सत्यमेव जयते

MANUAL ON SEWERAGE AND SEWAGE TREATMENT SYSTEMS

PART A: ENGINEERING

THIRD EDITION - REVISED AND UPDATED

MINISTRY OF URBAN DEVELOPMENT, NEW DELHI
http://moud.gov.in

CENTRAL PUBLIC HEALTH AND ENVIRONMENTAL ENGINEERING ORGANIZATION

IN COLLABORATION WITH

JICA

JAPAN INTERNATIONAL COOPERATION AGENCY

NOVEMBER 2013

9.3.8 Advanced Anaerobic - Aerobic Type On-site Treatment System (Johkasou)

There are various kinds of packaged treatment technologies. This subsection describes package type treatment plant, taking Japanese Johkasou as an example, and on-site construction type treatment plant.

9.3.8.1 Classification of Treatment Systems

Treatment systems are classified into various types according to capacity and performance.

i. Capacity

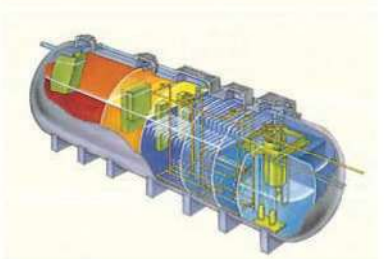
Treatment systems are classified into three types according to capacity: a small-scale unit is for several to more than a dozen people, who live in individual houses, a medium-scale system is for up to hundreds of people, who live in a condominium or small village and a large-scale system is for thousands of people in a large commercial building or factory.

Package-type is applied from small to large-scale systems. When unit is applied to large-scale, multiple tanks are connected. Package-type is made from plastics such as GFRP (Glass fibre reinforced plastics) or steel plates (that depends on the treatment method), so they can be manufactured in a factory.

The on-site construction type is made from RC and constructed on-site, so it looks nearly like a small-scale sewage treatment plant.

The classification according to the treatment capacity is mentioned in Table 9.9

Table 9.9 Classification according to treatment capacity (Example of Japan)

Package-type			On-site construction-type
Small-scale	Medium-scale	Large-scale	Medium/Large-scale
(About 5 to 50 people)	(About 51 to 500 people)	(Approx. 500 to 5,000 people)	(More than 500 people)
			

ii. Performance

Treatment processes are classified into three kinds according to performance:

1. Process that mainly removes BOD-related contaminants,
2. Process that removes BOD-related contaminants and nitrogen, and
3. Process that removes BOD-related contaminants, nitrogen, and phosphorus.

In addition, advanced treatment for better effluent quality is possible by applying membrane separator or flocculation separation or activated carbon adsorption, etc. Some package-types contain membrane separator unit in it. The classification according to the treatment performance is mentioned in Table 9.10.

Table 9.10 Classification according to treatment performance (Example of Japan)

Type	Treatment Method	Treated water quality, mg/L		
		BOD	T-N	T-P
Package type Small scale Medium scale Large-scale	BOD reduction	≤20	—	—
	Nitrogen removal	≤20	≤20	—
	Nitrogen and phosphorus removal	≤20	≤20	≤1
	Membrane separation	≤5	—	—
	Nitrogen and phosphorus removal	≤5	≤10	≤1
On-site construction Type Medium scale Large scale	Contact aeration	≤20	—	—
	Activated sludge			
	Flocculation separation (A)	≤10	—	≤1
	(A) and activated carbon absorption	≤10	—	≤1

9.3.8.2 System Configuration

A treatment system consists mainly of pre-treatment, main treatment, advanced treatment (if necessary), and disinfection processes.

i. Pre-treatment process

This process removes insoluble substances that are difficult to decompose biologically by means of sedimentation, floating, and screening. In the large-scale system, a flow equalizer is planned for stabilizing the biological treatment.

ii. Main treatment process

The main treatment process biologically removes BOD-related contaminants by aerobic treatment and removes nitrogen by combination of anoxic and aerobic treatment. The system employs a sedimentation tank for solid-liquid separation in most cases, but use of a membrane separator in place of the sedimentation tank makes it possible to downsize the system and to improve the quality of treated sewage further.

iii. Advanced treatment process (to be installed if necessary)

This process removes COD-related contaminants and phosphorus from the biologically treated sewage by means of flocculation sedimentation, sand filtration, activated carbon absorption, and dephosphorization.

iv. Disinfection process

This process disinfects E. coli and other bacteria to make effluent water safer.

