APPENDIX – A4-1

New Technology related to Sewerage Facilities

New Technology related to Sewerage Facilities

Sewerage facilities have a vital role to play in ensuring a hygienic and comfortable life by improving the living environment and preserving a satisfactory water environment through appropriate treatment of sewage and rain water.

However, large amount of energy and enormous resources are necessary for the construction, operation and maintenance of sewerage systems that contribute to preserving such a comfortable living environment and satisfactory water environment. Moreover, environmental loads are also imposed, such as generation of greenhouse gases.

India too needs to take steps to prevent global warming, achieve sustainable development and build up a recycling-oriented society. This necessitates energy and resource conservation within the sewerage system itself, which in turn requires the introduction of new technologies.

Considering the increase in sewerage systems in India and the present status, technology is needed to spread sewerage systems efficiently and effectively across the country. Introduction of technologies that facilitate operation and maintenance of facilities at economic construction cost and O&M cost is demanded. Furthermore, introduction of technology for recycling treated effluent as a measure against deficient water resources, effective utilization of sludge and energy recovering technology for building up a recycling-based society, space-saving technology in urban areas with limitations on sites for sewerage facilities, and introduction of other technologies are also necessary.

New technologies are demanded in sewerage facilities in India to achieve the following:

- ✓ Reduce construction cost, and operation and maintenance cost
- ✓ Improve treatment functions
- ✓ Improve operation and maintenance capability
- ✓ Re-use treated effluent
- ✓ Effectively use sludge
- ✓ Recover resources and energy.

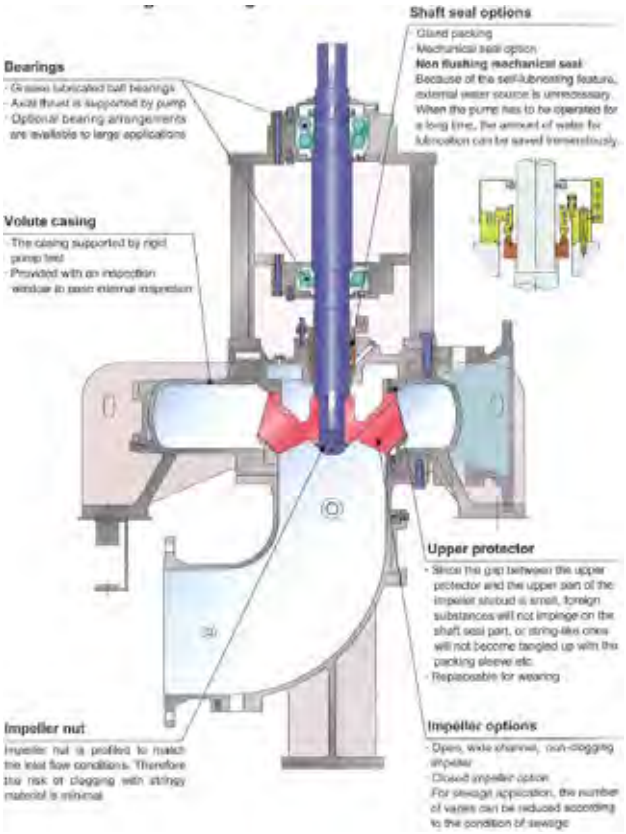
In this chapter, new technologies that meet the objectives stated and their overview are introduced in the following three fields:

1) Management of sewerage system
2) Sewerage facilities
3) Operation and maintenance of sewerage facilities

1 Pump

(A) CFV Vertical Volute Casing Pump

Trade name : TORISHIMA CFV Vertical Volute Casing Pump
Application : Rain water drainage, Sewage transfer, etc.
Performance range : (Head) 5 to 120m (16 to 390 ft)
(Capacity) 180 to 72,000m3/min (790 to 317,000 U.S.gpm)
(Size) 200 to 3,000mm (8” to 120”)
Specialty : - solid handling design to prevent clogging of the pump casing and impeller
- ease of maintenance; the rotating assembly can be withdrawn from the casing without disconnecting the pipings
- vertical type saves the installation space
- flexible installation single-floor type, two and three-floor type installations available
Company : Torishima Pump MFG. Co., Ltd.
Figure :



(B) SPV Vertical Mixed-Flow Pump

Trade name : TORISHIMA SPV Vertical Mixed-Flow Pump

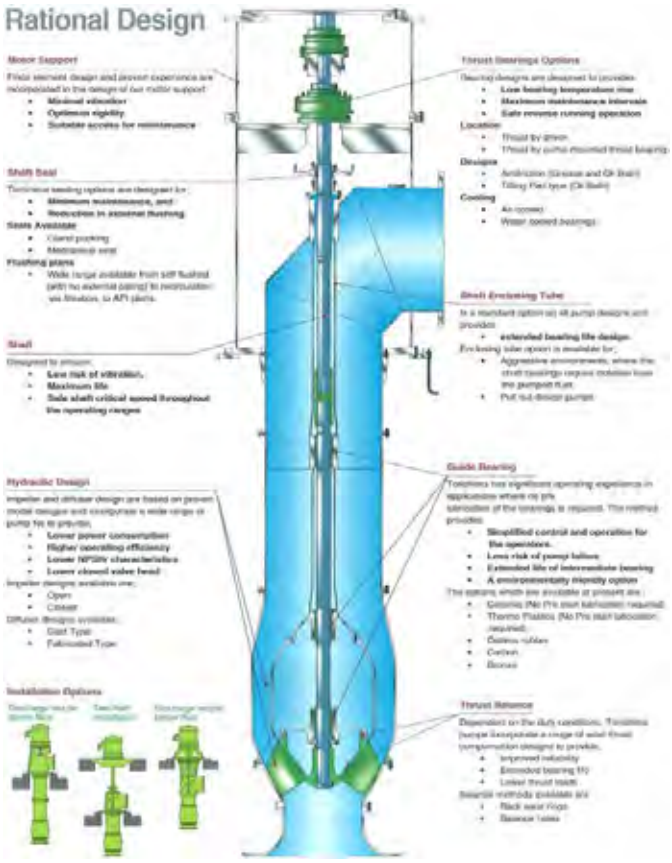
Application : Sewage transfer, Sludge transfer etc.

Performance range : (Head) up to 100m
(Capacity) up to 1,360m3/min (360,000 U.S.gpm)
(Temperature) up to 80 C (176 F)
(Size) 300 to 2,800mm (12” to 110”)

Specialty : - provide a wide range of expertise in material selection of pump diffuser casing & impeller, shaft, discharge bend and rising main
- provide a wide range of technical design services to support the mixed flow bowl pump through the product lifecycle

Company : Torishima Pump MFG. Co., Ltd.

Figure :



(C) KKD Pump

Trade name : EBARA KKD Pump

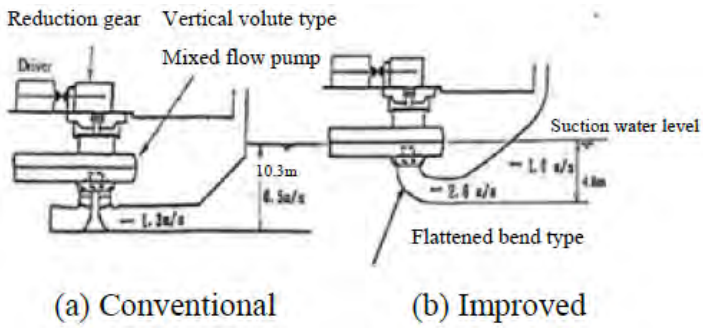
Application : Rainwater drainage

Outline : (Pump type) Vertical shaft mixed flow pump
(Discharge capacity) 1.5m3/s to 10m3/s (per unit)

Specialty : - Use of higher Specific Speed to downsize the pumping equipment effected along with improvement in suction performance
- Use of higher flow velocities at pump suction and discharge
- Use of higher flow velocities in suction approach with improved sump configuration for large vertical units- provide a wide range of expertise in material selection of pump diffuser casing & impeller, shaft, discharge bend and rising main

Company : EBARA CORPORATION

Figure :



2 Sewage Treatment Facility

(A) Grinder

Trade name : Sumi cutter

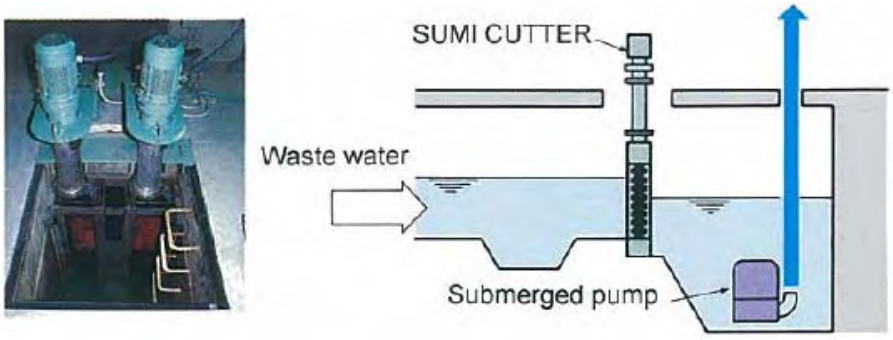
Application : Influent channel, Sludge pipeline, etc.

Outline : Sumi cutter can effectively grind solid bodies such as cloth, woods and empty cans floating in the sewage, and prevent problems such as damage to sewage plant equipment or clogging of sewage pipes

Specialty : - protect sewage plant equipment
- functionable in the water
- superior grinding performance
- site control panel (option) enables complete unmanned operation
- self cleaning mechanism

Company : Sumitomo Heavy Industries Co., Ltd.

Figure :



(B) Diffuser, Aerator

(B-1) Aerowing

Trade name : Aerowing

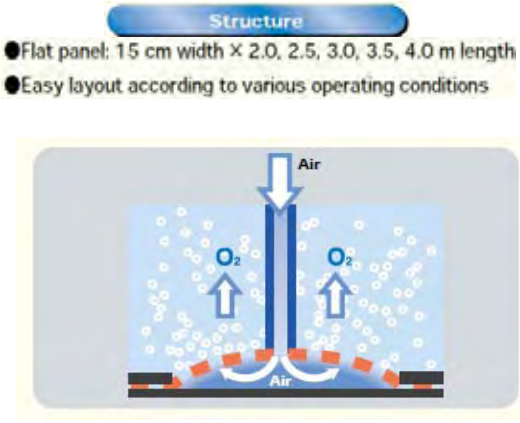
Application : Biological reaction tank

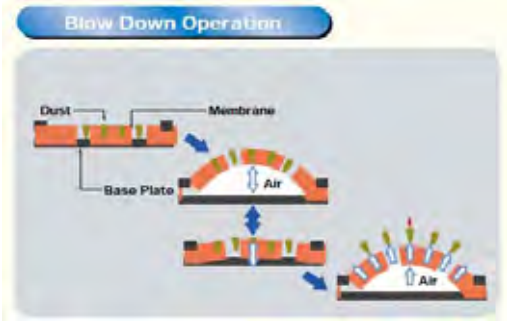
Outline : The fine bubble diffuser is comprised of the special membrane attached to stainless steel board. Inner pressure of membrane exceeds 500mmAq by air supply, stomas of membrane are opened and fine air bubbles of about 1 mm diameter are made.

Specialty : - fine air bubbles of about 1 mm diameter attains more than two times higher oxygen transfer efficiency, reduces required air by 50%, and saves the blower energy by 50 %.
- non-clogging membrane diffuser is durable for 10 to 15 years.
- capable of intermittent operation
- maintenance free
- easy layout according to various operating conditions

Company : SANKI Engineering Co., LTD.

Figure :





(B-2) Ataka Membrane Diffuser

Trade name : Ataka Membrane Diffuser

Application : Biological reaction tank

Outline : Ataka Membrane Diffusers yield high oxygen transfer efficiencies by use of special membranes.
Three types of diffuser shape are available to deal with various conditions, ranging from increase, remodeling, or renovation of sewage treatment facilities to replacement of diffusers alone while utilizing existing facilities.

Specialty : - Ultrafine bubbles bring high oxygen-transfer efficiencies.
- Low pressure loss can reduce power for blowers.
- Low pressure loss enables parallel operation with existing diffuser facilities at the same water depth.
- A lineup of Japan's first domestic membrane diffusers
- Special EPDM membranes maintain quality for a long time.
- Even when operation is stopped, pores are protected from clogging; this allows intermittent operation.

Company : Daiki Ataka Engineering Co., Ltd.

Figure :

panel type

tube type

disc type

(B-3) High-Density Installation Type Air Diffuser

Trade name : High-Density Installation Type Air Diffuser

Application : Biological reaction tank

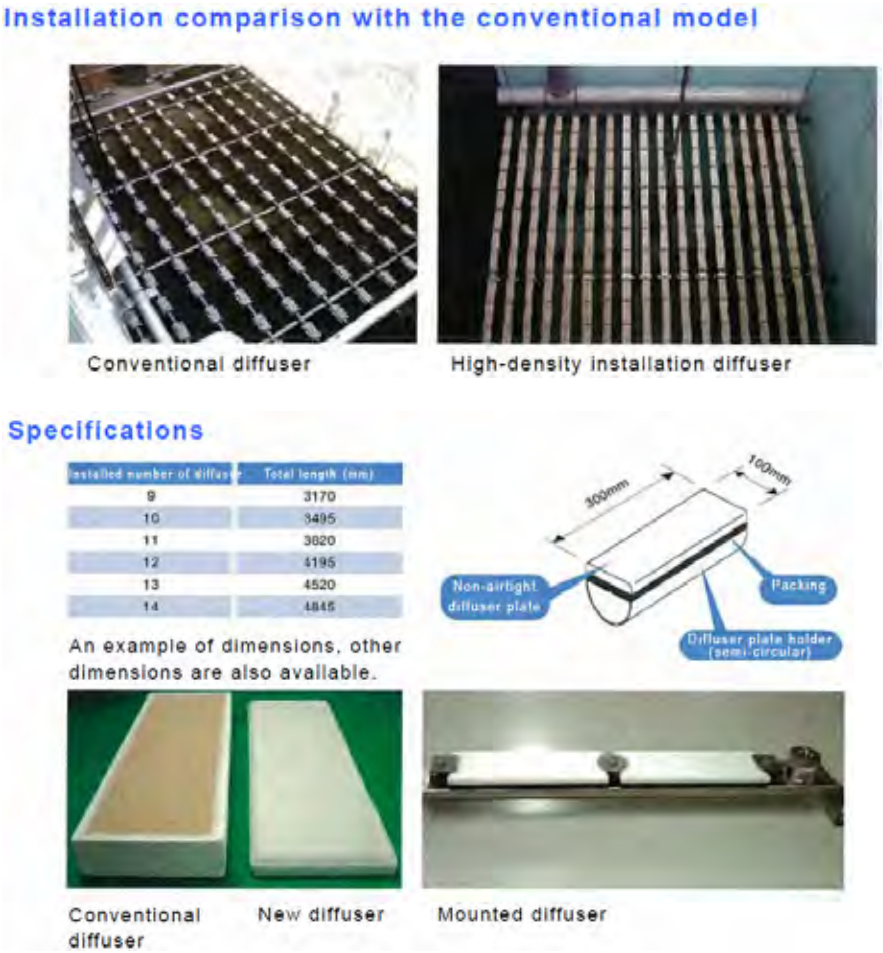
Outline : The recent promotion of advanced wastewater treatment has increased the overall oxygen requirement for aeration tanks. Furthermore, carrier and nitrification denitrification systems require the installation of many air diffusers within limited space – i.e. at a high density. To meet this demand, we have developed an air diffuser suited for such installation and with enhanced oxygen transfer efficiency.

Specialty : - Enhanced oxygen transfer efficiency.
- High-density installations of diffuser plate holders

- Increased effective aeration area of the diffuser
- Enhanced carrier fluidity
- Environmentally friendly.

