Remediation Project Report of Dioxins Contaminated Soil in Nose Town,Osaka Japan

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Abstracts

Approximately 11,000 tons of dioxins contaminated soil had collected on the ground surface near the municipal garbage incineration facility in Nose Town , Osaka Japan.
Konoike Construction Co., Ltd. has conducted on-site remediation project on those contaminated soils. The treatment was accomplished using the Thermal Phase Separation Method (TPS).[1] This paper introduces the system of soil remediation procedures and gives a report of executed soil remediation project with specific emphasis on the TPS method.

Introduction

Nose town is located to the northern edge of Osaka , Japan. In this town were 11,000 tons of dioxin contaminated soil dominated by the PCDF's . Those soil was contaminated by splashing of the water from cooling tower used for cooling the off-gas discharged by incineration facility for garbage generated from the surrounding residence and office district. Konoike Construction have successfully treated these contaminated soils on-site using the TPS method. Following the contaminant removal by TPS method, at present the condensed waste from the TPS method is being treated by the GeoMelt method.
Soils contaminated with dioxins may be treated by various methods ; Vitrification, Incineration, Direct or Indirect Desorption, Chemical Treatment, Washing and Solvent Extraction.
The GeoMelt method, which is an on-site vitrification system, was used in the Hashimoto Project arising out of the dismantling of the incineration facility at Hashimoto, Wakayama that contained wastes and soils contaminated with dioxins. This was the first time that the use of on-site remediation of soils contaminated with dioxins was done in Japan.[2] In this project, the GeoMelt method demonstrated excellent performance in its deconstruction of dioxins. However, it was found that the GeoMelt method proved costly , approximately 5,700US$/ton （700,000 Yen/ton） at the unit price , where there was relatively low to medium concentration of dioxins.
After the Hashimoto Project, efforts were made to combine the TPS method which is a type of indirect thermal desorption process with the GeoMelt method, to reduce the costs of soil treatment. Studies were done using the bench scale test which showed excellent results using the combined method for treatment of dioxin contaminated soils. Subsequent to the success of the tests, M.O.E test program adopted this method and confirmed its suitability as the remediation method for soils at the Nose site.[3] Arising from this confirmation TOYONOGUN –KANKYO-SHISETSU-KUMIAI approved the use of this method, and that was further supported by the committee of residents and remediation and environmental experts.

Methodologies

Fig.1 shows the combined TPS and GeoMelt process. The method consists of 4 part treatment process.

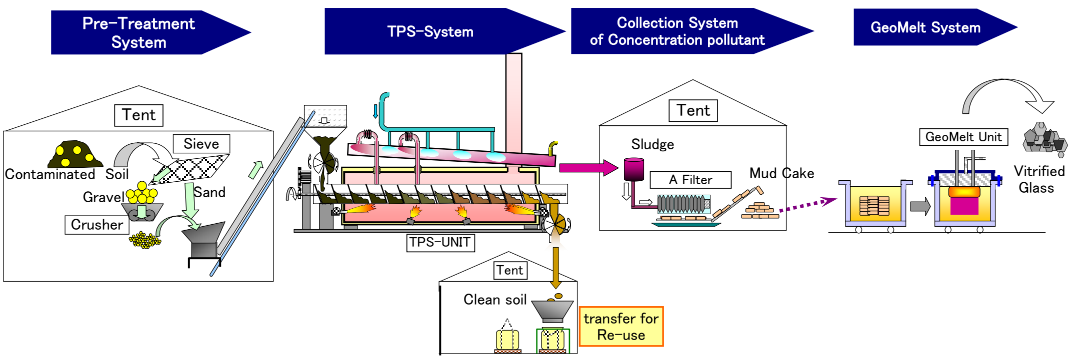

Fig1. TPS+GeoMelt method flow

①Pre-treatment system : This system consists of sieving , crushing and washing the contaminated soil. The process starts by the sieving and separation of the contaminated solids into 3 kinds of sizes. The stone larger than 100mm sieve size is washed and cleaned. The gravel of 30 – 100mm sieve size are crushed and later mixed with the soils which are less than 30mm sieve size. These soils are then fed into the TPS system.
②TPS system : This system removes the dioxin contaminants from the soil. This process separates the dioxins from the soils to produce clean soil and a small quantity of sludge containing the dioxins. The clean soil is confirmed free from dioxins and is reusable as a backfilling or other earthwork materials. Details of the TPS system will be further elaborated at a later chapter below.
③Collection system of a concentration pollutant : The concentrated sludge of dioxins from the TPS system , is then passed through a filter press that produces the dioxins condensed mud cake .
④GeoMelt System : the final process consists of the melting of the dioxins condensed mud cake. In this process the dioxins are decomposed by the use of thermic energy at approximately 1,600℃.

