REVIEW AND INVESTIGATIVE WORK ON CLOSED SYSTEM DISPOSAL FACILITIES IN SERVICE FOR AN IMPROVEMENT OF DISPOSAL TECHNOLOGIES(Ⅲ)

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ABSTRACT

The closed system disposal facilities (hereafter referred to as "CS") means: the landfill system with a roof. The number of CS in total, including those under construction and design are going to reach 50 as of 2008 in Japan. Some systems have already been in service for several years and a few of them have completed their service. Our research group reported in a former paper on the results of an investigation of 35 CS by sending inquiries to consultants, general contractors and managers who were operating CS. We continued our investigations of other CSs constructed and/or planned after our former investigations. Our group, as noted before, aims at making investigative work on existing or planned CS so as to seek valuable information. The information we ask for is not only including plain information but also information on problems to solve, on designing, constructing and operating technologies for CS in order to improve the closed type landfill system technology. We hereby report some statistics on the situation of CS in Japan obtained from the inquiries and some are results and counter measures we considered to solve problems or to improve CS technologies.

keywords : Landfil, Closed System Disposal Facilities,

INQUIRIES AND DISCOVERY OF PROBLEMS ON CS

We have already had information from former inquiries for the existing CS and this time we executed similar inquiries in addition for other CS planned or constructed after the previous investigation and got answers from 46 CS including former investigation in total. The inquiries are sent to relating consultants and general contractors asking about the following; design conditions, design concepts, thoughts on construction works and maintenance. Major items included in the inquiries are as follows;

(1) General specifications of the CS
(2) Conditions of the installation site
(3) Drawings and/or brochures
(4) Basic structure of CS
(5) Methods of bringing in and depositing of waste
(6) Waste stabilization methods
(7) Measures to control indoor environmental conditions
(8) Measures to control outside environmental conditions
(9) Methods of proper finishing of dumping, closure and ultimate land use of landfill sites
(10) Others

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In addition to the inquiries, we visited to several users of CS to listen directly to opinions from them about situations on the actual operation and maintenance and to get information on problems or issues of the system so that it can be improved.

We already reported in APLAS 2006 (Hanashima et al., 2006) on problems and tasks that closed system landfill sites have, which we discovered from the answers to our inquiries.

We continued the investigation after the inquiries to extend our knowledge on the subjects, especially on the relationship between the CS and the neighborhood residents, and the situation of leachate from CS that have been disused.

STATISTICS ON CS

We analyzed the answers to our inquiries from 46 CS and got some statistical data to show the present conditions on CS in Japan. Figures 1 through 7 show several samples of statistics on CS in Japan that are classified by various parameters.

The figures do not show the data of the facilities from which no answers were obtained.

Waste composition dumped in CS

Figure 1 depicts the composition of waste dumped in CS and mainly incinerated residue plus incombustible (52%), but there is also only incombustibles CS (30%), only incineration residue (11%), combustibles plus incombustible (7%). The incinerated residue and incombustibles have a tendency to increase the rate.

But there are three CS which deposit combustibles plus incombustibles. In the case where combustible wastes are dumped, it can be considered to generate gases such as CH_4, H_2S or H_2 and very careful maintenance and monitoring for indoor environmental conditions of CS should be performed.

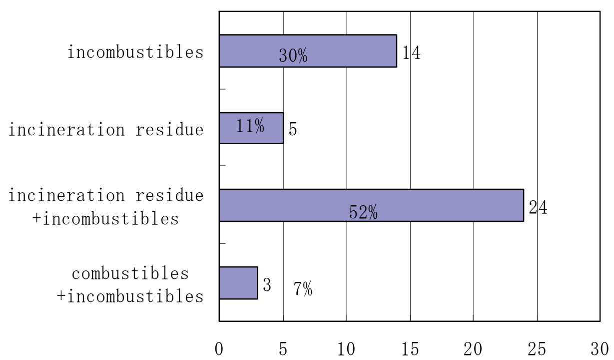


Figure 1 Waste composition deposited in CS

Dimensions of CS

Figure 2 shows dimensions of CS constructed or planned. Deposit capacity of CS is showed in figure 2(a) and the capacity of most CS are smaller than 50,000m^3 (85% in total) and the largest CS has a capacity of 195,000m^3 as of today.