Company : METAWATER Co., Ltd.

Figure :



(B-5) Submerged Mechanical Aerator/Agitator

Trade name : AQUARATOR

Application : Biological treatment process

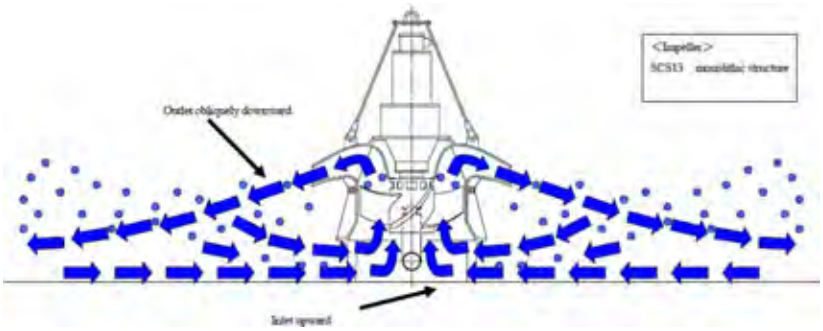
Outline : AQUARATOR improves the functions needed for aeration by separating the power sources for the air supply function and the air diffusion function, and logically embodying the latter function in a submerged machine, thereby significantly improving the power efficiency in aeration (Ministry of Construction in Japan: Technology Evaluation No. 81102).

Separating the power sources enables it to function as a submerged agitator for both anaerobic and aerobic applications, and can be easily be optionally selected for standard methods, or for anaerobic or aerobic processes according to the method for sewage disposal.

Motor Power – from 1.5 to 30 kW.

Specialty : - No clogging
- Free Anaerobic/Aerobic Agitating
- Easy to Control Air Volume and Variable Speed
- Easy and Economical Maintenance
- Easy Installation and Transfer, Simple Servicing
- Ambient noise, and no occurrence of Foul smell, Flying septage

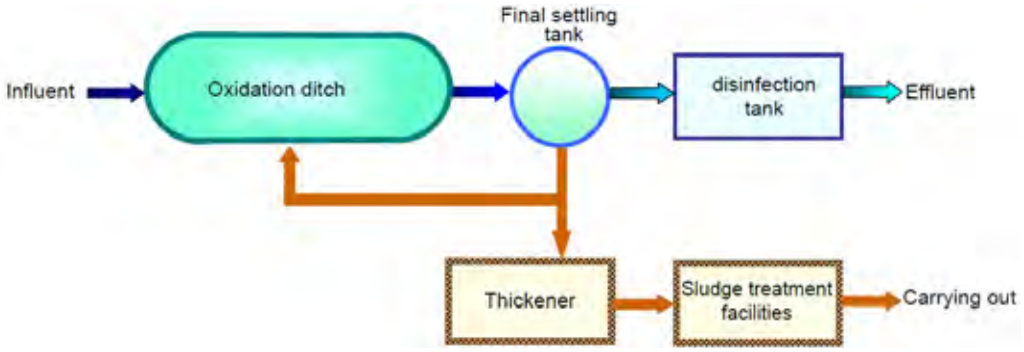
Company : Hanshin Engineering Co., Ltd.
Figure :



(C) Oxidation Ditch

The oxidation ditch (OD) is a sort of equipment used for a long-term aeration. It consists of a long channel of an elliptical or circular shape equipped with mechanical aeration devices for generating a water flow and stirring water in the channel to supply oxygen. Thought it requires a relatively large area, it has a simple structure and can be easily operated as well as being able to remove nitrogen easily. Thus, it has recently been widely used in relatively small wastewater treating plants. Typically, primary sedimentation tank is not installed.

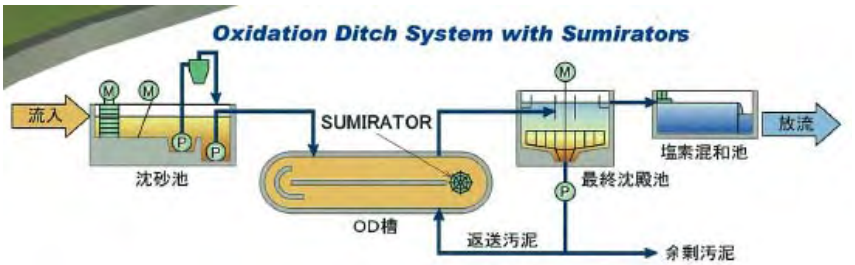
Several types of aerator are used for oxidation ditch system.



Source: Japan Sewage Works Agency

(C-1) Vertical shaft type aerator for oxidation ditch system

Trade name : Sumirator
Application : Oxidation ditch
Outline : Vertical shaft type aerator has 4 functions
-circulating function
-pumping function
-aerating function
-spiral flow function,
Specialty : -simple structure and easy operation
-high efficiency of oxygen transfer rate and less power consumption
-less maintenance & damageable & wear points due to direct coupling of Motor, reduction gear and impeller
-Low noise and splashing due to Low revolution of the impeller
Company : Sumitomo Heavy Industries Co., Ltd.
Figure :



Sumirator

(C-2) Horizontal axis type aerator for oxidation ditch system

Trade name : Aqua-rotor

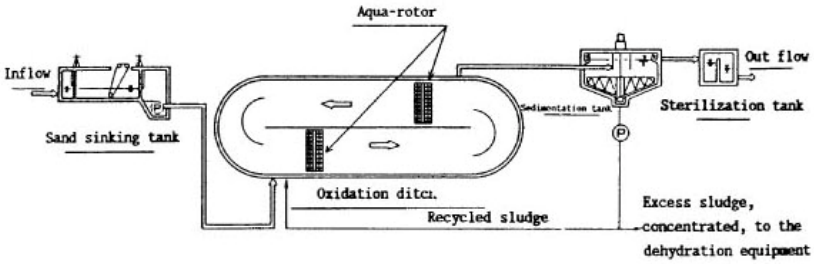
Application : Oxidation ditch

Outline : The aqua-rotor aerates by rotating a shaft equipped with a number of L-shaped blades. The aqua-rotor generates a stirring flow in the up-down and right-and-left directions. It exerts a high performance with an efficiency of 2-2.5 kg·O_2/kWh and 2 to 3 kg·O_2/(m·h)

Specialty : - It can be easily maintained
- It is hard to be effected by load fluctuations and forms only a little sludge
- OD can be easily controlled by changing the rotation of the rotor and the dipping depth
- It requires relatively little energy as the rotor is operated efficiency
- It can perform nitrification and denitrification easily

Company : METAWATER Co., Ltd.

Figure :



Aqua-rotor

(C-3) Submerged Propeller OD system

Trade name : Submerged Propeller OD system

Application : Oxidation ditch

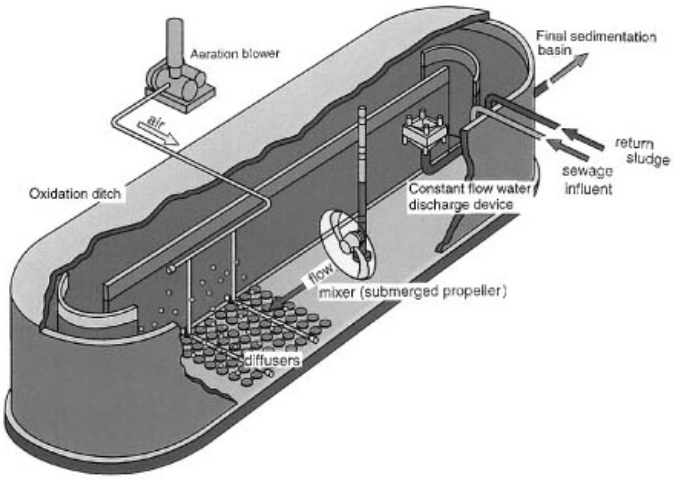
Outline : In this system, aeration and stirring are done in separate units, which enables adjustment of the volume of the oxygen supply without affecting the flow velocity. The activated sludge mixture is stirred and the flow velocity is generated by rotating the submerged propeller in the water inside the ditch. Oxygen is supplied by supplying air with a blower to the diffuser installed at the bottom of the ditch, thereby generating bubbles.

Specialty : - Since the diffuser and stirring device are independent sewage can be stirred inside the tank with the submerged propeller even when air supply to the diffuser is stopped. Complete an-aeration operation is possible.
- The installation area can be minimized because the water depth (5-6 m) is greater than that of a conventional unit (2-3 m)
- Since the membrane rubber diffuser disc generates minute bubbles of about 2 mm, the submerged propeller is installed across the watercourse, and water

flows inside the ditch, highly efficient oxygen solution can be obtained

Company: JFE Engineering Corporation
Ebara Engineering Service Co., Ltd.

Figure :



(D) DHS-Biotower

Trade name : DHS-Biotower

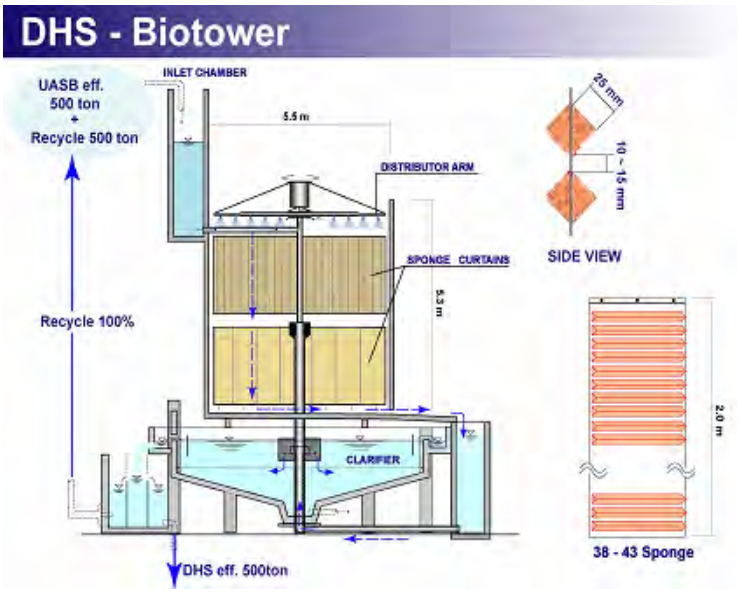
Application : Post treatment for UASB

Outline : UASB wastewater treatment plants have several advantages, such as low energy consumption, low excess sludge, stable operation against fluctuations of raw water quality, etc. However, treated water quality is not so good compare with activated sludge process.

DHS (Down flow Hanging Sponge) post-treatment can enhance the treated water quality discharged from UASB to the same level of activated sludge process. DHS System is composed of aerobic bio-media sponge and the mechanism is so simple that easy operation and maintenance can be achieved.

Company : Ebara Engineering Service Co., Ltd.

Figure :



(E) Non-Aeration Wastewater Treatment System

Trade name : Non-Aeration Wastewater Treatment System

Application : Sewage Treatment

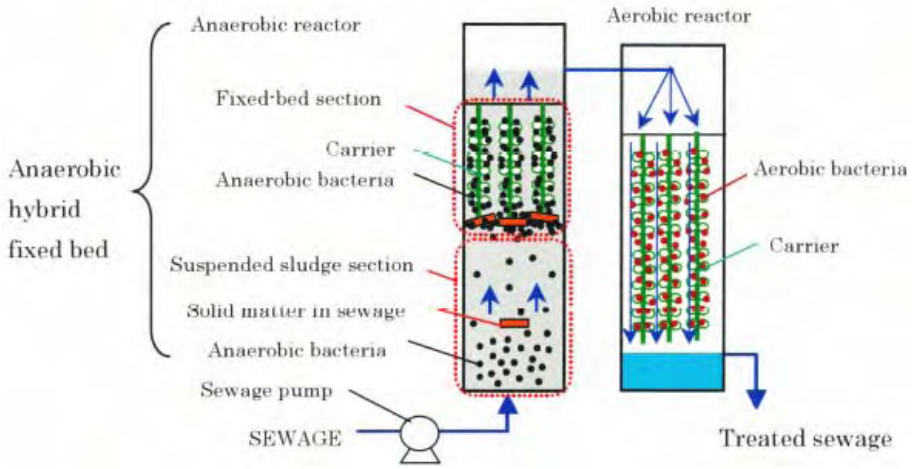
Outline : This system comprises tow processes, an anaerobic reactor using anaerobic self-granulating bacteria (granules) and an aerobic treatment, and this system has the characteristic of using an anaerobic reactor that combines a suspended sludge section and a fixed-bed section utilizing a carrier.

Specialty : - A decrease in the quantity of SS and bacteria in the treated sewage by entrapping SS and holding bacteria onto the carrier

- An increase in the upward flow velocity compared relative to that of UASB, and thereby an anticipated decrease in the time needed for treatment.
- Target performance : Compared to the conventional activated sludge process,
  1) It ensures a consistent level of treated-sewage quality throughout the year (BOD: 15 mg/l or less, SS: 15 mg/l or less)
  2) It decreases the annual energy consumption by 30%
  3) It decreases the annual sludge volume by 30%

Company : The joint research of Japan Sewage Works Agency and Toshiba Corporation (Period of the joint research: Oct. 2008 to Mar. 2011)

Figure :



(F) MBR (Membrane Bioreactor)

(F-1) MACBIO Process

Trade name : MACBIO Process

Application : Biological reaction tank

Outline : The MACBIO Process is comprised of membrane separation equipment as well as other incidental equipment. The main component of the separation equipment is the Zenon hollow fiber membrane.

Specialty : - No need for a settling tank, space saving, easy management

-High MLSS operation is possible, as well as compact reaction tank

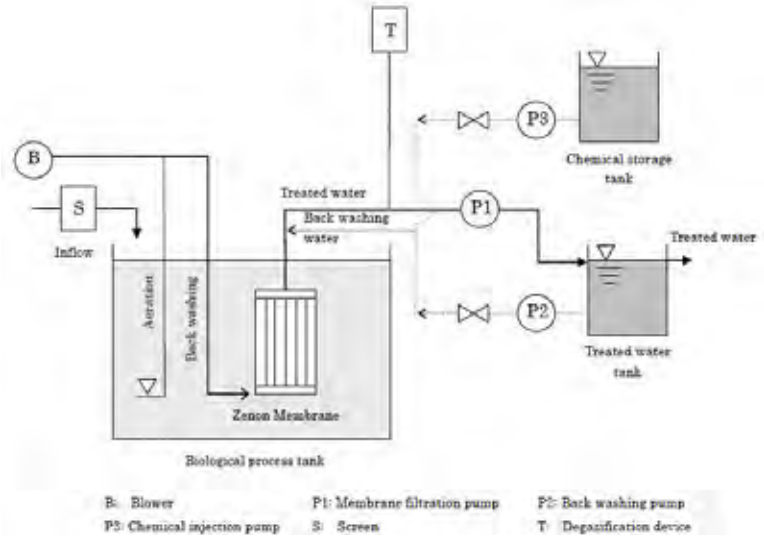
Because the process has a high solids/liquid separation function, high MLSS operation (10,000-15,000 mg/L) is possible; therefore, the reaction tank capacity can be compact.

-High quality effluent can be attained

Bacteria such as e.coli and pathogenic protozoa (Cryptospordium, etc.) contained in water undergoing treatment can be removed when the treated water passes through the small 0.1 μm pore diameter membrane. High quality, safe and sanitary treated water can be attained.

Company : NISHIHARA Environment Technology Inc.