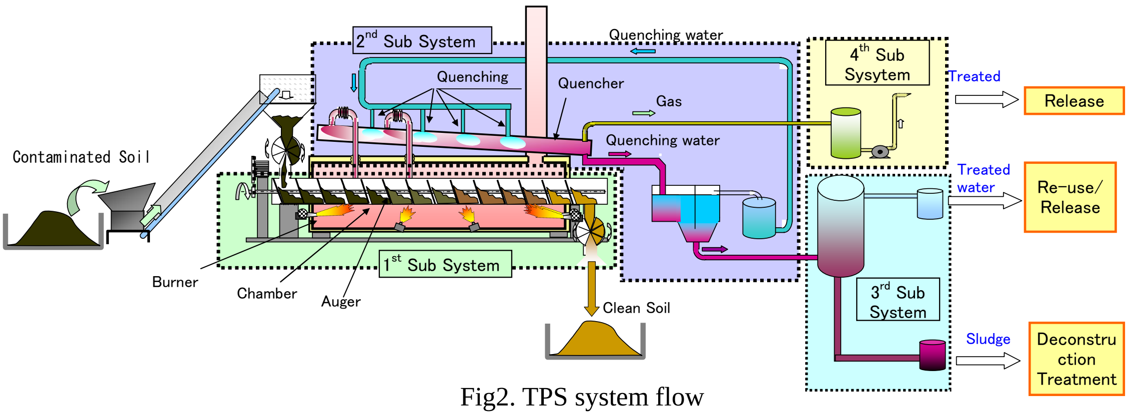

Fig2. TPS system flow

Fig.2 shows the flow chart of the TPS system. This system consists of 4 part Subsystem.
The 1^{st} Subsystem : This subsystem performs the thermal treatment of soils. The contaminated soil is fed from the hopper to the chamber through a rotary valve. In order to prevent any gas leakages, pressure in the inside chamber is maintained lower than the outside chamber. In the chamber the soil is driven by rotary augur. The soils are indirectly heated during the driving process to temperatures of between 400-650℃. At these high temperature zone, contaminants in the soil such as PCBs , PCDDs and PCDFs vaporize to gas and are thus removed from the soil.[4] The vaporized gas also includes steam generated from water in the contaminated soil. The clean soil is discharged from the end of the chamber through the rotary valve. This soil is cooled by a water spray, then the soil is analysed and tested for levels of dioxin concentration.
The 2^{nd} Subsystem : This subsystem consists of the quencher as well as the treatment system for the water used in quenching. In this process hot gas from the chamber is cooled using spray water. This enables the contaminants and dust to be trapped into the quenching water. The water containing the trapped contaminants is directed into a stilling tank. In the stilling tank the denser solution containing the contaminants and dust settles down leaving the upper portions of the tank with lighter levels of contaminants. This upper lighter water is cooled and recycled into the system. The dense water containing the solubles is fed into the 3^{rd} Subsystem. The cooled gas from the water spray is fed to the 4^{th} Subsystem.
The 3^{rd} Subsystem : This subsystem is the water treatment system. Effluent from the 2^{nd} Subsystem is processed to meet the criteria for drainage water. This may include a small volume of dioxins condensed waste (sludge) as a waste from the system. The 3^{rd} Subsystem consists of coagulation process , micro filters and activated carbon filters. This system ensures that almost all contaminants are removed from the water by the process of coagulation. The little remaining contaminants are further removed by micro filters. However the success of this coagulation and filtration process depends on if the water contains any oils or solvents because the contaminants dissolve in them thereby making this process not work properly.
The 4^{th} Subsystem : This subsystem is the gas treatment system. Immediately after quenching the gas with water spray , the gas feeds into a mist- separator , a mechanical filter and an activated carbon filter. The mist-separator

is able to remove the mist that contains the contaminants. The mechanical filter efficiently removes the physical particles. This process meets the criteria of stack gas when there are no PCB's or solvents. This means that the activated carbon filter works as a safety net of the stack gas that allows the gases to be released to the ambient air from the stack.