Figure 2(b) and figure 2(c) illustrate the capacity of one (1) block, and the area of each block and the figure 2(d) shows the number of blocks in CS. For most of the CS, 87% of all, the capacity of one block of their site is less than 30,000m3.

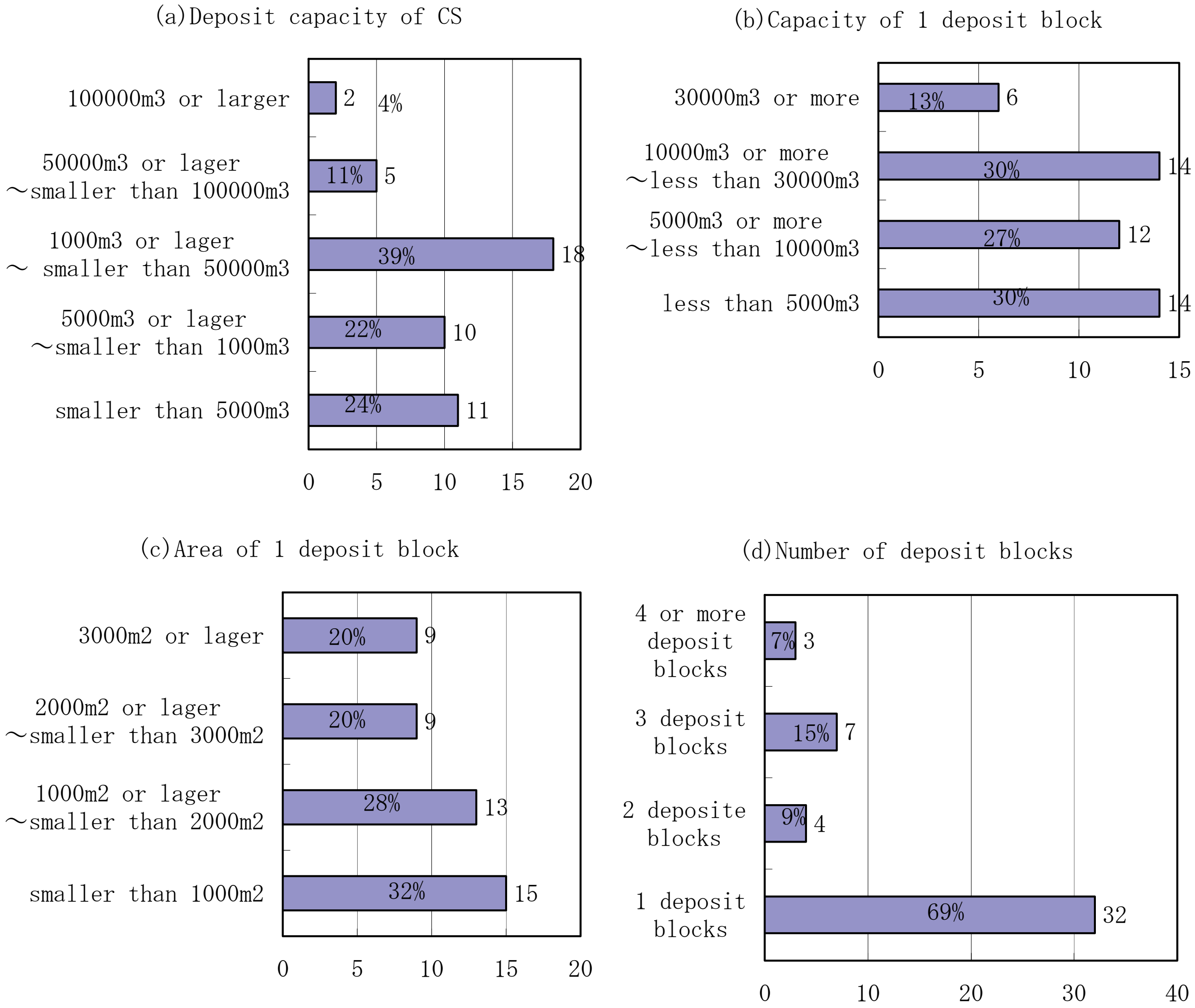
For the area of the block, smaller than 1,000m^2 the block has the largest percentage (32%) and 3,000m^2 or more is 20%. As for the number of blocks, one (1) block type that will not need to shift covering structure, has the largest numbers of installation (69%) and the percentage of CS having 4 blocks and more is 7%.