Figure :



(F-2) Membrane Bio-Reactor system

Trade name : Membrane Bio-Reactor system

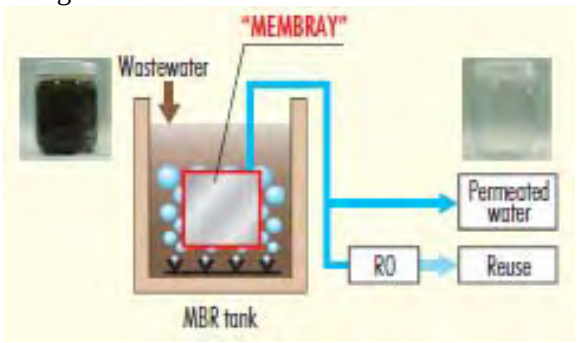
Application : Biological reaction tank

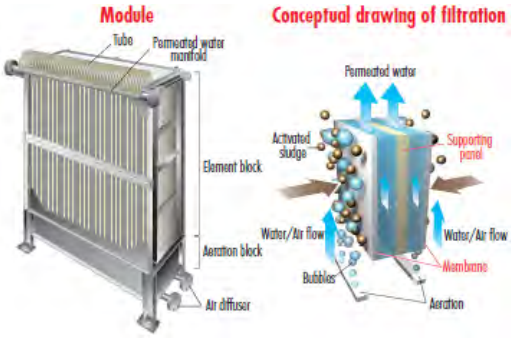
Outline : The conventional activated sludge method (CAS) has bio-reactor and sedimentation tank. As MBR system separates sludge using membranes inside bio-reactor, sedimentation process is not required.
In this system, Toray's MEMBRAY submerged flat sheet membrane module is used.

Specialty : - High quality treated water
- Small footprint
- Treated water can reuse for irrigation and construction
- Combining with RO allows recycling for cooling water …etc
- Maintenance is easy
- More than 30 sites installation including 30,000 m3/day STP (2009, Jeddah KSA)

Company : Suido Kiko Kaisya Ltd.

Figure :





(F-3) Hitachi Submerged Membrane Bioreactor Systems

Trade name : Hitachi Submerged Membrane Bioreactor Systems

Application : Biological reaction tank

Outline : "Hitachi Submerged Membrane Bioreactor Systems" jointly developed by Japan Sewage Works Agency and Hitachi Plant Technologies is an advanced biological treatment technology. It is suitable for sewage treatment facilities and industrial

wastewater treatment facilities, as it is low maintenance, space saving, has low initial costs and features an advanced treated water quality by combining activated sludge treatment and submerged membrane filtration processes.

Specialty : - Low Maintenance

Clog-resistant : simple flat sheet flat sheet membrane design

Low maintenance: as sludge sedimentation tank is not required

Easy inspection: as membrane modules adopt flat sheet membrane elements with a large surface area

- Space Saving

No sedimentation tank is required, as excess sludge is separated by membranes

Shorter treatment times and compact design

Sludge concentration tank is not required, as excess sludge is of high density and can be immediately dehydrated

- Low Cost

Simple and compact design leads to initial cost saving

Reduced sludge disposal cost, as less excess sludge is produced

- High Quality Treated Water

Capable of removing phosphorus and nitrogen in 6 hour retention times

It is also capable of removing Coliform Bacteria through MF membranes and viruses are absorbed by high density activated sludge

Treated water can be recycled for landscape watering. It can be also used for industrial water or air-conditioning cooling water when altering existing MF membranes with RO membranes

- High Reliability

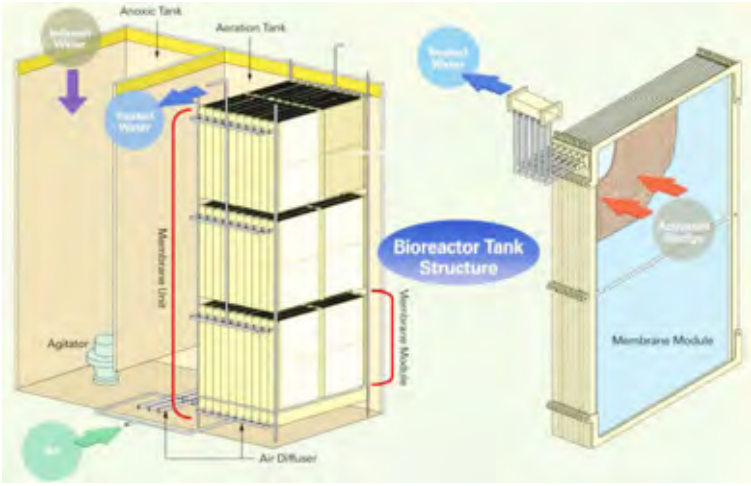
It uses PVDF membrane made by advanced resin processing technology

- Energy Saving

Blower energy requirement are lowered by positioning membrane modules in a vertical formation to reduce the volume of pumped air required to clean membrane surfaces

Company : Hitachi Plant Technologies Ltd.

Figure :



(F-4) Submerged Membrane Unit

Trade name : KUBOTA Submerged Membrane Unit

Application : Biological reaction tank

Outline : The Membrane Unit consists of a Membrane Case (Upper part) and a Diffuser Case (Lower part). The membrane case houses multiple membrane cartridges that are connected to a manifold pipe via transparent tubes, while the diffuser case

houses a diffuser. You can pull out individual membrane cartridges for maintenance work. The membrane sheet is made from Chlorinated Polyethylene with a nominal (maximum) pore size of 0.4μm (average: 0.2μm).

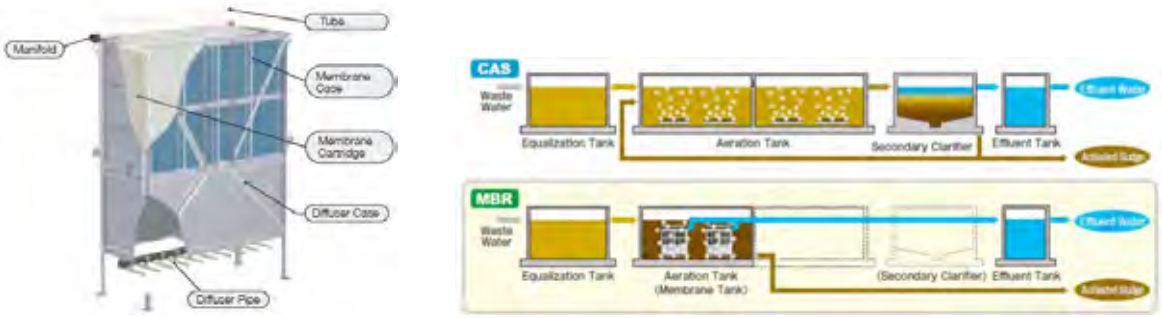
Specialty : -Diffuser Cleaning:Easy maintenance with unique system

By opening the cleaning valve, you can clean the diffuser system utilizing a backflow of mixed liquor and air. This valve is closed during aeration. If a magnetic valve is installed, this operation can be performed automatically.

- Simple Structure
-Simple Chemical Cleaning
- Simple Maintenance
- Simple Replacement

Company : KUBOTA Corporation

Figure :



(F-5) PTFE Membranes

Trade name : PTFE Membranes

Application : Biological reaction tank

Outline : The membrane module of hollow fiber is made from PTFE (Poly-Tetra-Fluoro-Ethylene) with nominal pore size 0.2μm.

Specialty : - Chemical resistance (pH 1-14), highly Alkali resistance

Remove fouling material by Alkali and Acid washing.

Quickly restore the original permeability after chemical cleaning, ensuring stable operation for a long period of time.

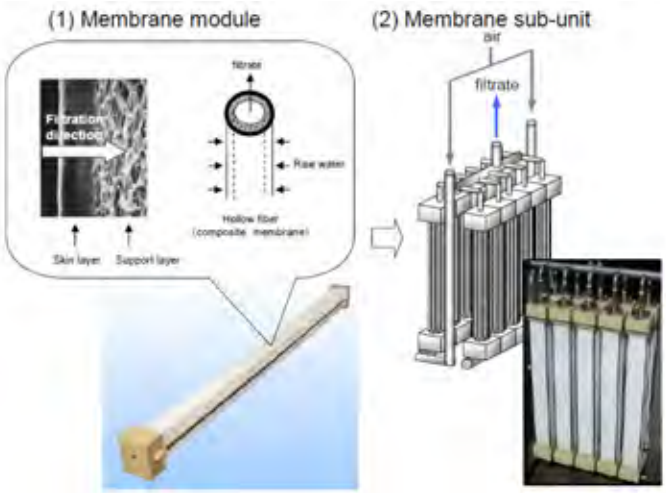
- Excellent Mechanical strength/long-life

Six times the tensile strength of other organic membranes.

Less mechanical damage and long-life cut the running cost.

Company : Maezawa Industries, Inc.

Figure :



(G) SBR (Sequencing Batch Reactor)

Trade name : IC Process (Intermittent Cyclic Activated Sludge Process)

Application : Biological treatment

Outline : The installation consists of two identically equipped tanks with a common inlet, which can be switched between them. The tanks have a "flow through" system, with raw wastewater (influent) coming in at one end continuously and treated water (effluent) flowing out the other intermittently. While one tank is in settle/decant mode, the other is aerating and filling mode.

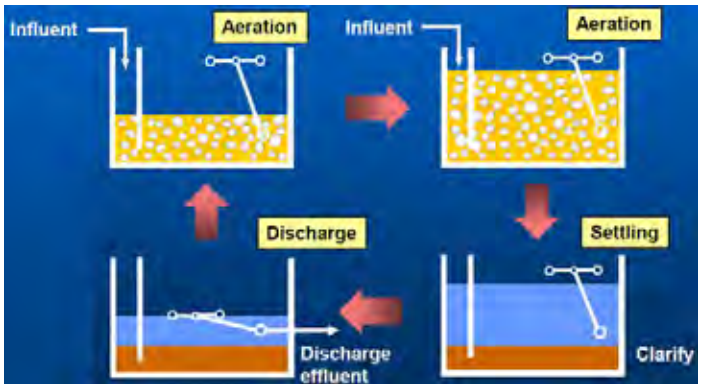
Equipment of IC process

- IC Decanter
- Jet Aeration System
- New Flex Diffuser
- IC Controller
- Sludge Level Meter

Specialty : - Low construction cost
- Stable organic treatment
- Capable of coping with fluctuation of influent quantity and quality
- High N, P removals
- Large number of reference installations

Company : NISHIHARA Environment Technology Inc.

Figure :



(H) Advanced Treatment

(H-1) Continuous upflow sand filter

Trade name : Resandfilter

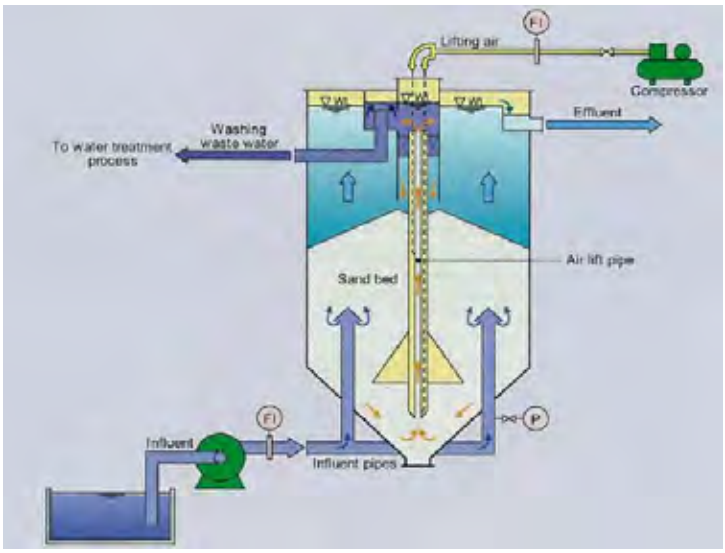
Application : Advanced treatment

Outline : Resandfilter is a continuous upflow sand filter for simple filtration of sewage treated water, pretreatment of membrane process, etc., and can decrease suspended particles and turbidity from water.

Specialty : -simultaneous operation of filtration and sand washing
-stable performance for filtered water quality
-small footprint system with high filtration rate
-easy and energy saving operation
-simple system with reasonable initial cost

Company : Sumitomo Heavy Industries Co., Ltd.

Figure :



(H-2) Fiber Media Rapid Filtration

Trade name : IFW Fiber Media Rapid Filtration Equipment

Application : Advanced treatment

Outline : The fiber filter media with high void volume and media back-washing system by water stream mixing in IFW make extensively possible higher rate filtration and smaller energy consumption than the conventional sand filter

Specialty : -Saving space due to high-speed filtration

A filtration velocity is about 6times of the conventional sand filter.

-Energy-saving operation

The fiber filtering media has less pressure loss due to its high void ratio. Therefore lower head pump can be used.

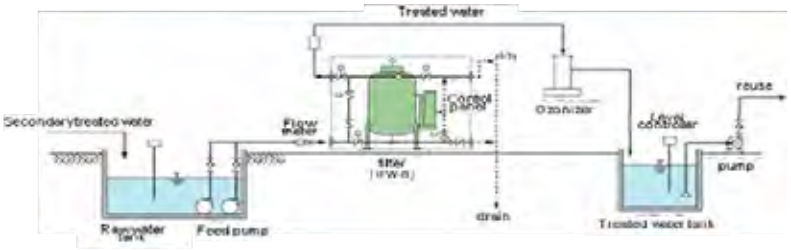
-Reliable back-washing of filter media with less washing water

Reliable filter media washing can be achieved by agitator device. It can lead to a long term stable operation.

Company : ISHIGSKI COMPANY, LTD.

Figure :

Flow chart: Example of reuse of secondary effluent of sewage treatment



Fiber filter media

Structure

(H-3) Advanced Treatment by Employing Media

Trade name : The Linpor® Process

Application : Advanced treatment

Outline : The Linpor® Process is a wastewater treatment process that utilizes sponge carriers (Linpor® Cubes). It requires to add the following equipments in the current conventional activated sludge system and has a drastically shorter HRT.

- Sponge carrier (Linpor® Cube)
- Baffle plate (screen) to prevent outflow of carriers
- Circulation air float pump
- Mixing equipment (for anaerobic and anoxic tanks only)

Depending on the target of treatment, there are 3 types of the Linpor® Process.

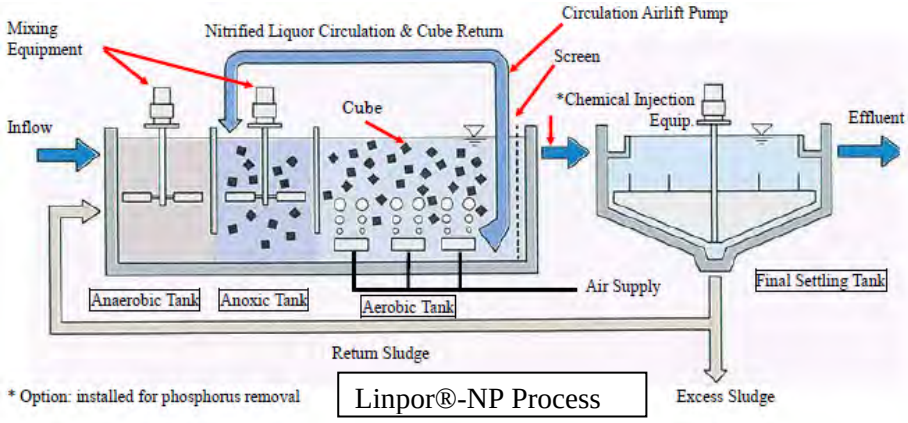
1) Linpor®-C for organic constituent removal
2) Linpor®-CN for nitrification/denitrification
3) Linpor®-NP for nitrification/denitrification and biological phosphorus removal

Specialty : - Because the Linpor® Cubes can hold a high concentration of activated sludge (10~15g-MLSS/L-carrier), the MLSS concentration in the reaction tank can be maintained at a higher level than that dictated by the load of the water surface area of the final settling tank (suspended sludge).