Site condition

Fig-3 and Pic-1 show the site arrangement of the TPS system plus other auxiliary tents at the Nose site. The contaminated soil which comes packed is carried into a pre-treatment tent through a sub-tent. An exclusive dust collector is connected to the pre-treatment tent. This dust collector purifies the gases that have been polluted during the pre-treatment works of the contaminated soil and also keeps the pressure inside the tent negative. The sub tent has three doors that effectively prevent the polluted air from escaping into the ambient air outside until the soils are transported.

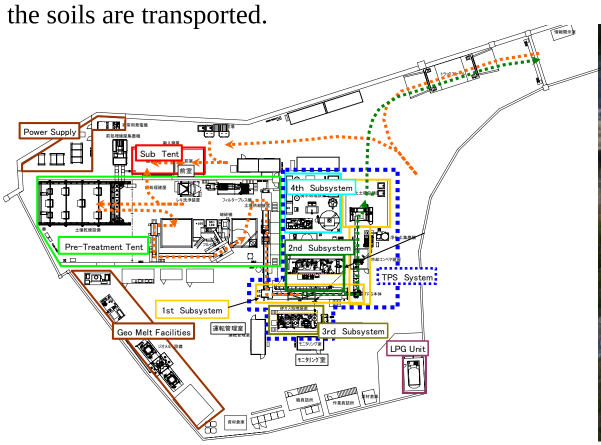

Fig-3 site arrangement

Pic-1 Site View

Table 1 shows the site condition and Table -2 shows the criteria of the project. The running parameters are also shown on table 1. The contract price of this project was approximately 16 million US$(1.97billion yen). It included not only remediation but also site arrangement , contaminated soil excavation , transportation and disposal of clean soil.

Table-1 The site Condition and Running Parameter

Name of Projects	TOYONOGUN BIKA center Contaminated soil remedeation Project
Cliants	TOYONOGUN KANKYO SHISETSU KUMIAI
Contractor	Konoike Construction Co., LTD.
Place	19-1 Yamauchi, Nose, Osaka Japan
Contract term of works	10 Aug. 2005 ～ 31 Jul. 2007 (Include additional works)
Soil weight	Approximately 11,000ton
DXNs Concentration	～10,000pg-TEQ/g
Running parameter	Feed rate = 1.0～1.75t/hr
	Retention Time = 45min
	Temperature = 700℃

Table-2 Criteria of this work

item		unit	Criteria
OutPut	Treated Soil	pg-TEQ/g	10
	Stack Gas	ng-TEQ/m^3	0.10
	Treated water	pg-TEQ/L	10
anvients	ambient air	pg-TEQ/m^3	0.6
	drainage of rain water	pg-TEQ/L	1.0
	soil	pg-TEQ/g	1000
Air of working Area	Pre-Treatment	pg-TEQ/m^3	—
	TPS treatment	pg-TEQ/m^3	2.5
	After Treatment	pg-TEQ/m^3	2.5

Results and Discussion

Fig 4 shows a comparison of the concentration levels of dioxins in the soil before and after using the TPS method at the Nose site including the M.O.E test program at same condition.

The target removal rate of dioxins at this project is 99.9% (at maximum concentration) and control is done using feed rate (treatment weight per unit of time) , temperature and residence time for target removal rate.