Anyhow, recently constructed CS or constructed CS in the future sees a future trend becoming larger in dimension and capacity.

Material and structure of the covering system

Material and structure of the covering system are shown in figure 3. Figure 3(a) shows that the percentages of roofs made of plastic sheets and steel plates are 15% and 85% respectively. The plastic sheet structure seems not to be strong against heavy snowfall, but actually, 3 CS out of a total of 7 that have plastic sheet structures are installed in the areas that have a heavy snowfall in the winter. The plastic sheet structure displayed its durability against the snowfall.

From the figure 3(b), most CS have a span length of less than 20m (47%) . The percentage of CS having 40m or more is 9%.



Figures 2 Dimensions of CS

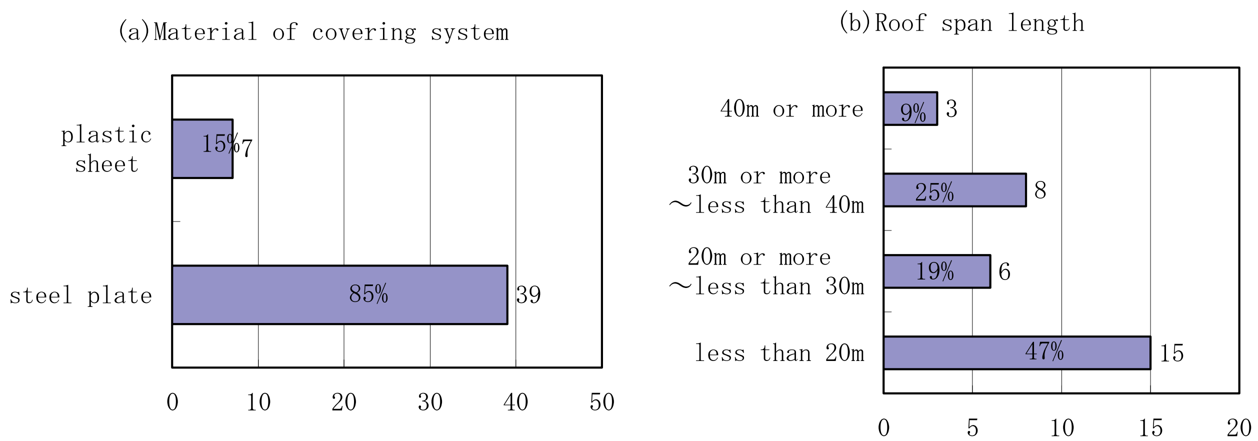


Figure 3 Material and structure of covering system

Storage structure

The statistic data on storage structure of CS are depicted in figure 4. Figure 4(a) shows most of CS has a reinforced concrete structure (51%). That is because the depth of CS is 5 to 10m in depth as shown in figure 4(b) and in order to get a larger volume for depositing with a minimum span of roofing, a higher slope gradient is adopted, so that a reinforced concrete structure is advantageous against a dam or a dam and sheathing structures. The slope gradient of CS structures is indicated in figure 4(c) and a vertical type has the largest share of 55%.