- High concentration of sludge contained in the sponge accounts for the long SRT and the large volume of nitrifying bacteria. In turn, this results in a high nitrification rate. Furthermore, anoxic conditions exist within in the cubes, making denitrification occur easily.
- The Linpor® Cubes have excellent durability. Cases of continued use for 15 years or longer have been cited outside of Japan. Within Japan, there are cases of 6 years or longer. Therefore, sponge replacement is not necessary.
- The dimensions of the carriers are 12mm x 12mm x 15mm and are larger than those of other companies. To prevent the outflow of the carriers, a punching plate with 8mm openings is employed as a baffle screen. The accumulation of scum on the plate is small. Hence, there is no risk of the water level increasing due to clogging. Furthermore, a fine screen for inflow is not necessary
- Due to the nature of the carriers, nitrifying and denitrifying bacteria naturally adhere to the carriers as the carriers circulate in the reaction tank.

Company : NISHIHARA Environment Technology Inc.

Figure :



(H-4) Immobilized Microorganism Treatment System

Trade name : The Pegasus Process

Application : Advanced treatment

Outline : Hitachi Plant Technologies immobilized Microorganism Treatment Systems represent a remarkable advance in nitrogen removal processes.
Nitrifying pellets containing of microorganisms, are added to the Nitrification tank to accelerate nitrification. The phosphorus removal process combines biological removal with physicochemical removal achieved by adding a flocculant. These treatment systems aim to realize a space-saving design, low cost and high efficiency.

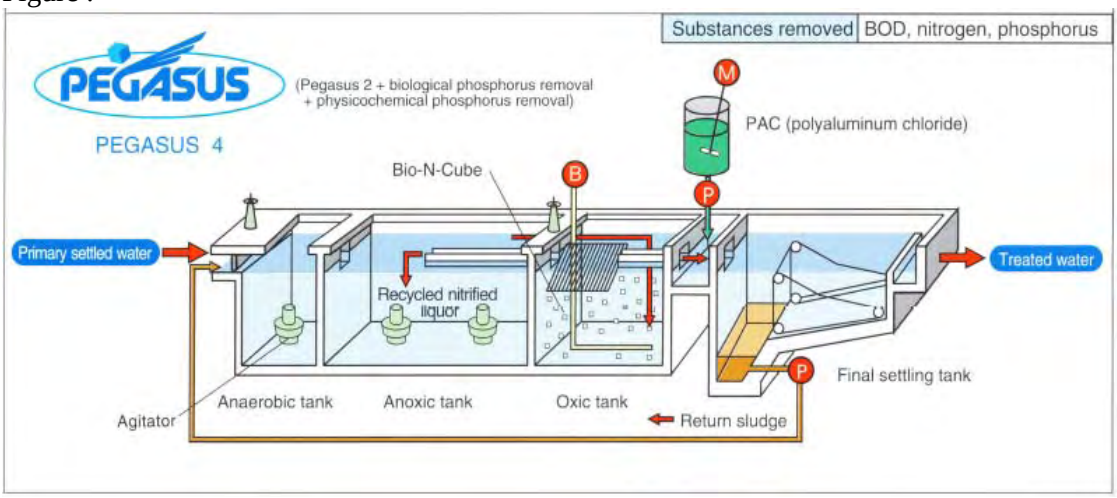
Specialty : - Simultaneous BOD/nitrogen removal in a retention time of 6-8 hours.
The general sludge recycling method for simultaneous BOD/nitrogen removal usually requires a retention time of 12-16 hours. The aeration tank capacity must be increased when it is applied to the standard activated sludge treatment facilities for BOD removal (whose retention time is 6-8 hours). The Pegasus Process retention time is 6-8 hours (based on our survey) for simultaneous BOD/nitrogen removal. This means that easy modification is possible without increasing aeration tank capacity.

- Removes nitrogen efficiently even at a low water temperature.
Because in the Pegasus Process nitrifiers can be sustained within Bio-N-Cubes, efficient nitrogen removal is achieved even at low wastewater temperature.

- Efficient nitrogen removal with chemical addition
In case of chemical addition for phosphorus removal, the efficiency of nitrification is decreased if general recycling method is used. And more increased capacity of aeration tank is necessary. The Pegasus Process assures efficient nitrogen removal keeping efficient nitrification because nitrifiers can be sustained within Bio-N-Cubes.

Company : Hitachi Plant Technologies Ltd.

Figure :



(H-5) Step-feed Multistage Denitrification-nitrification Process

Application : Advanced treatment

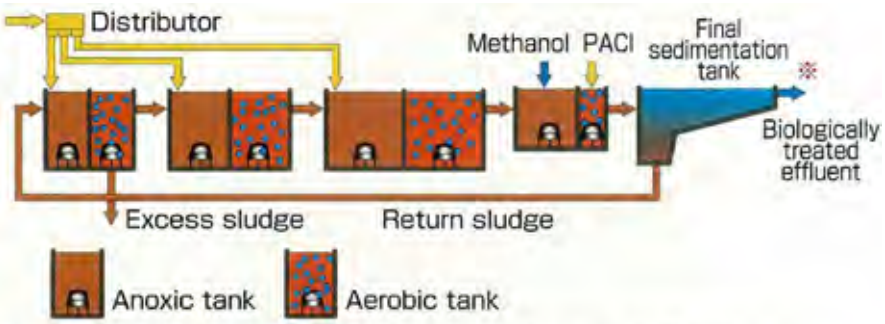
Outline : This process employs multistage anoxic and aerobic tanks in series, and the sewage is fed to anoxic tanks in each stage evenly. The step feed of sewage provides effective distribution of BOD and reduction of nitrogen load, and achieves effective and stable nitrogen removal.

Specialty : - This process has a high rate of denitrification. By optimizing the conditions, T-N removal of 60-80% is possible.
- The reactor of this process can be made compact since the average MLSS concentration increases in accordance with step-feed introduction.

- This process no longer needs circulation of nitrified liquor, energy consumption has to be cut to about 70% of the circulating process.
- Modification to this advanced sewage treatment process can be carried out without sacrificing existing treatment capacity.
- The O&M of the process is easy since each stage receives the same organics and nitrogen loads, and it does not require complicated controls.

Company : Japan Sewage Works Agency

Figure :



Flowdiagram of Step-feed multistage denitrification-nitrification process with Methanol-dose post-denitrification tank

(I) Disinfection

(I-1) Ultraviolet Disinfection System

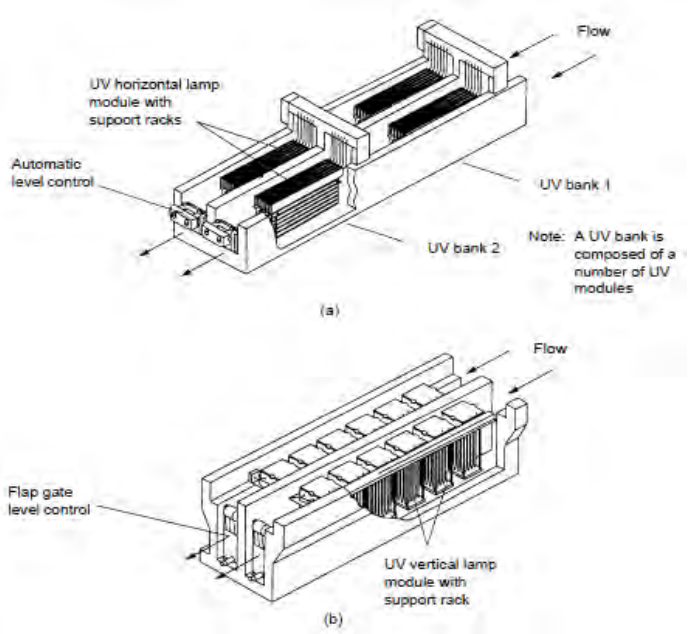
Application : Disinfection

Outline : An Ultraviolet (UV) disinfection system transfers electromagnetic energy from a mercury arc lamp to an organism's genetic material (DNA and RNA). When UV radiation penetrates the cell wall of an organism, it destroys the cell's ability to reproduce.

The main components of a UV disinfection system are mercury arc lamps, a reactor, and ballasts. The source of UV radiation is either the low-pressure or medium-pressure mercury arc lamp with low or high intensities.

Specialty : - UV disinfection is effective at inactivating most viruses, spores, and cysts.
- UV disinfection is a physical process rather than a chemical disinfectant, which eliminates the need to generate, handle, transport, or store toxic/hazardous or corrosive chemicals.
- There is no residual effect that can be harmful to humans or aquatic life.
- UV disinfection is user-friendly for operators.
- UV disinfection has a shorter contact time when compared with other disinfectants (approximately 20 to 30 seconds with low-pressure lamps).
- UV disinfection equipment requires less space than other methods.

Figure :



Source: Crites and Tchobanoglous, 1998.
(a) adapted from Trojan Technologies, Inc.
(b) adapted from Infilco Degremont, Inc.

(I-2) Ozone Disinfection System

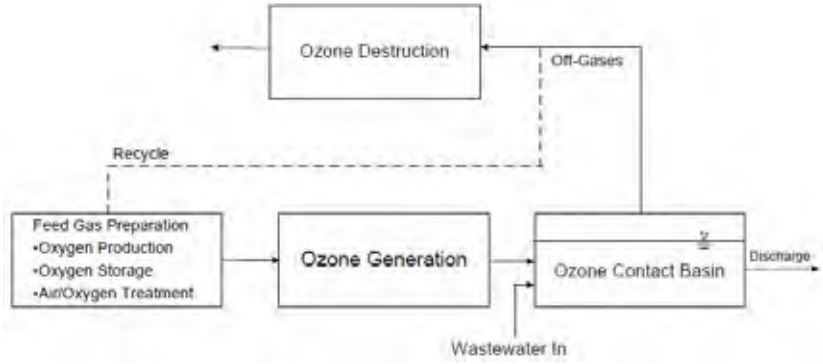
Application : Disinfection

Outline : Ozone is a very strong oxidant and virucide. The mechanisms of disinfection using ozone include:

- Direct oxidation/destruction of the cell wall with leakage of cellular constituents outside of the cell.
- Reactions with radical by-products of ozone decomposition.
- Damage to the constituents of the nucleic acids (purines and pyrimidines).
- Breakage of carbon-nitrogen bonds leading to depolymerization.

Specialty :
- Ozone is more effective than chlorine in destroying viruses and bacteria.
- The ozonation process utilizes a short contact time (approximately 10 to 30 minutes).
- There are no harmful residuals that need to be removed after ozonation because ozone decomposes rapidly.
- After ozonation, there is no regrowth of microorganisms, except for those protected by the particulates in the wastewater stream.
- Ozone is generated onsite, and thus, there are fewer safety problems associated with shipping and handling.
- Ozonation elevates the dissolved oxygen (DO) concentration of the effluent. The increase in DO can eliminate the need for reaeration and also raise the level of DO in the receiving stream.

Figure :



Source: U.S.EPA, 1986

Ozone Generator

Source: Toshiba Corporation

.

(J) Water Reuse

(J-1) Membrane Filtration System

Trade name : Ceramic Membrane Filtration System

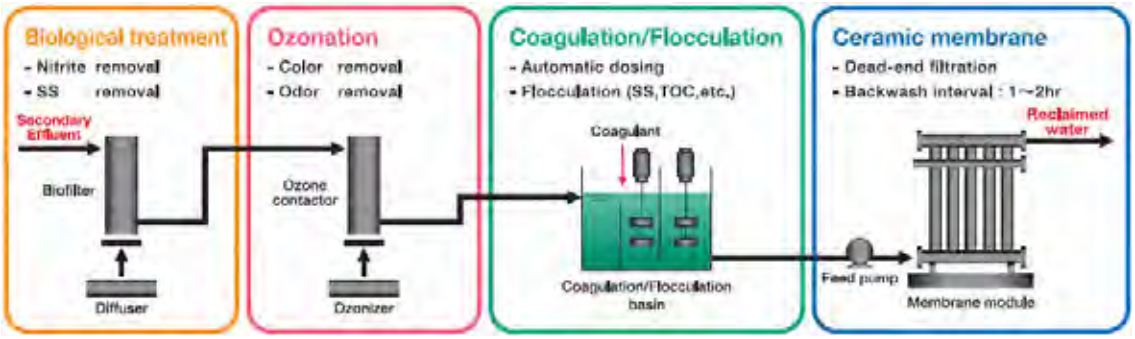
Application : Water reuse

Outline : This system is small in size, meets excellent filtrate quality, and has been developed combining unique core technologies, ceramic membrane and ozone system.

Specialty : -High quality water (excellent filtrate quality, safety and reliability with ozone disinfection and robust ceramic membrane)
-space-saving design
-easy operation and maintenance (robust ceramic membrane leads no membrane breakage)

Company : METAWATER Co., Ltd.

Figure :



(J-2) BIOPAC System

Trade name : BIOPAC SYSTEM

Application : Water reuse

Outline : The BIOPAC is an aerobic type biofilm treatment system with a fixed bed of granular media. It is similar to gravity filters, in which raw water goes downward through granular media and discharges from the bottom. However, an aeration system at the bottom keeps aerobic conditions and breeds aerobic bacteria on the media. Water and air make counter-current flows, where the air bubbles go up in winding way between the media. Thus longer retention time of the bubbles in he media is available and oxygen absorption efficiency is improved.

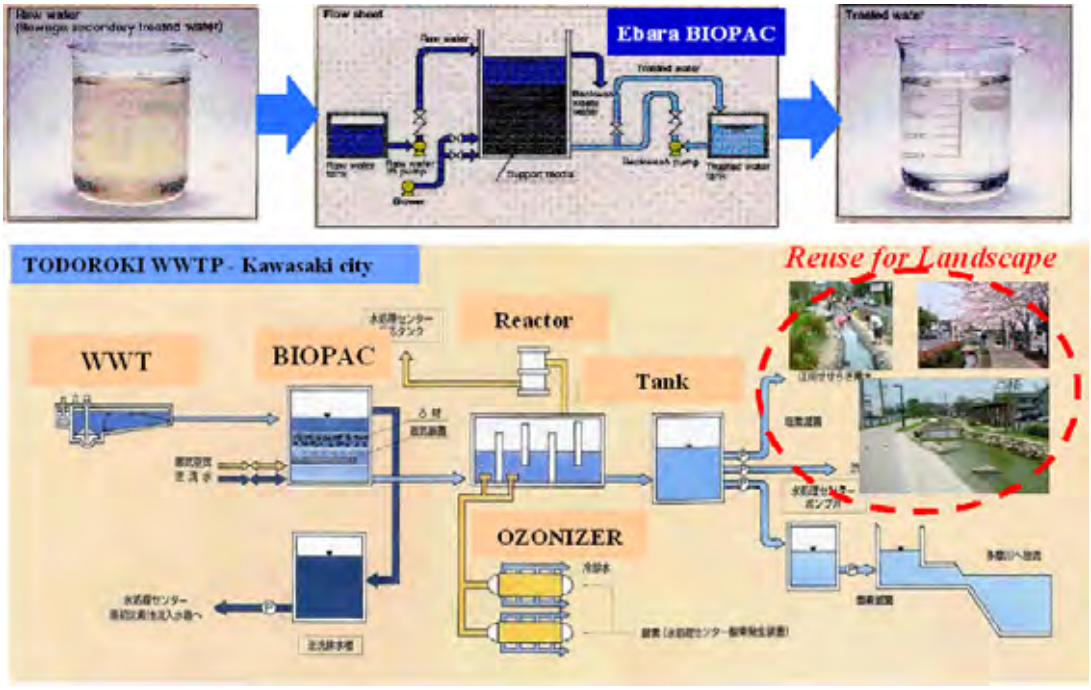
Specialty : Considering rapid growth of economy as well as population, shortage of water

resources become critical issues widely, especially for emerging countries. Desalination by RO technology is one of solutions for the issue, however it consumes much energy and accordingly the cost of water production is higher.