Fig-4 data shows that the almost rate of removal of

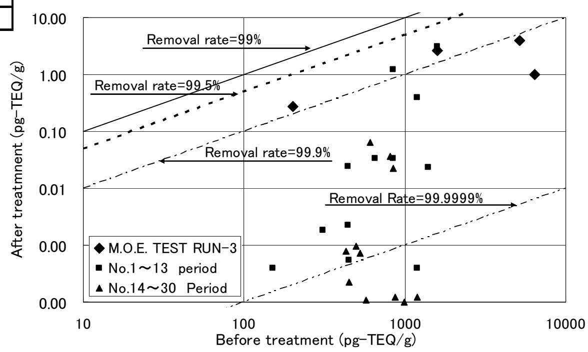

Fig.4 Dioxins Concentration before/after treatment and Removal Efficency

dioxins is higher than 99.9% but less than the 99.9999% which is the removal rate of the GeoMelt method. It is based on the foregoing that we consider that the TPS method is the most suitable for low to medium concentrations and large volumes of soils contaminated with dioxins. The data confirms that our proposition is correct.
Table 3 shows the concentration of dioxins in stack gas at the Nose Site. All the data certify the set criteria. Table 4 shows the dioxins concentration at each sub-system by the bench scale test of Nose site sample soils.[5] As can be seen, the dioxins concentration of the desorption gas is very high but nevertheless meets the criteria of stack gas after passing through the HEPA filter. This demonstrates the effectiveness of the activated carbon filter to work as a safety net. After the process of quenching, it was found that the dioxins concentration of bench scale test(13ng-TEQ/m^3) is different from dioxins concentration of M.O.E. test Run-3 (0.31ng-TEQ/m^3). We suppose that this disparity comes from the efficiency of the quenching system. It is therefore our observation that the performance of the quenching system sets the lifetime of the HEPA filters particularly if there is no refreshing systems.
Table 5 shows the concentration levels of dioxins in treatment water at the Nose site. This data certifies the criteria set for drainage water. Table 6 shows the dioxin concentration levels at each Subsystem of water treatment system at the Hashimoto Site.[6] The Hashimoto site used the same type of water treatment system as the Nose site. It can be seen that the dioxins concentration levels are very high before the water treatment. However, as for removal of the particles in water by coagulation process and micro filtration system, the dioxin concentration in water meets the criteria set. We can therefore conclude that the removal of particles from water is a very important procedure for water treatment.

Table-3 Gas Treatment results

Run No or Period No.	DXNs concentration (ng-TEQ/m^3) After Quenching	stuck Gas
M.O.E. Test Run-3	0.31	0.0000024
1-st	-	0
12-th	-	0.0000027
27-th	-	0.00060
criteria		0.10

Table 4 Dioxins Concentration at Gas Treatment Systems

Desorption gas	57	ng-TEQ/m^3
After Quenching	13	ng-TEQ/m^3
After HEPA filter	0.00055	ng-TEQ/m^3
After Carbon filter	0.000034	ng-TEQ/m^3

Table 5 Water Treatment Results

Run No. or Period No.	DXNs concentration (pg-TEQ/L)	SS (mg/L)
M.O.E.	0.14	1.2
Test Run-3	0.074	<1
1-st	4.6	<1
2-nd	0.96	<1
5-th	0.39	1.5
7-th	0.40	<1
9-th	2.4	<1
11-th	0.022	1.2
12-th	0.74	2.0
15-th	2.2	1.2
17-th	3.6	1.2
19-th	7.0	2.1
21-th	3.5	<1
23-th	2.7	<1
25-th	0.063	<1
27-th	2.7	<1
Criteria	10.0	200

Table 6 Dioxins Concentration at Water Treatment

sampling point	concentration	
Before Treatment	19000	pg-TEQ/L
After Coagulation process	360	pg-TEQ/L
After 10 μm-cartridge Filter	0.12	pg-TEQ/L
After Activated Carbon Filter	0.00086	pg-TEQ/L

Acknowledgements
We have successfully done an on-site soil remediation on large volumes of dioxin contaminated soil by the TPS method at the Nose site.
The project is scheduled for completion in May 2007 using the GeoMelt method that will decompose the contaminants collected by the TPS.
In this project it is our observation that the TPS method is suitable for remediation of soils contaminated with dioxins of low to medium concentrations. The removal rate of contaminants in soil using the TPS method is all over 99.5% and almost over 99.9 % in this project
Indeed, this percentage may vary depending on feed rate, the temperatures and residence time. However, these variables can be fixed to control the removal rate.
For the gas and water treatment, it is considered essential to remove the particles in the gas and the water to satisfy the criteria when there are PCDDs and PCDFs contaminants.

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