9.3.8.3 Example Design in Japan

- Treatment flowchart and system configuration

Figure 9.16 shows the flowchart and configuration of a package-type treatment system based on the “anaerobic filter and contact aeration method (for BOD reduction)” as an example. This system consists of anaerobic filter, contact aeration, sedimentation, and disinfection tanks.

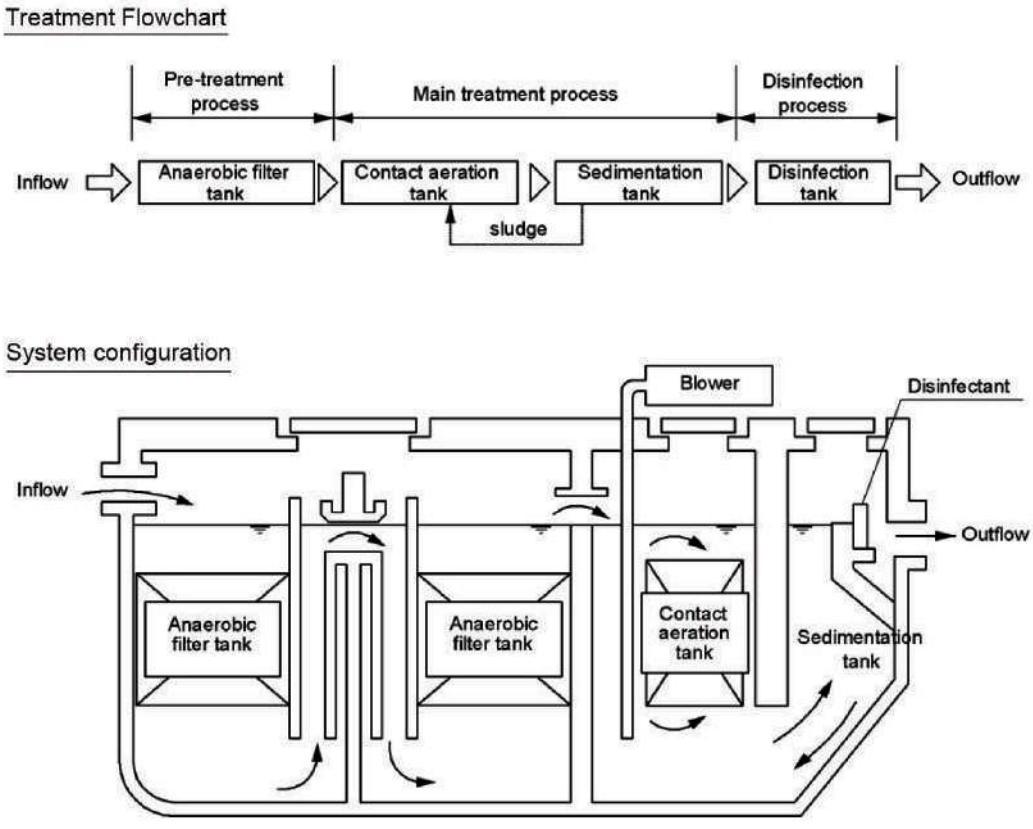


Figure 9.16 Treatment system based on the anaerobic filter and contact aeration method

• Outline of the system components

- Anaerobic filter tank

The main purpose of this tank is to remove solid matter that cannot be removed by biological treatment. In addition, anaerobic microorganisms adhering to the surface of the filter media submerged in this tank decompose part of BOD-related contaminants.

- Contact aeration tank

In this tank, the aerobic microorganisms are activated by the air supplied by blower and biodegradation takes place. That is, BOD-related contaminants are consumed and decomposed by the microorganisms. The contact media is installed in this tank and microorganisms are adhered on it to improve contact efficiency. Introduction of moving bed bioreactor (MBBR) contributes to reduce size of the package-type.

- Sedimentation tank

The purpose of this tank is solid-liquid separation. Supernatant and sludge contained in biologically treated sewage are separated by gravity sedimentation. Supernatant is transferred to subsequent process and the settled and separated sludge returns to the previous tank, resulting in a gradual rise in the sludge concentration of the aeration tank.

- Disinfection unit

This process disinfects E. coli and other bacteria contained in the supernatant from sedimentation tank to make effluent water safer. As the disinfectant, solid chlorine is used.