BIOPAC SYSTEM is the most economical system to produce utility water by reclamation of wastewater or sewage water. It is incorporated into existing wastewater plants and purifies the treated water furthermore to utilize it as flushing for toilet, landscaping, recharging raw water resources, etc. Since this system utilizes activated carbon filtering technology (and ozone technology, if any), the cost of recycled water production is much less than RO system.

Company : EBARA ENGINEERTING SERVICE Co., Ltd.

Figure :



3 Sludge Treatment Facility

(A) Anaerobic Digestion

(A-1) Egg Type Digestion Tank

Trade name : Egg Type Digestion Tank

Application : Anaerobic digestion

Specialty : - By virtue of its egg-shaped construction, the dead space within the tank is negligible, and the mixing is completed uniformly; hence, higher rate of sludge digestion and gas generation

- The small area of water surface at top tends to reduce the scum formation, which can also be crushed easily
- The mechanical mixing equipment consumes lesser power than the conventional gas mixing or pump mixing equipment by about 30%

Company : Kajima Corporation

Figure :

(B) Mechanical Thickening and Dewatering

(B-1) Layered Multi-disc Screw Press

Trade name : Volute Dewatering Press

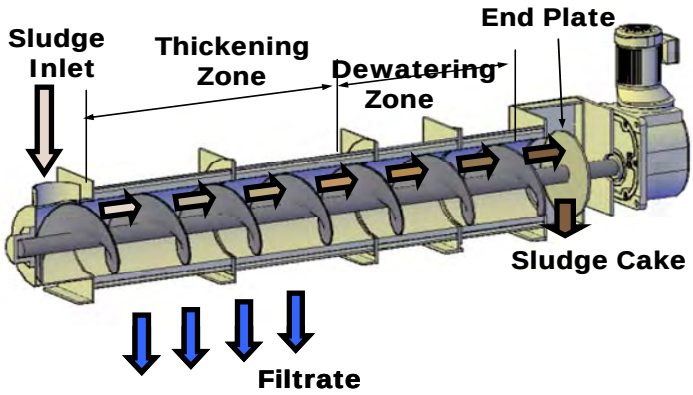
Application : Sludge Treatment

Outline : The main body is composed of accumulated Moving Rings, Fixed Rings and Screw. The accumulated rings work as a filter. Solids and liquid are separated by the pressure caused by the Screw. The Screw pushes the internal edges of the Moving Rings (The internal diameter of the Moving Rings is smaller than the diameter of the Screw.). Therefore the Moving Rings move continuously in the gaps between the Fixed Rings when the Screw rotates, which cleans the gaps and prevents clogging.

Specialty : - various applications (sewage, food factory, chemical plant, etc.)
- clog-free structure(low rinsing water consumption, high resistance to oily sludge)
- low power consumption
- low initial and running cost (total cost is one third of centrifuge type)
- various size (1 - 300 kg-DS/h)
- built in-thickening zone (low concentrated sludge from an aeration tank is dewatered directly)

Company : AMCON INC.

Figure :



(B-2) Continuous pressurizing dehydrator

Trade name : ISGK Pressing rotary outer cylinder-type screw press

Application : Sludge Treatment

Outline : Pressing rotary outer cylinder-type screw press ISGK is a continuous pressurizing dehydrator which reduces sludge volume efficiently by

cylindrical. There are two versions of ISGK available, standard version and high efficient version with a thickener attached.

Specialty : - Easy Maintenance

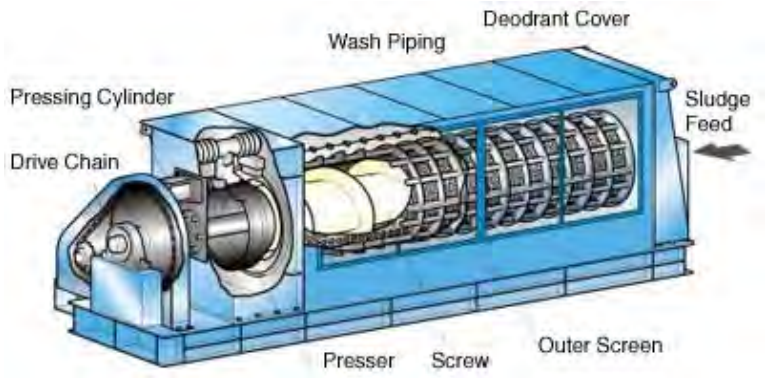
As compared with the conventional dehydrator using filter cloth, less consumable parts and less washing water consumption, and easier maintenance.

- Environmentally friendly dehydrator

Electric power consumption accounts for about 1/15 of centrifugal dehydrator rotating at high speed. The vibration and noise level of ISGK are lower than centrifugal dehydrator.

Company : ISHIGSKI COMPANY, LTD.

Figure :



(B-3) Decanter Centrifuges

Trade name : Tomo-e Decanter Centrifuge, TECO Series

Application : Sludge Treatment

Specialty : - Less susceptible to concentration levels - Low-concentration sludge dewaterable

- Hard-to-dewater sludge such as OD sludge is efficiently dewatered.
- Large throughput per unit
- Performance of sedimentation type does not deteriorate by screen blocking
- Operational and automatic controls are easy
- Easy odor prevention by completely enclosed system
- Capable for non-stop 24-hour operation

TECO Series – Cost effective

- Bowl capacity and throughput remain intact by elongated bow
- Manufacture cost and motor capacity are reduced by elongated bowl
- Cost reduction is achieved by revising structure, materials, and procurement measures.
- Small footprint is enabled by vertical drive motor

Company : TOMOE ENGINEERING CO.,LTD.

Figure :

(B-4) Sludge Dehydrating and Drying Device

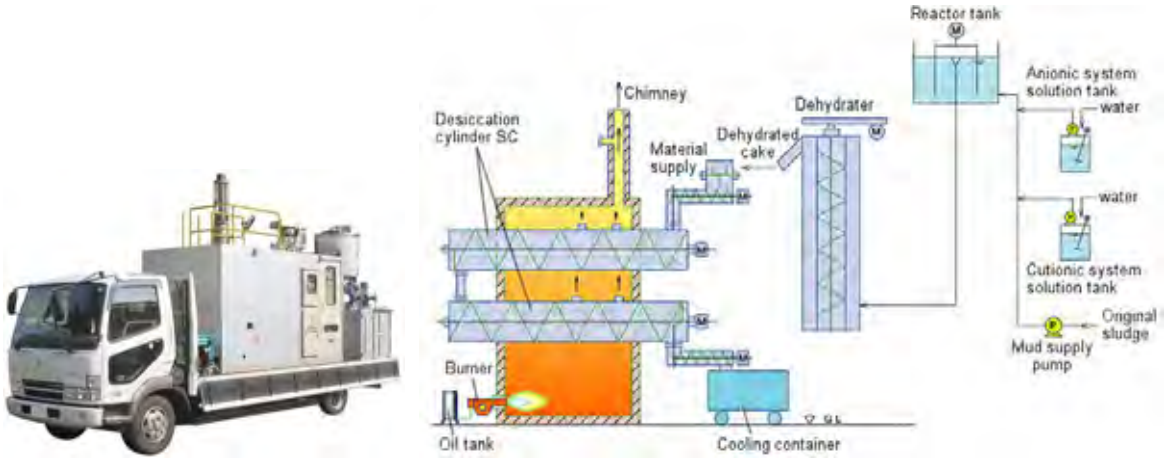
Trade name : Sludge Dehydrating and Drying Device

Application : Sludge Treatment

Specialty : - The vertical hydrator is compact
- Low-cost has been achieved by thorough cost reduction in design
- Dried sludge with steady quality is produced by automatic operation
- Moisture content of dried sludge can be adjusted up to 10-50%

Company : Torishima Pump MFG. Co., Ltd.

Figure :



(C) Sludge Reuse

(C-1) Sludge drying system

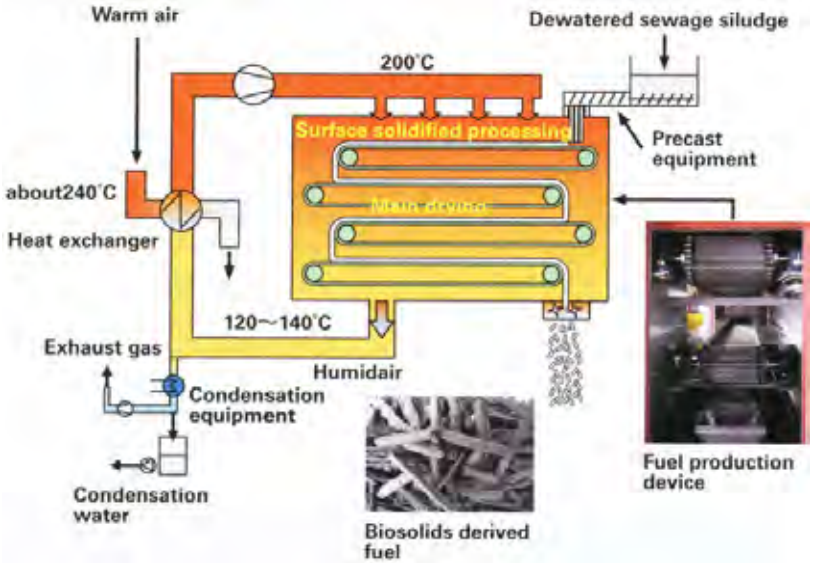
Trade name : Sludge drying system

Application : Sludge Treatment

Specialty : - High energy conversion efficiency to biosolids from sludge with low-grade heat source of 200° C
- Extremely low dust level by performing sludge sticks and drying them in belt dryers
- Control of unbearable odors by face-hardening sludge-

Company : JFE Engineering Corporation

Figure :



(C-2) Sludge Carbonization System

Trade name : Sewage Sludge Carbonization System

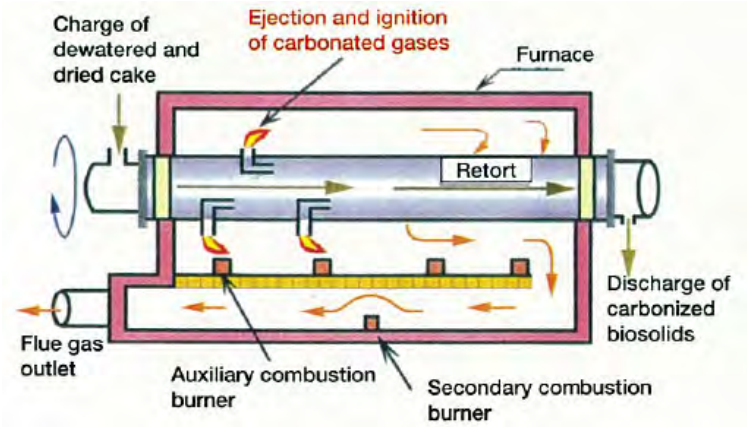
Application : Sludge Reuse

Outline : The process thermally decomposes sewage sludge under oxygen depleted condition and generates granular carbide. The carbonized sludge consists of carbon and inorganic components and has many features more than activated carbon.

Specialty : - The carbonized sewage is light in weight
- The processed sewage is odorless and no pathogen
- The high porosity gives high moisture content and low bulk density for horticultural soil
- Its high specific surface gives attached sites for any microorganisms
- The radiative thermal absorption is high
- The adsorption capacity performs for odors, colors, toxic organic compounds etc.
- It is useful as a fuel like a charcoal,

Company : Japan Sewage Works Agency

Figure :



(C-3) BITREC System

Trade name : BITREC System

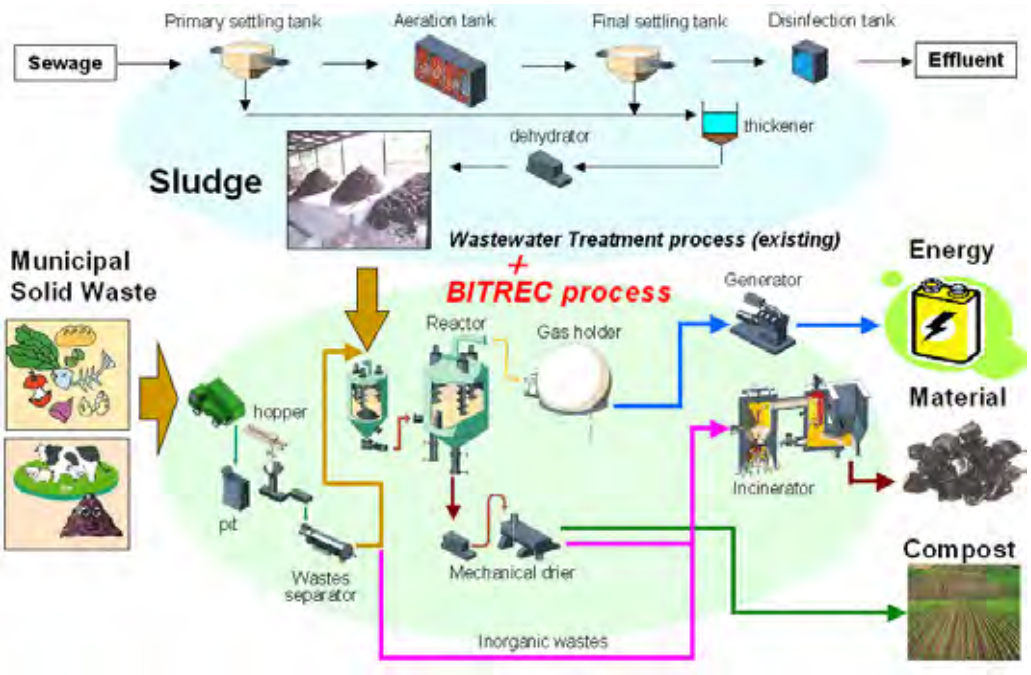
Application : Sludge Reuse

Specialty : Recently disposal of sludge from wastewater treatment plants become a crucial environmental problem in many countries. In common way, the sludge will be disposed by landfill, however this method would be faced with many difficulties, such as leakage of methane gas & offensive odor, environmental contamination occurred by spilling leachate out, shortage of available land area, etc.

BITREC System is an outstanding solution on this problem. This system can produce electrical energy, compost and construction materials by mixing of dehydrated sludge and municipal wastes and excreta utilizing methane fermentation technology. In addition, as this system can be installed to the existing wastewater treatment plant, you can easily grade up the existing plant as value producing plant.

Company : EBARA ENGINEERTING SERVICE Co., Ltd.

Figure :



(C-4) Value composting System

Trade name : Value composting System

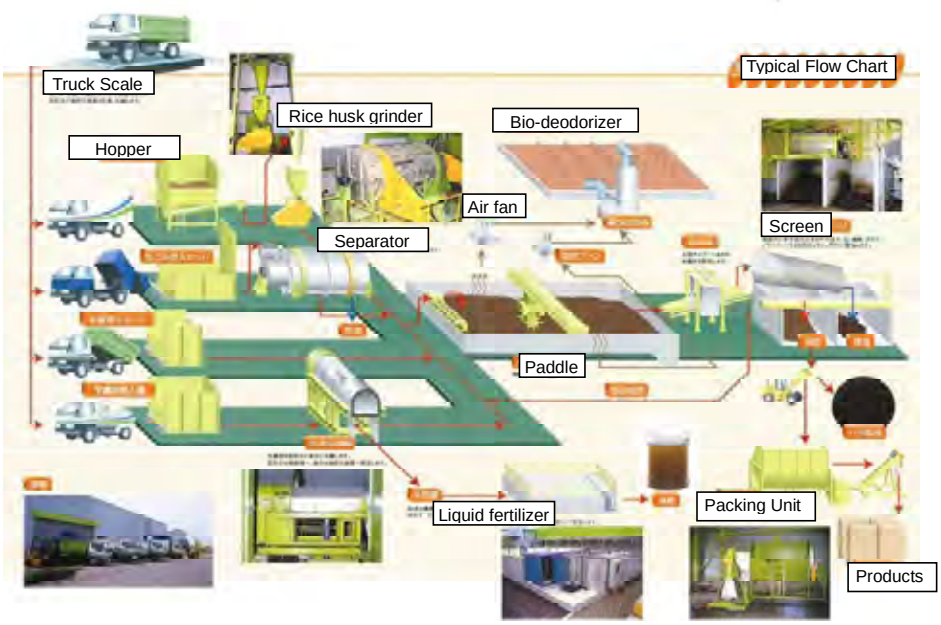
Application : Sludge Reuse

Specialty : Value composting System produces high quality composting materials from the sludge. They can be utilized for soil fertilization for planting, because of the following features.

