidental dislocation from its’ original position. The fasteners when dropped during dismantling, must be easily retrievable and should not damage any equipment or endanger personnel, else fixed fasteners shall be used.
(iii) An emergency stop button, preferably of mushroom head type shall be located adjacent to all equipment. More than one emergency stop button shall be used, if access around the item is restricted.

(iv) Permanent warning signs shall be posted at visible location, dangerous areas and shall clearly indicate the nature of risk at that area. This includes warning signage at low voltage room and other hazardous areas.
This page has been intentionally left blank.