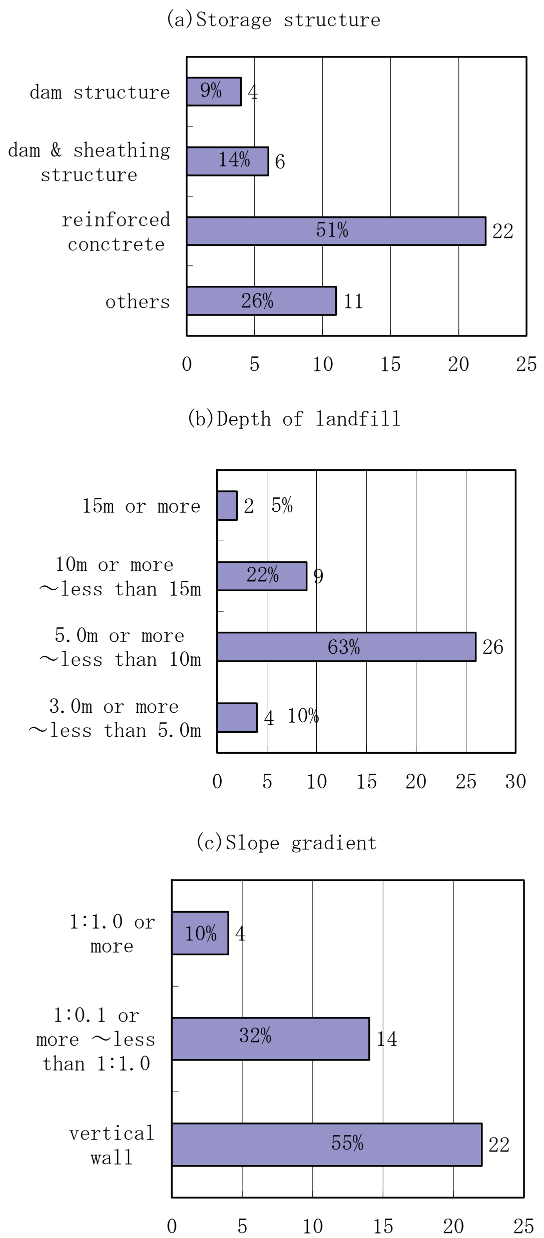


Figure 4 Structure of CS

Structure of waterproofing system

The Joint Order amended in June 1998 specifies the standard for landfills in Japan. The Joint Order designates the structure of the sub surface liner systems as follows;

a) The surface of clay layer, that is at least 50cm thick and has K(permeability coefficient) not exceeding 10nm/sec, should be covered with a lining sheet.

b) The surface of watertight asphalt concrete, that is at least 5cm thick and has K not exceeding 1nm/sec, should be covered with a lining sheet.

c) The non-woven fabric surface covered with double lining sheets. Non woven fabric must be placed in between the double lining sheets so that both sheets will not be damaged at the same time.

d) (Exceptional provision) A structure consisting of a mortar sprayed slope covered with a lining sheet or rubber asphalt is acceptable in the case of slopes where the slope angle exceeds 50% and the risk of leachate storage does not exist.

As for CS, the same specification of the Joint Order is applied. Figure 5(a) shows the structure statistics of waterproofing systems for the bottom of CS. The figure illustrates that CS with double liner sheets have the highest percentage of share 58%, and a concrete plus a liner sheet structure follows.

Figure 5(b) depicts a statistic data for structures of waterproofing systems for side wall and slope faces. The figure shows that CS having double liner sheets on the side wall and CS with concrete plus a liner sheet have a share of 44%. It has been discussed whether concrete could be added or omitted, as a waterproofing structure or not, but the conclusion has not yet been decided. Anyway, when the concrete structure is designed as a waterproofing structure, some technical consideration and measures should be taken into consideration for the concrete wall.

Figure 5(c) shows the setting method of liner sheet for side walls. The case of using flat bar is 44% followed by fixing with concrete.