1) Soften the land soil with plenty air by multi-aggregated structure
2) Enhance the water-retention mixed with polymer.
3) Providing plenty of nutrition that are not contained in chemical fertilizer (Cu, Mg, Br)

Company : EBARA ENGINEERTING SERVICE Co., Ltd.

Figure :



4 Electric Facility

(A) Generator

(A-1) Biogas engine generator

Trade name : Compact size digestion gas engine generator Model:BG25A

Application : Sludge digestion gas

Outline : Rated output 25 / 30 kW

Fuel gas concentration : Methane level 55% - 65%

Fuel gas consumption : 11- 15 Nm3/h

Power generation efficiency (Maximum) : 30% or above

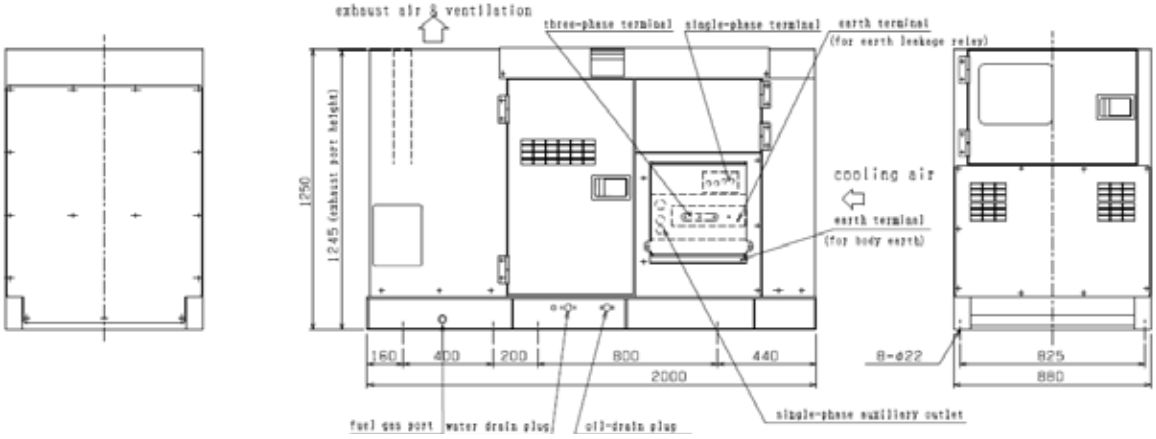
Specialty : - This equipment is a gas engine generator built by altering commercially available engine generator to run on biogas.

- This equipment is equipped with a high-efficiency, high-quality aluminum radiator for engine cooling.

- This equipment has an emergency stop, alarm and alarm display for engine troubles (low oil pressure, high water temperature, etc.) as well as a pre-warning function to display a problem at an early stage and a digital instrument panel which displays an error even after an emergency stop.

Company : OHARA CORPORATION

Figure :



(A-2) Micro Gas Turbine Co-generation System

Trade name : EBARA Digestion Gas fueled Micro Gas Turbine Co-generation System TA100

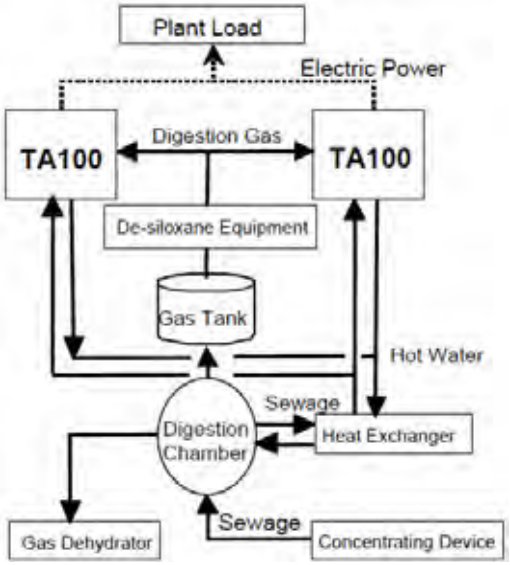
Application : Sludge digestion gas

Outline : Rated output 95 kW

Fuel gas consumption : 53.6 Nm3/h
Heat efficiency : 29%
Recovered Heat (Hot water) : 163 kW
(Steam) : 98kW
Total cogeneration Efficiency : 79% / 59% (Hot Water/Steam)

Specialty : - Prevent from Global Warming by usage of Digestion Gas
8,600 hour operation per year of one unit provides electric power around 800,000 kWh, and around 450tons CO2 reduction (if exhaust heat energy is utilized, it becomes around 900tons)
- Furnish 3 functions, “Electric Power Generator”, “Hot Water Heater or Steam Boiler” and “Excess Gas Burner”
MGT can be alternative facilities of existing heater, boiler and flare stack
- High Operating Reliability
In addition to proven hardware technologies, Ebara offers dedicated remote monitoring system which assures highest operating reliability and on-condition and preventive maintenance.

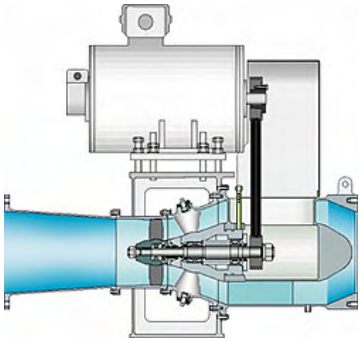
Company : EBARA CORPORATION
Figure :

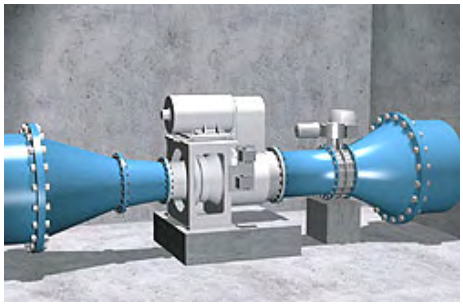


(A-3) Micro Hydropower Generating Equipment

Trade name : Toshiba Micro Hydropower Generating Equipment
Application : Effluent conduit
Outline : Toshiba Micro Hydropower Generating Equipment can utilize hydraulic energy of low head and of small-scale water resources.
Specialty : - Wide output range of 5 to 200kW
- Applicable for wide flow range, using 3-types of Hydro-eKids™
- Flexible application for various types of sites
- Small and compact package
- Reduced installation cost
- Reduced concrete volume for foundation
- Applicable from low head(2m)

Company : TOSHIBA CORPORATION
Figure :





(B) Instrument Equipment

(B-1) Weir and Parshall Flume-type Flow meter

Trade name : Weir and Parshall Flume-type Flow meter

Application : For flow measurement and flow control of open conduit channels in water supply facilities and sewage facilities.
For automatic control of pumps, valves, and gates.

Outline : This apparatus continuously measures the flowing quantity of the open conduit channels. The head of water caused in Weir or the Parshall flume is detected with the Submerged Level Detector. This level signal is operated with level/flowing quantity converter and the flowing quantity value is output.

Specialty : - Accurately detects water heads of 0 m to 0.1 m.
- The level/flow converter outputs instantaneous flow and cumulative pulses.
- The level/flow converter can make automatic calculations using its flow formula program.
- Span can be adjusted on-site.
- Because the Submerged Level Detector is used, the maintenance check can be facilitated.

Company : JFE Advantech Co., Ltd.

Figure :

(B-2) Submerged Level Detectors

Trade name : Submerged Level Detectors

Application : Our submerged level detectors support various fields and applications including clean water, sewage, rivers, seawater, and chemical solutions.

Outline : Our submerged level detectors measure water depth by detecting water pressure. These detectors can serve for monitoring water levels, and automatic control of pumps and gates.

Specialty : - Robust structure

Sensor employs a differential transformer. The robust structure offers high shock resistance.

- Excellent lightning and noise protection

Sensor utilizes a differential transformer, providing excellent lightning protection, and junction box and converter feature built-in lightning arresters. These features provide enhanced protection against lightning-induced voltage and noise.

- Superior resistance to sludge and floating objects

Since the detector is installed underwater, it is not affected by surface water conditions such as floating objects, ice, and unsettled water surfaces caused by high winds. Moreover, the pressure receiving section of the SL-C series employs a sludge-resistant structure that protects the detector from sludge.

- Environmentally friendly

SL-180B/C is Rohs Directive compliant and can be used with eco cables.

Company : JFE Advantech Co., Ltd.

Figure :

(B-3) Sludge Density Meters（Dual scattered-light）

Trade name : Sludge Density Meters（Dual scattered-light）

Application : Type SD-40 detects the density of sludge discharged from sedimentation tank and concentrators, in sewage treatment plants and water works. It achieves the accurate observation of sludge density, and helps to control the discharge of sludge.

Outline : The SD-40 type density meter can continuously measure wide-ranging sludge from crude sludge, excess sludge to thickened sludge of the sewage works, without influences of void or sludge color variation, and could be used for the control of chemicals injection for sludge treatment and online continuous monitoring of the sludge concentration.

Specialty : - Automatic correction according to sludge color. Because the SD-40 automatically corrects for any change in sludge color, it can be used to observe black digested sludge.

- Excellent sludge removal features. The end of the detector is shaped to

prevent sludge from adhering to it. In addition, SD-40 is equipped with an automatic clearing mechanism as standard. Thus, the meter is capable of performing stable measurement over a long period.

- Easy maintenance. The detector can be replaced without stopping the flow of sludge.
- Bypass piping is not required.

Company : JFE Advantech Co., Ltd.

Figure :

Converter

Detector, Connection Pipe

(B-4) Optical DO Meter

Trade name : Optical DO Meter

Application : The dissolved oxygen is measured in the aeration tank such as sewage treatment plants.

Outline : This apparatus is used for measurements of the dissolved oxygen in the aeration tank such as sewage treatment plants and factory wastewater plants. Not the diaphragm type used so far but an optical sensor is used, and it is excellent in stability and the response.

Specialty : - Because it is a method to measure the optical longevity (time) not influenced easily by the light intensity, it is possible to measure it with stability for a long term.
- The Replacement part is only a sensor cap. Electrobath is unnecessary. Maintenance is easy.
- Because oxygen is not consumed when measuring it, the liquid DO without flow velocity can be measured.
- It is an automatic setting as for the property data when the sensor cap are exchanged by having built memory IC into the sensor cap.

Company : JFE Advantech Co., Ltd.

Figure :

Converter

Detector

(B-4) Monitoring system for small region

Trade name : Monitoring system for small region

Application : This system can be applied for monitoring of sewerage facilities in wide area.

- Small-scale sewage treatment plant
- Relay Pump Station
- Manhole Pump

etc.

Outline : This system can monitor and control relay pump station, manhole pumps, wastewater treatment plant scattered over a wide area regardless of location, time and size of the plant by using the personal computer with WEB browser.

Recent development in IT technology brought the development of social infrastructure of the network by the Internet service, lower prices and social penetration of personal computers and cellular phones diffusion.

This system can construct a most appropriate and simplified operation system using by net work technology even the monitoring area is wide complex area

Specialty : - Flexible monitoring system

Can be monitoring the condition even in office, home and electrical room at any time. The required monitoring devices are only personal computers and WEB browser.

At the time of trouble, the system can report to cell phones.

- Reliability

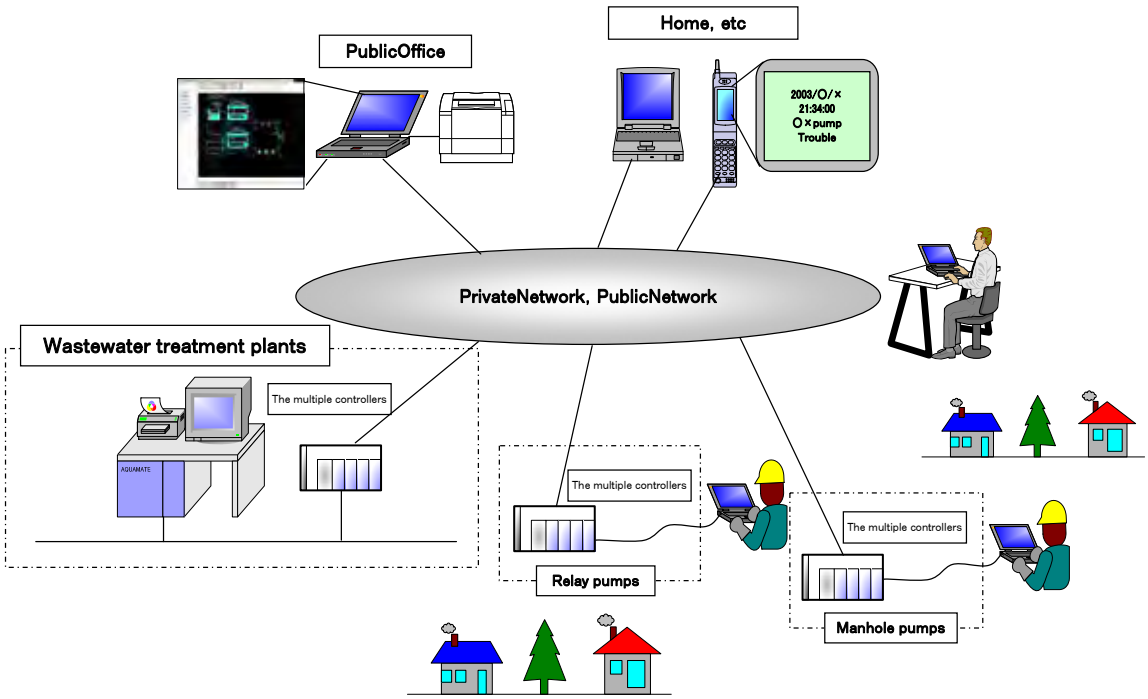
Since this system save/store operation data of the facilities into multiple controller, there is no data loss due to communication failure. These data can be edited and saved in monitoring side.

- Easy extension

This system can be adopted for the existing facilities without modification

Company : Nissin Electric Co., Ltd.

Figure :



5 Sewer Construction

(A) Shield Tunneling Method

Trade name : DK Shield Method

Application : Sewer Construction

Outline : The DK Shield Method controls muddy soil pressure in three phases to minimize disturbance to the ground, and thus controls tunnel driving.

1. Convert excavated soil into muddy soil
   Mud making agent is injected into soil that has been excavated from the tunnel by a cutter. Excavated soil is then kneaded forcefully with the agent using kneading blades and changed to muddy soil with plastic fluidity and impermeability.
2. Stabilize the face with muddy soil
   Kneading chamber and screw conveyor are filled with muddy soil. Then, muddy soil pressure is generated by the thrust of a jack to resist groundwater pressure and earth pressure for providing face stability.
3. Control tunnel driving by muddy soil pressure
   Muddy soil pressure is constantly monitored using muddy soil cells attached to the bulkhead. Tunnel driving is controlled by changes in the rate of shield advance and the rotational speed of the screw conveyor so that muddy soil pressure becomes equivalent to the total of earth pressure at rest and water pressure.