• Example specifications

Table 9.11 (overleaf) shows a package-type treatment system for 10 persons.

ii. On-site construction-type

• Treatment flowchart and system configuration

As an example of on-site construction-type treatment systems based on “the contact aeration method and the flocculation sedimentation method,” Figure 9.17 (overleaf) shows the flowchart and configuration. This system consists of a screen, a flow equalization tank, a contact aeration tank, a flocculation sedimentation tank, a disinfection unit, and a sludge treatment unit.

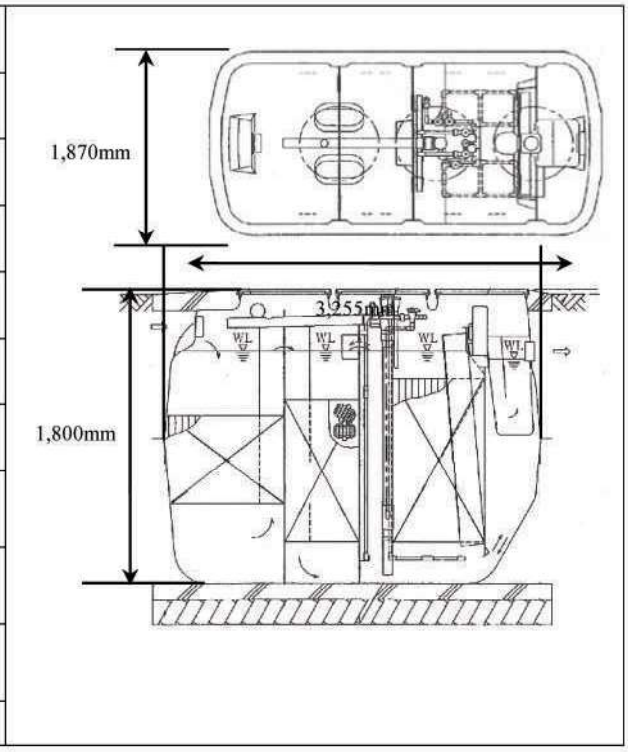
• Outline of the system components

- Screen

The purpose of this screen is to remove foreign matter. The screen is classified into three types according to mesh size: the coarse, fine and micro screens. A combination of them is planned according to the characteristics of sewage.

Table 9.11 Example specifications for a package-type treatment system in Japan

Capacity (A)	
10 Persons (2.0 m^3/day*)	
Weight (equipment only)	
470 kg	
Main body material	
FRP	
Tank volume, Equipment capacity	
Anaerobic filter tank	No. 1: 2.13 cum No. 2: 1.414 cum
Contact aeration tank	2.037 cum
Sedimentation tank	0.717 cum
Blower	120 L/min × 130 W



(A):The daily amount of sewage per person is 200 L.