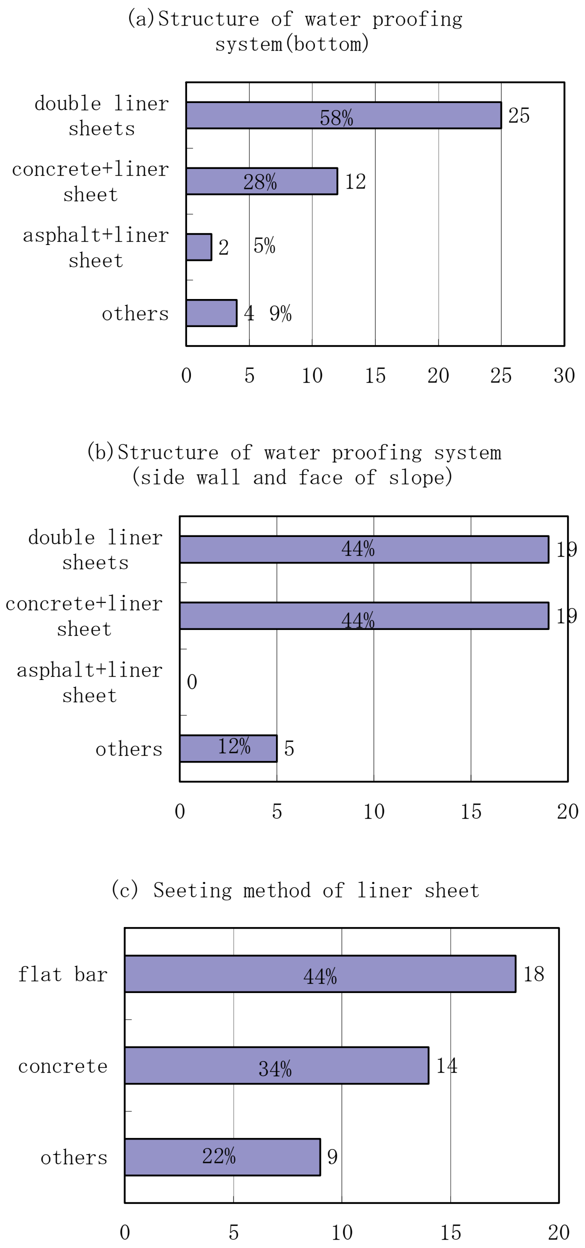


Figure 5 Structure of waterproofing system for CS

Waste stabilization systems

The waste stabilization is one of the important technical issues in CS. Figure 6 illustrates the structure of CS from the viewpoint of waste stabilization. The figure shows the semi-aerobic system, which is the most common in Japan and has the largest share of 79%. The semi-aerobic system supplies air which is necessary for the stabilization reaction in waste, through the leachate collection pipes located at the bottom of waste layer and the natural air flow caused by an ascending current of warmed air through the biological reaction in waste. So as to enhance stabilization reaction in waste, some CS adopted aerobic systems that are equipped with blowers to send air artificially from the bottom of the waste layer.

Because CS is not exposed to natural rain fall, controlled water supply is usually required for the stabilization and flushing of contaminants in the waste.

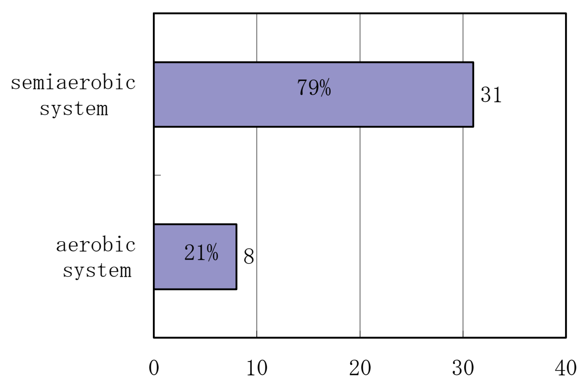


Figure 6 Waste stabilization systems

Figure 7 shows the destination of treated leachate. For five(5) CS, leachate is treated and desalinated by electro dialysis or reverse osmosis, and then desalinated water is reused for sprinkling usually without the discharge of water to the outside. This type of leachate treatment is applied for CS whose deposited waste includes incinerated residues which contains high inorganic salt.

