Overview of Waste Management and the Facility Maintenance

Center for Material Cycles and Waste Management Research
National Institute for Environmental Studies, Japan (NIES)
An example flow diagram in the waste incineration facility

- Combustible waste
- Rough crusher
- Receiving pit
- Crushing pit
- Gasification furnace
- Melting furnace
- Slagging device
- Slag pit
- Boiler
- Cooling tower
- Catalytic reaction tower
- Bag filter
- Dust treatment system
- Induced air blower
- Dust bunker
- Export
- Power generation
- Steam turbine
- Melter inside air
- Exhaust gas heater
- Air heater
- White smoke prevention
- Chimney

Legend:
- Waste flow
- Exhaust gas
- Slag
- Steam
- Fly ash

Incombustible materials: Iron, Aluminum

Hot water supplied to the residual heat utilization facility

In-house consumption

Melter inside air

Induced air to prevent white smoke

Steam turbine

Dust bunker

Export
・In a municipal waste treatment plant, each system is housed in the building under negative pressure.
・Daily inspections and periodical inspections are conducted.
・In the periodical inspection, operation may be stopped to carry out work inside the furnace.

Source: Mitsubishi Heavy Industries Environmental & Chemical Engineering Co., Ltd. Homepage
Locations of potential high dose rate in the incineration facility

The dust is knocked off at regular intervals. There is no significant accumulation of dust at the bag filter system. The dose rate is relatively low.

A large volume of dust (fly ash) is accumulated in the dust storage tank. The dose rate is high in the proximity.
Accumulation of radiocesium in the melting facility

Radioactivity concentration in dust

Radioactivity concentration distribution in the refractory of the back combustion chamber (middle)

Source: “Survey on the ambient dose rate inside the rotating surface melter and the penetration of radiocesium into the refractory” by Abe et al., The 1st Workshop of The Society for Remediation of Radioactive Contamination in the Environment (2012)
Handling of incineration fly ash containing radiocesium

Discharge of ash from the fly ash hopper ⇒ Note dispersed dust

Transportation of flexible bag containers

Filling the flexible bag container

Storage of flexible bag containers
Treatment of disaster waste in Miyagi Prefecture

(Miyagi Eastern Block Secondary Processing Plant)

The issue in the future is the disaster waste treatment in the project managed directly by the national government in Fukushima Prefecture.
Landfill disposal site

Landfill works: Transportation and placement using trucks ⇒ Leveling with heavy equipment ⇒ Covering with soil
(Reference) What is the behavior of radiocesium in the waste when being incinerated?

The radiocesium in the waste will be divided into two parts: one part is volatilized or forms small liquid drops when the flame temperature is 850°C or higher and it is discharged along with the exhaust gas; and that the second part remains in the ash.

Source: Mitsubishi Heavy Industries Environmental & Chemical Engineering Co., Ltd. Homepage
What is the behavior of the volatilized radiocesium in exhaust gas?

When the exhaust gas is cooled, radiocesium in the form of a gas or a liquid will form chemical compounds, most likely (radio)cesium chloride, in solid form, and the resulting solid particles are transported along with other materials as dust particles.

Cesium chloride, etc. in the form of gas \(\rightarrow\) Condensed Dust particles (fly ash) (Several tens of μm in average)

The temperature near the bag filter drops to 200°C or below

Characteristics of cesium chloride (CsCl) in exhaust gas
Boiling temperature (temperature to transform from liquid to gas phase): 1300°C
Melting point (temperature to transform from solid to liquid phase): 646°C
Vapor pressure of CsCl (cesium chloride) is substantially lower compared with dioxins. All are trace contaminant but the estimated vapor pressure of CsCl is 9 to 11 orders of magnitude lower than the values of the dioxins.

Radiocesium is solidified more easily than dioxins are, meaning it is removed more easily with the bag filter.

(Reference) Comparison of vapor pressure at temperatures of 150 and 170°C near the bag filter (Calculated by NIES)

<table>
<thead>
<tr>
<th>Temperature (°C)</th>
<th>Vapor pressure of 2,3,7,8-T4CDD (Pa) (tetrachlorodibenzo dioxin)</th>
<th>Vapor pressure of OCDD (Pa) (octachlorodibenzo dioxin)</th>
<th>Vapor pressure of CsCl (cesium chloride) (Pa) (Note that this is an estimated value)</th>
</tr>
</thead>
<tbody>
<tr>
<td>150</td>
<td>0.522</td>
<td>7.15E-03</td>
<td>2.75E-12</td>
</tr>
<tr>
<td>170</td>
<td>2.560</td>
<td>4.79E-02</td>
<td>3.37E-11</td>
</tr>
</tbody>
</table>
What is the behavior of radiocesium contained in the dust?

- Dust particles containing radiocesium may be removed or collected efficiently with a bag filter.

- A pre-coating layer of chemical agent is formed on the filter. Dust particles deposit as a layer on the coated filter and particles having a size of submicron order (less than $1\mu m$) are removed.

Mechanism of removing particles with the bag filter:

1. Exhaust gas enters the filter cloth.
2. A pre-coating layer of chemical agent is formed on the filter.
3. Dust particles deposit as a layer on the coated filter.
4. Particles having a size of submicron order are removed.