Specialty : - Applicability to a wide range of soil types
   This method is applicable to diverse soil types because sand, gravel, silty clay, Shirasu, and alternations thereof can be converted to muddy soil with plastic fluidity and impermeability using mud making agent.

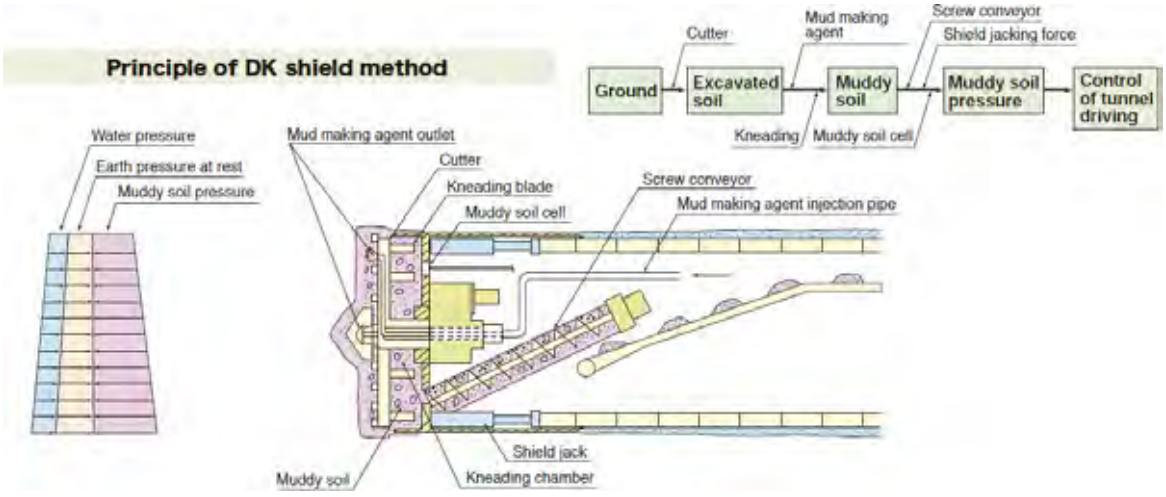
- Minimization of settlement
   The face is retained by muddy soil and thus there occurs hardly any disturbance of the soil. Ground surface

- Simultaneous backfilling
   Shield perimeter and the kneading chamber are waterproofed by muddy soil, so no backfill material affects the face. Simultaneous backfilling is thus ensured.

- Applicability at great depths and under high water pressure
   Tunnel driving tests under a maximum water pressure of 0.7 MPa have confirmed satisfactory performance of the method under high water pressure. The method is applicable to great depths exceeding 50 m.

Contact company : Shield Tunneling Association of Japan

Figure :



(B) Pipe Jacking Method

Trade name : Pipe Jacking Method

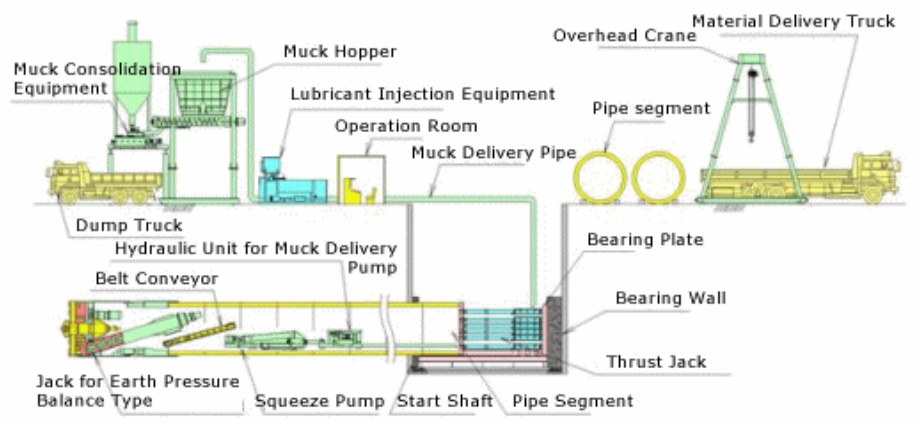
Application : Sewer Construction

Outline : Pipe Jacking allows pipes or small tunnels to be constructed without digging up the ground. Sections of pipe are dropped into a pit, and pushed horizontally into the ground, to emerge up to a kilometre away. A small-diameter tunnel-boring machine is usually used to excavate spoil at the advancing tunnel heading.

Specialty : - Inherent strength of lining
- Smooth internal finish giving good flow characteristics
- No requirement for secondary lining
- Considerably less joints than a segmental tunnel
- Prevention of ground water ingress by use of pipes with sealed flexible joints
- Provision of invert channels in larger pipes to contain the dry weather flow of a sewer in a combined system
- Less risk of settlement
- Minimal surface disruption
- Minimal reinstatement
- Reduced requirement for utilities diversions in urban areas

Contact company : Japan Micro Tunneling Association

Figure :



Conceptual Illustration (TAIHO CORPORATION)

6 Sewer Rehabilitation

(A) New SPR system

Trade name : New SPR system

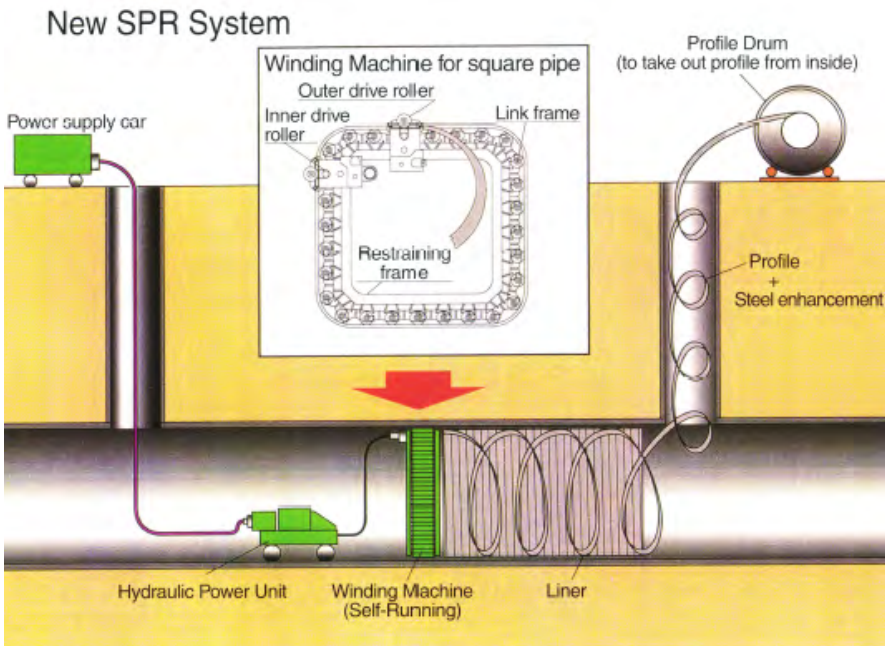
Application : Sewer rehabilitation

Outline : A profile strip is fed into the existing pipe, and the self running winding machine advances inside the pipe as forming a liner. The winder rotates along a restraining frame and forms the liner matching the inner surface contour of existing pipe and plastically deforming the steel-reinforced strip.

The winding machine, container-based drum (a drum which contains a rolled strip of profile and feeds the strip as a liner is formed), are outlined below.

Specialty : - a liner can be formed in an in-service pipe without stopping the sewage
- longitudinal slope adjustment is possible
- rehabilitation work can be performed via manholes 60cm in diameters
- a renovated pipe nearly two times as strong as the original pipe can be formed
- the system can be applied to not only round but also to any non-circular shapes such as rectangular, horseshoe, and elliptical

Contact company : Sekisui Chemical Co., Ltd.
Figure :

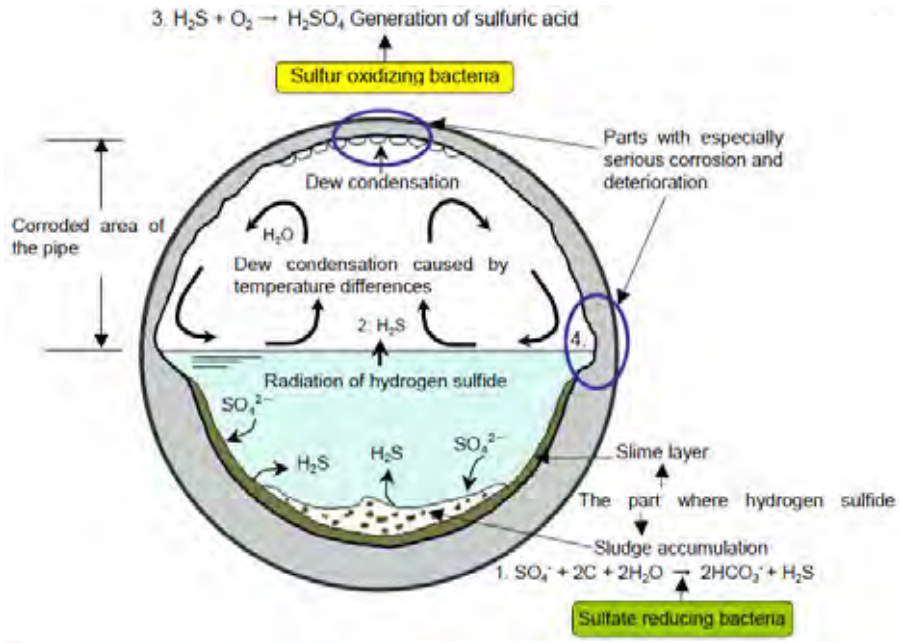


7 Corrosion control measures for sewerage structure

Japan Sewage Works Agency (JS) published a technology evaluation report on corrosion control measures for sewerage structure in March 2001, after the thorough discussion by Technology Evaluation Committee.

- Mechanism of concrete corrosion in sewage system facilities -

1) Production of hydrogen sulfide (H_2S) from sulfate (SO_4^{2-}) by sulfate reducing bacteria in wastewater and sludge under anaerobic condition.
2) Emission of hydrogen sulfide gas from liquid to gas phase.
3) Generation of sulfuric acid from hydrogen sulfide when sulfur-oxidizing bacteria are present in aerobic condition in dew condensation of sealed concrete structures.
4) Deterioration of concrete as a result of the reaction of sulfuric acid against concrete components.



A test result has shown that where average concentration of hydrogen sulfide is 100 sppm, the corrosion and deterioration of concrete will progress by 6 - 8 mm per year.

- Measures against concrete corrosion -

Classification of measures	Strategies	Practical methods
Corrosion prevention	- Inhibiting sulfide formation. - Inhibiting hydrogen sulfide production. - Inhibiting sulfide acid production.	- Prevention of anaerobiosis by injecting air, etc. - Construction of appropriate structure to prevent disturbances in flow. - Oxidation and immobilization of sulfide by chemical addition. - Inhibition of bacterial activity by chemicals
Corrosion protection	- Perfection concrete from sulfuric acid by lining. - Using materials highly resistant to sulfuric acid.	- Coat-type lining, sheet-lining, buried frames, etc. - Sulfate resisting cement mortar and concrete*

*JS has made joint research with private companies since 2000.

- Comprehensive measures are important -

- It is important to select and combine appropriate technologies to prevent and protect concrete corrosion to be applied to various corroding conditions and facilities.
- In repairing existing facilities, unlike newly constructed facilities, it is important to diagnose corrosion and deterioration, remove corroded and deteriorated parts (chipping), recover the chipped face, and set up temporary facilities and consider the operating method for existing facilities during the construction period.

Contact company: Japan Sewage Works Agency

APPENDIX – A5-1

Outcomes of Expert Committee Meetings

OUTCOMES OF EXPERT COMMITTEE MEETINGS

Meetings were held between the JICA Study Team (hereafter called "JST") and the Expert Committee on 26-27 August 2010, 27-28 October 2010, and 19-20 January 2011 in New Delhi. The participants of the meetings are listed in Appendix A1-1. The outcomes of the meetings are described below.

(1) First Meeting

The first meeting between the JST and the Expert Committee was held over two days on 26th and 27th August 2010, the first day devoted to discussing the Manual on Sewerage and Sewage Treatment (hereafter "Design Manual") and the second day to the Operation and Maintenance Manual (hereafter "O&M Manual").

(A) Meeting on August 26, 2010 (Design Manual)

The JST proposed to undertake field studies in 9 States & 1 UT and study the performance of about 48 existing sewage treatment plants in order to have first hand information. The Study Team would prepare the 'Interim Report' on the basis of the field visits to decide the broad topics to be covered in the proposed Manual. This interim report would serve as a base document for drafting the proposed Manual. The interim report prepared by the Study Team would also be reviewed and finalized by the Expert Committee. The Team Leader briefly explained the following criteria for selection of sewage treatment plants in cities and towns in 9 states & 1 UT in the country:

- Size of cities and towns
- Capacity of existing sewage treatment plants (STPs)
- STPs employing conventional sewage treatment processes or any new technologies
- Number of sewage treatment plants in the State, and
- Management entity

The members of the Expert Committee suggested inclusion of the following for the field visits:

(i) Hilly areas such as Sikkim and Kashmir

(ii) Some STPs applying SBR, MBBR and MBR technologies

(iii) Onsite sanitation and disposal of sludge may be studied for Gujarat state

(iv) Sewage collection networks including house-sewer connections, man holes, pumping stations, etc.

(v) Karur STP and Ooty STP may be considered.

The Expert Committee recommended that while revising and updating the Design Manual, the following issues be addressed in addition to the guidelines stipulated in the existing manual:

- The policy, objectives and goals, and key issues stated in the National Urban Sanitation Policy
- Latest sewage treatment technologies available globally and their application to Indian conditions
- Tertiary treatment technologies

- Approach and guidelines for separate systems
- Guidelines for urban storm water drainage not to be considered as a separate manual on urban storm drainage system is under preparation by another Expert Committee appointed by the Ministry
- Incremental sanitation method
- Guidelines for PPP, Social/Community Development
- Health and safety measures that should be mandatory during construction, operation and maintenance of sewerage systems
- Policy guidelines for quality maintenance during construction, operation and maintenance, sustainable solutions such as recycle and reuse of treated wastewater, reuse of gas and sludge, etc.
- Package or compact sewage treatment plant
- Removal of phosphate, nitrogen, and nitrate in the sewage treatment plant
- Making house-sewer connections mandatory by formulating and implementing suitable bye-laws for existing and proposed sewer networks
- Low cost sanitation

The following points were generally agreed to by both parties:

1. Sub-committees shall be formed by the Indian side
2. At the next Expert Committee meeting, draft TOC to be prepared and presented by the JST
3. Expert Committee members can submit draft TOC to JST through MOUD

After detailed deliberations and discussions on the proposed manual, the Expert Committee and the JST decided that the title of the proposed manual would be retained as it is in the present form, that is, “Manual on Sewerage and Sewage Treatment” (Design Manual). The tentative chapters for the Design Manual decided during the meeting were:

- Planning
- Management, Administration, Legal and Financial Aspects
- Design and Construction of Sewers
- Design and Construction of Sewage Pumping Stations
- Design and Construction of Sewage Treatment Facilities
- Design and Construction of Sludge Collection facilities
- Recycle and Reuse
- Onsite Management
- Newer Trends

It was further decided that details of each chapter of the Manual would be worked out by the JST and the same would be forwarded to the Member Secretary who would in turn forward the

same to all the members of the Expert Committee for their opinions during the next meeting. It was decided that the second meeting of the Expert Committee for the Design Manual would be held on 27th October, 2010.