Nine(9) CS are recycling their leachate after treatment without desalination. In this case, waste deposited in the CS is mainly incombustibles, incinerated residue is not dumped and the salinity of leachate is low.

In eight(8) CS, the leachate volume is very small, then leachate is transferred to other facilities such as sewage treatment plants and so consequently leachate is not discharged to public waters from the CS. Sixteen(16) CS treat leachate and discharge treated leachate into the public waters.

From the statistics, 22 of 41 CS adopt no-discharge system for leachate.

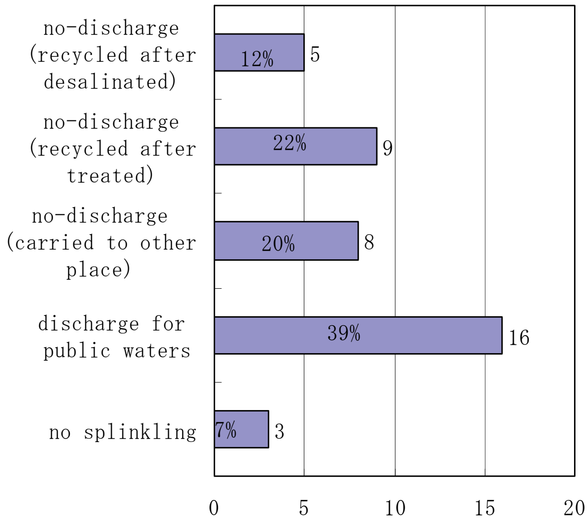


Figure 7 Destination of treated leachate

Trend of properties of leachate (Example cases of facilities that completed their service)

Of existing fifty (50) CS, only a few of them completed their operation. This section describes the trend of properties of leachate produced by a facility that completed their operation.

【Facility data】

Area of landfill 800m^2

Capacity of landfill 6,333m^3

Buried wastes incinerated residue (75%) and incombustibles (25%)

Operation began in April, 2002

Figure 8 shows the measurements of properties of the leachate produced by the facility that began the operation in April, 2002.

The facility was closed in June, 2005, and then, the roof was removed in March, 2006

The trend of properties of the leachate is as described below.

・The BOD and COD reached their maximum values in the early time of the disposal when the amount of disposed wastes is low and water is sprinkled steadily.

・T-N increased slowly until the facility was closed.

・Cl- is steady at approximately 20,000mg/L during the facility is in service.

・Every property reduced their level due to water sprinkling of high intensity after completion of operation of the facility.

・The facility maintains steady properties even after the roof was removed.