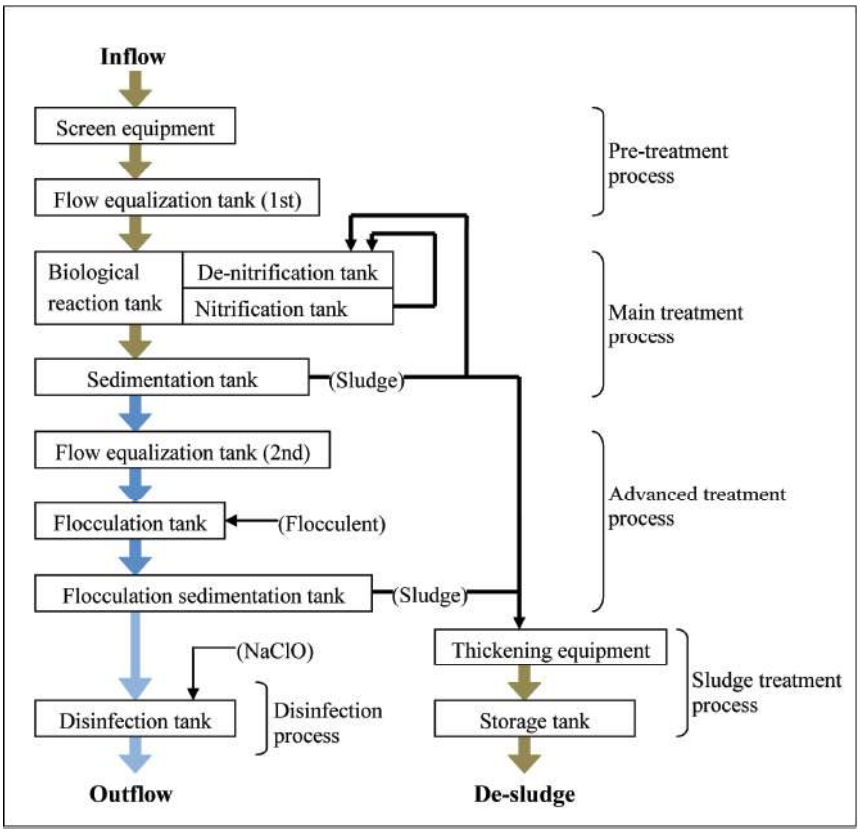


Figure 9.17 Flowchart of the contact aeration method and flocculation sedimentation method

- Flow equalization tank

  In the on-site small-scale treatment system, load changes due to rise or reduction in the flow rate of sewage and have a direct impact on the biological treatment function. This tank is installed before the biological reaction tank to have a stable load on it. The capacity of the flow equalization tank shall be specified according to changes in the flow rate of sewage.

- Contact aeration tank

  This unit consists of contact aeration and sedimentation tanks. The former is filled with a contact media to form and put biological film on the media surface and to biologically treat the sewage by letting it come into contact with the film under aerobic conditions. The contact aeration tank is equipped with an aerator that maintains the aerobic environment, and a back washing machine that removes biota generated excessively from the contact media.

- Flocculation sedimentation tank

  This tank removes COD-related contaminants and phosphorus by adding a flocculent to the sewage. The agent is classified into two types: one is an aluminium coagulant (e.g. aluminium sulphate) and the other is a ferric flocculent (e.g. polyferric sulphate). The unit consists of flow equalization, flocculation and flocculation sedimentation tanks.

- Disinfection unit

  This unit disinfects the treated effluent. Solid or liquid (sodium hypochlorite) chlorine is used as the disinfectant.

- Sludge treatment unit

  This unit receives and stores sludge generated in the biological reaction and flocculation sedimentation tanks. In certain circumstances, a sludge thickening or dehydrating unit may be planned. The stored sludge shall be regularly extracted and delivered to the outside. An example of designing an on-site construction-type sewage treatment system is shown in Appendix A.9.3.

9.3.8.4 Features

i. Advantages

- Since package-type treatment equipment can be fully manufactured in a factory, quality control of the product is easy and the price can be reduced due to a mass production effect.
- A treatment system for home use (5 to 10 persons) requires an area of 3 to 5 m^2; that is to say, it is a compact system. Moreover, when it is installed underground, the space above can be used for several purposes such as a garage.
- This system, being a product manufactured in a factory, does not require complicated work on site during installation, so the installation time is short (about one week). Accordingly, it can improve environmental sanitation quickly.

- The treatment system requires running costs, such as electric charges and chemical expenses, and the treated water is comparable to that of conventional treatment system. In addition, planning advanced treatment can result cleaner effluent and remove nitrogen and phosphorus.
- Where membrane separator is applied, BOD contained in the effluent is reduced to less than 5 mg/l, and the treated effluent can be reused for various purposes.
- The treatment system can be constructed more cost-effectively and faster, because sewer is shorter compared with conventional system, especially in areas with low-medium population density, areas that have not been covered by sewer and individual houses or buildings.

ii. Notes on application

Keeping the performance of a treatment system high requires proper maintenance, which varies depending on the scale and treatment method of the system. Common works to achieve this are listed below. Each work requires expertise, so it is necessary to build up an implementation system, to train inspectors (vendors), and to educate users to increase their awareness of the importance of maintenance. For more information about the maintenance of treatment systems, see Part B Operation and Maintenance.

- Maintenance and inspection

  Inspecting mechanical components including the blower, replenishing tanks with chemicals including disinfectants, etc.

- Water quality check

  Checking the aeration tank for DO testing the quality of the discharged water, etc.

- Cleaning

  Removing foreign matter from the screen and extracting generated sludge.

9.4 DECISION MAKING FOR ON-SITE TREATMENT TECHNOLOGY

9.4.1 General

Employing on-site sewage treatment technology requires an in-depth survey of requirements of the installation site, such as the volume and quality of treated sewage, the selection of a method based on the resulting data and the determination of the scale. After the determination of the basically required performance and scale, the treatment method shall be chosen in consideration of the following requirements:

i) The method shall be as simple as possible.

ii) The maintenance shall be easy.

iii) The construction and maintenance costs shall be low.