(B) Meeting on August 27, 2010 (O&M)

During the meeting, copies of the following three documents were distributed to the Expert Committee members:

1. Manual on Sewerage and Sewage Treatment, 1993, published by the Ministry of Urban Development,
2. Manual on Operation & Maintenance of Water Supply Systems, 2005, published by the Ministry of Urban Development, and
3. A Report on 'Willingness to Pay for Drinking Water Supply and Sanitation' published by the Department for International Development, Regional Water and Sanitation Group – South Asia, 1997.

After a talk given by JST Leader (same as the talk given on 26th August) for the benefit of new Expert Committee members participating in the meeting, it was recommended by the Expert Committee that the manual should consist of three parts:

1. Engineering,
2. Operation and Maintenance, and
3. Management

The chapters finalized by the Expert Committee for the revision and updating of the Manual on Sewerage and Sewage Treatment on 26th August, 2010 would be covered in the part "Engineering."

After having detailed deliberations and discussions on the proposed O&M Manual, the Expert Committee and the JST decided that the following chapters would be included under the "Operation & Maintenance" and "Management" parts.

Operation and Maintenance

- Introduction (Existing scenario, Objectives of this Manual, Legal Frameworks)
- Strategy
- Gravity Collection Systems
- Pumping Stations and Pumping Mains
- Pretreatment
- Primary Treatment
- Secondary Treatment
- Disinfection
- Tertiary Treatment
- Sludge Treatment
- Treatments for Reuse

- Resource Recovery (Gas, Treated Effluent and Sludge)
- Onsite Systems
- Human Resources
- Quality Monitoring and Control (Wastewater, sludge, Operation Record)
- Instrumentation and Automation
- Electrical and Mechanical Equipments (Energy auditing)
- Health and Safety

Management

- Management Information System (MIS)
- Institutional Development
- Financial Management (Billing and Collection)
- Customer Relation
- Community Participation
- PPP and PSP
- Regulatory Framework

It was further decided that details of each chapter of the Manual would be worked out by the JST and the same would be forwarded to the Member Secretary who would in turn forward the same to all the members of the Expert Committee for their views during the next meeting. It was decided that the second meeting of the Expert Committee on O&M would be held on 28th October, 2010.

(2) Second Meeting

The second meeting between the JST and the Expert Committee was held over two days on 27th and 28th October 2010, with the first day devoted to the Design Manual and the second day to the O&M Manual. The draft TOCs after accepting the Expert Committee's recommendations are shown in Appendix A5-3.

(A) Meeting on October 27, 2010 (Design Manual)

The JST presented the findings of the first round of field visits conducted by the JST to the 14 locations in various parts of India and graded various STPs after evaluating them based on various parameters. The Team rated Nerul STP as the best maintained among all the STPs visited by the Team. After the presentation on the findings by the JST, the Expert Committee members recommended the following:

- Reduce the number of STPs to be visited henceforth
- Spend more time at one location and study the sewerage network and its related issues in detail

The JST accepted the recommendations of the Expert Committee and decided to visit Allahabad (2nd-4th November), Bengaluru (8th-10th November) and Chennai (11th-13th November) before returning to Japan on 17th November.

The Table of Contents of the Manual was vigorously debated and discussed. Some of the suggestions made by Expert Committee members were:

- Septic tanks with soak pit and small-bore-systems were ideal for hilly areas and should find a place in the Design Manual.
- Inclusion of the Johkaso system of Japan in the manual for information purpose.
- Decentralized system should come as a section under Chapter 3 Design of Sewer Systems
- A section on decentralized system in regard to treatment would be included in the Treatment Plant Design chapter
- Expert Committee members could work on the guidelines for on-site sanitation themselves and evolve them
- Standardized designs of two-pit latrines (on-site system) were available and could be included in the Manual
- Information on Eco-system (on-site) could also be included as alternative on-site method in the Manual
- The most important aspect of the Manual for the field engineer was worked-out design examples of various aspects of the Sewerage System. This should be included for different treatment methods used in the appendix forming the most important part of the manual for the designer. The JST should therefore ensure that relevant worked out design examples are included
- The JST should recommend the instrumentation and measurements that were necessary according to plant capacities; such as for plants up to 20 MLD, up to 40 MLD and so on, the instrumentation and measurements that are necessary.

The draft TOC on Part C (Management) prepared by JST was based on the O&M for Water Supply in India. The main points modified during the meeting were:

1. Subsection on Regulatory Framework to be included under the Section on Legal Aspects.
2. Human Resources Development to be added
3. Mention to be made in the chapter of Financial Management for appointing a separate Head of Accounts for Sewerage System in the municipalities. This was very important since funds get diverted to other purposes rather than to sewerage.
4. Financial Resources Generation to be added to Sec. 3.2
5. Tariff should lump together Fixation, Levy, Billing, Collection and Defaults.
6. Change all instances of Public to Community where feasible (for example, “Community Awareness” instead of “Public Awareness”)
7. Change all instances of “Wastewater” to “Sewage”
8. Public Redressal System to be included as one section in 4.2 of Customer Relation

Management.

The draft TOCs of the Design Manual and Part C Management were determined after extensive discussions as given in Appendix A5-3.

It was agreed that the 3rd Expert Committee meeting on the Design Manual would be held on 19th January 2011, and that the JST would present the Detailed Table of Contents including sections and sub-sections.

(B) Meeting on October 28, 2010 (O&M)

The JST made the same presentation as the previous day (October 27) for the benefit of new Expert Committee Members attending the meeting on this day.

Requests were made to the JICA Study Team by the Expert Committee members to find out the causes of the non-functioning of various STPs. The JST Leader indicated that this was not in the scope of work of preparing and revising manuals. The JICA Study Team did not have the time to investigate the causes of breakdown or non-working condition of facilities in various plants. The Team could only report its observations and the responses received from the staff of the plant on the causes of the breakdown.

Some of the EC members suggested that the subsequent visits to different plants by the JST should be cut down and the JST should concentrate on visiting fewer plants in more detail observing not just the STP but also the entire sewerage system starting from the household connection, collection of the raw sewage, the sewer network, conveyance means to the STP, disposal, re-use and so on. The manpower resources for the entire system should also be looked into by the JST so that the team had a better idea of the overall system before writing the Manuals.

A vigorous discussion was carried out on the contents of the O&M Manual, and the draft Table of Contents was finalized as given in Appendix A5-3.

It was decided that the 3rd Expert Committee Meeting on O&M would be held on 20th January 2011 as agreed upon by the Expert Committee and the JST. It was decided that the JST would present the Detailed Table of Contents including the Sections and Sub-sections in the 3rd Expert Committee meeting.

(3) Third Meeting

The third meeting between the JST and the Expert Committee was held on 19th and 20th January 2011. On the first day, the discussion was made related to Design Manual and on the second day the O&M Manual and Management parts were discussed. In these meetings, the draft TOCs prepared by JST, including Chapters, Sections, and Sub-sections for Part A Engineering, Part B Operation and Maintenance and Part C Management, were discussed in detail. Accepting the comments and suggestions of the Expert Committee members, presented TOCs have been modified and shown in Tables 5-1, 5-2, and 5-3 in the main Report.

(A) Meeting on January 19, 2011 (Design Manual)

In this Meeting JST presented a brief summary of the draft final report, Table of Contents of Part A Engineering, and the work plan in the next stage for the preparation of Manual.

As a part of draft final report, the JST presented outcome of the site visits to Allahabad, Bangalore and Chennai. Visit to these sewerage systems was undertaken to evaluate the feasibility of carrying out a pilot study for the purpose of collecting data. The objective was to explore the possibility of performing actual measurements of water flow and water quality and collecting data, which would enable calculation of mass balance in STPs. Visits were made to six STPs with mechanical dewatering facility, but the results showed that it would not be feasible to undertake the pilot study because of the following reasons:

- Time required for the study would be too long (6-8 months)
- At least 5 flowmeters would be required for measurement (cost of which would become excessive)
- Construction and modification work for fixing flowmeters would also incur high costs.
- Inadequate capacity of laboratory to undertake the contemplated water quality analyses.
- 2 out of the 6 STPs visited were not using mechanical dewatering facilities.

The JST emphasized that the focus would be on the Manual Preparation Plan. JST indicated that for preparing Table of Contents to be presented in this meeting, items such as resource recovery from sewage and sludge, energy savings, new treatment methods, MBR, SBR, nutrient removal, membrane processes, new pipe rehabilitation technology, unmanned inspection system for pipes, etc., were considered.

An important point discussed was the names of the manuals, and the EC recommended that the previous name of the manual be retained on all the three volumes as follows:

1. Manual on Sewerage and Sewage Treatment
   Part A Engineering
2. Manual on Sewerage and Sewage Treatment
   Part B Operation and Maintenance
3. Manual on Sewerage and Sewage Treatment
   Part C Management

Subsequently, the discussion started on Table of Contents. JST indicated that subsection level items (Level 3) were newly added in TOCs presented in the Draft Final Report (DFR) and will be discussed in this meeting. In the second EC meetings, the TOC were discussed and decided up to Sections level already. All items of the TOC in the subsection level were discussed vigorously by the EC members, and various items were added/changed/moved to other locations. Among major changes made to the TOC, Chapter 3 “Management, Administration, Legal and Financial Aspects” of Part A (Engineering) was decided to be removed since similar content existed in Part C (Management); however, the JST should ensure that all the items in this chapter were covered in Part C, and add them if they were not covered. In addition, the contents of Chapter 11 “Environmental Impact Assessment and Risk Management” were to be briefly incorporated in an appropriate chapter. Some of the items in the TOC are presented within brackets and the JST had to ensure that the items shown in brackets for certain subsections were included when writing the actual manuals. Based on the discussion, TOC of Part A Engineering has been modified and presented as Table 5-1 of the main report.

After the discussion on the TOC of the Engineering Manual was completed, the JST started discussion on the working groups to be formed by the Indian side. The JST explained briefly about the work plan henceforth (for the Second Phase). The scope of the study of the JST and the Indian side were explained. It was also explained that the Indian side needed to form Working Groups which would work together with the JST members giving them advice and data if necessary and discussing the draft chapters written by the JST members. The Working Groups (WG) would be formed by the CPHEEO, each group consisting of 2 to 4 members

appointed by the CPHEEO. The JST explained that there were no restrictions on the appointment of these WG members, and CPHEEO was free to select members of the WG as it saw fit.

The EC was given proposal of about 7 WGs each for Engineering and O&M Manuals and 2 WGs for Management Manuals. After the discussion, it was decided that only 4 WGs be formed each for Engineering and O&M manuals and 2 WGs for Management manual. It was decided by the EC that the slides of the WGs proposed by the JST should be sent to CPHEEO, which would send the same to all EC members inviting them as volunteers to join the working groups to which they wished to contribute.

Other points that were discussed during the meeting by the EC members were as follows:

a) One of the EC members pointed out that a tender was recently issued for an STP with impossible requirements as follows: Treatment: Activated Sludge Process; Influent characteristics: Ammonia - 50 to 246 and BOD - 245; Effluent characteristics: Nitrogen not to exceed 10.

   The member pointed out that some reasonable ranges of raw sewage characteristics should be provided for guidance in the manuals, since the manuals do not have legal binding. Some guidance related to these ranges is also provided in the book "Wastewater Treatment for Pollution Control and Reuse" by Soli J. Arceivala.

b) Reference was also made to the 74th Amendment of the Government of India for guidance to local bodies. The Manual could include a letter by some minister in the Foreword of the Manuals that best practices should be followed, and that local urban bodies should be advised to follow the Manual closely.

c) Measurement of flow by alternate method such as dye dilution was also described by an EC member.

d) Inverted siphons may be used when required, but a note should be mentioned that submersible pump is recommended for use when crossing water bodies, etc.

e) Patented processes should preferably not be mentioned but a general description could be given.

f) Sludge disinfection (heating and composting) should also be an item in the manual.

(B) Meeting on January 20, 2011 (O&M)

Similar to the presentation made on previous day (19th January), JST presented a brief summary of the draft final report, Table of Contents of Part B Operation and Maintenance and Part C Management, and the work plan in the next stage for the preparation of Manual.

As a part of draft final report, outcome of the site visits to Allahabad, Bangalore and Chennai was presented by the JST. Visits were made to six STPs with mechanical dewatering facility, but the results showed that it would not be feasible to undertake the pilot study because of the reasons mentioned earlier in this section.

The JST then explained about the work plan for the Second Phase for preparation of the Manual, in which the scope of the study to be undertaken by the JST and by the Indian side was presented. The JST emphasized that the formation of Working Groups comprising experts from Indian side is needed which would work together with the JST members giving them advice and

data if necessary and discuss the draft chapters written by the JST members. The Working Groups (WG) would be formed by the CPHEEO, each group consisting of 2 to 4 members appointed by the CPHEEO. The JST added that there were no restrictions on the appointment of these WG members, and CPHEEO was free to select members of the WG as it saw fit.

The EC was also given the proposal of about 6 WGs for Operation and Maintenance Manual and 2 WGs for Management Manual. An active discussion ensued and the number of working groups was reduced to 4 for Operation and Maintenance and was retained at 2 in case of Management. The topics covered under each working group for each manual were decided. The slides showing the composition of the working groups by topic would be sent by the JST to CPHEEO for further action on their part to select and form the members of different working groups. The final composition of Working Groups as discussed in the EC meeting is shown below.

Working Groups of Part A Engineering

Sub Working Group	Names of Chapters Covered (in bullets)
A-1	▪ Introduction ▪ Planning
A-2	Design of Sewerage Systems Related parts of following Chapters: ▪ Design and Construction of Sewers ▪ Design and Construction of Sewage Pumping Stations ▪ Design and Construction of Sewage Treatment Facilities ▪ Design and Construction of Sludge Treatment Facilities
A-3	Construction of Sewerage Systems Related parts of following Chapters: ▪ Design and Construction of Sewers ▪ Design and Construction of Sewage Pumping Stations ▪ Design and Construction of Sewage Treatment Facilities ▪ Design and Construction of Sludge Treatment Facilities
A-4	▪ Recycling and Reuse ▪ Onsite Management ▪ Emerging Trends

Working Groups of Part B Operation and Maintenance

Sub Working Group	Names of Chapters Covered (in bullets)
B-1	▪ General ▪ Safety and Health Management ▪ Budget Estimates for Operation and Maintenance
B-2	Sewage collection and transmission systems ▪ Sewer Systems ▪ Pumping Stations ▪ Electrical and Instrumentation Facilities
B-3	▪ Sewage Treatment Facilities ▪ Sludge Treatment Facilities ▪ Quality Analysis
B-4	▪ Environmental Conservation ▪ Onsite Systems

Working Groups of Part C Management

Sub Working Group	Names of Chapters Covered (in bullets)
C-1	▪ Institutional Framework ▪ Community Participation ▪ Public Private Partnership
C-2	▪ Management Information System ▪ Financial Management ▪ Asset Management

The Table of Contents of the O&M Manual prepared by the JST including contents up to subsection levels (Level 3) were discussed in detail. Several modifications, changes, and

additions were suggested by the EC members. Based on the comments of the EC, Table of Contents for Part B Operation and Maintenance and Part C Management have been modified and presented in Tables 5-2 and 5-3 in the main report. Some of the typical changes to the Table of Contents were as follows:

a) Add a subsection on “Adherence to laws and regulations of India”.

b) Change the title of subsection 1.2.2 to “Problems with effluent”

c) Add a subsection on subcontracting work with examples

d) Change instances of “public awareness” to “community awareness”.

e) Under the subsection on Do’s and Don’ts for community include information on not throwing items such as solid waste, or puncturing of sewers, etc.

f) The contents of the O&M Manual should be written in a language as simple as possible.

g) The section on submersible pumps should cover pumps with centrifugal impeller and screw impeller.

h) Some details of immersible pumps should also be given (submersible pumps requires minimum depth for operation, whereas this restriction does not apply to immersible pump).

i) A subsection on lift stations (called “manhole pumps” in Japan) for sewer pipes to be included.