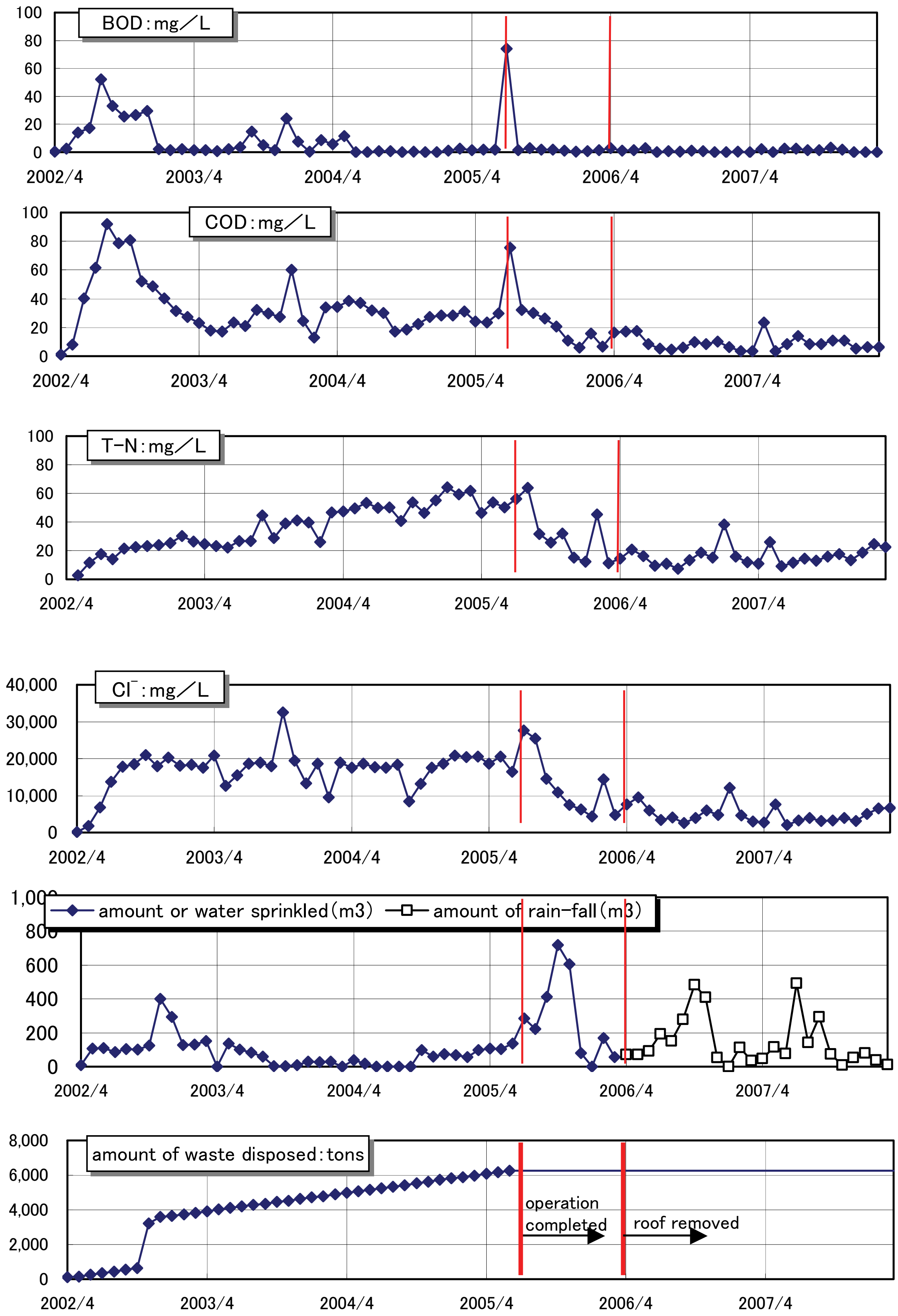


Figure 8 Results of leachate analysis

CONCLUSIONS

(1) We continued investigation of works by sending inquiries to consultants and general contractors, and by visiting CS in service to collect useful information on emerging issues to devise proper solutions. Hereby we reported some statistics to introduce the situation of CS in Japan.

(2) Statistics show most CS deposit incineration residue plus incombustibles or incombustibles only. CS depositing of partial combustibles should take much care to proceed with stabilization of waste and to control indoor environmental conditions.

(3) The capacity of most CS is 10,000m^3 or smaller, and the largest one has a capacity of 195,000m^3. Those CS are separated into one to six blocks.

(4) Steel plates are used mainly for materials of the covering system and some CS use plastic sheets. The roof span is usually less than 20m, but roofs having a span of 40m or more have already been constructed.

(5) As for the waterproofing system, double liner systems and concrete plus liner sheet are used.

(6) Semi-aerobic systems are adopted for waste stabilization for almost CS and some CS use aerobic systems.

(7) The example case facility that completed the operation shows low concentration of the leachate after closing the site and after removing the roof. This means that the water sprinkling during the disposal period functions effectively.

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