June 19, 2020

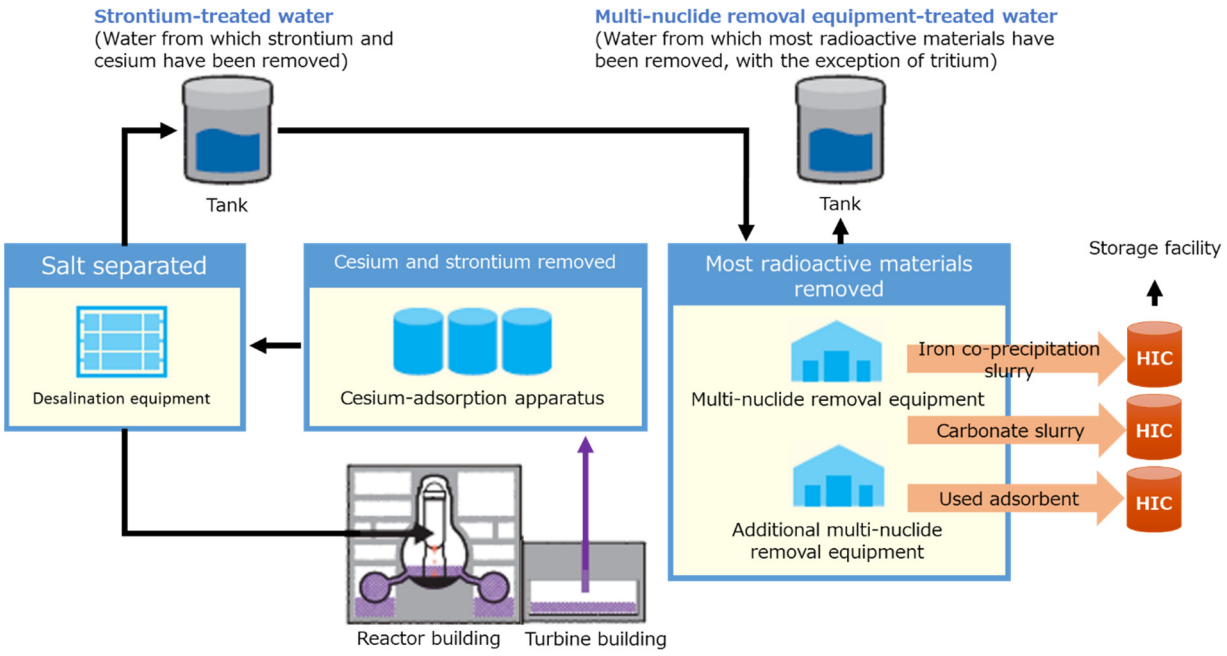
Plan for the Stabilization and Treatment of Waste generated by Contaminated Water Purification and Treatment Facilities

1. Waste generated from the purification and treatment of contaminated water

At the Fukushima Daiichi Nuclear Power Station, contaminated water is purified using various equipment in order to reduce the amount of radioactive materials it contains. This water that has been treated with multi-nuclide removal equipment (hereinafter referred to as, “treated water”) is then stored in tanks.

Multi-nuclide removal equipment, which comprises one part of this system, is able to reduce the concentration of most of the radioactive materials (62 types) in the contaminated water with the exception of tritium. The purification and treatment process generates two types of waste. One is a thick mixture of liquid and solids called "**slurry,**" ("iron co-precipitation slurry" and "carbonate slurry") and the other is "**used adsorbents**". This waste is stored in polyethylene storage containers called “**HIC**”[*1].

<Contaminated water purification and treatment>



*1 HIC (High Integrity Container)

Storage containers made of stainless steel-reinforced polyethylene made specifically for use with multi-nuclide removal equipment

HIC

HIC filled with waste are stored safely within on-site temporary storage facilities in large concrete boxes that shield the radiation.

Temporary storage facility for HIC

Concrete box

Slurry and used adsorbents stored in HICs are generated by multi-nuclide removal equipment.

During the pretreatment process, chemicals are injected to remove radioactive materials and adsorption inhibitors. As a result, two types of slurry are generated: “**iron co-precipitation slurry**” (See photo #1 below) and “**carbonate slurry**” (See photo #2 below). Radioactive materials contained in the pretreated water (62 types) are selectively adsorbed by adsorbent materials. After adsorbing contaminants, these materials are treated as waste and referred to as “used adsorbents” (See photo #3 below).

1. Iron co-precipitation slurry

2. Carbonate slurry

3. Adsorbent

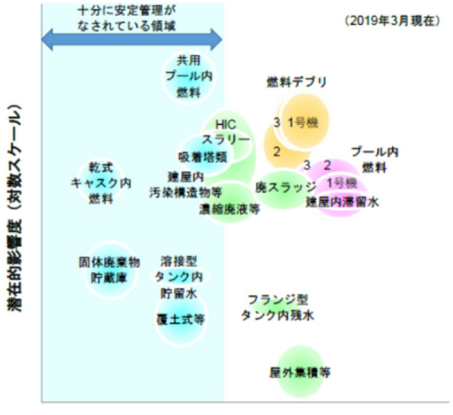
2. Further reducing risks associated with storage (stabilization)

In its "Technical Strategy for the Decommissioning of the Fukushima Daiichi Nuclear Power Station 2019," the Nuclear Damage Compensation and Decommissioning Facilitation corporation (NDF) rates liquid waste “slurry” as being “relatively high” in its evaluation of various sources of risk (See diagram on the right).

The main risks associated with slurry are as follows:

1) Leakage of slurry stored in HICs

2) Degradation of HIC due to radiation



Risk level of maior risk sources

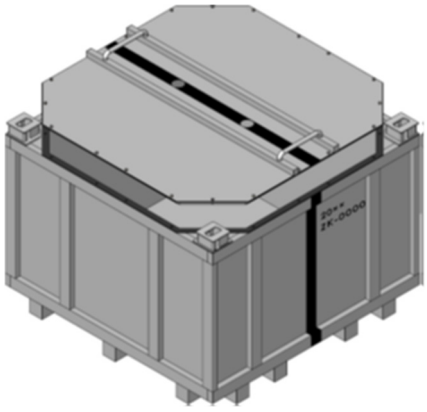
To address the above risks associated with storage in HICs, we have reduced the amount of liquid slurry injected into HICs to prevent leaks and we also drain the supernatant water from the HICs.

In addition, safety measures have been implemented at the temporary storage facility where HICs are stored to prevent slurry leaks, such as using watertight concrete boxes and installing leak detection equipment. In regards to the degradation of HIC due to radiation, we have analyzed the impact that radiation has on HICs[*2] and have suitably determined the service life of these containers in order to ensure HIC integrity.

* 2 In regards to the number of years that HIC integrity can be ensured, we have confirmed that HIC with the highest surface doses (14mSv/h) will maintain integrity for approximately 10 years, and that HIC with lower surface dose rates can be used for several decades or more.

The storage of slurry in liquid form poses various risks as mentioned earlier, so we are currently working on a plan to further reduce these risks associated with storage.

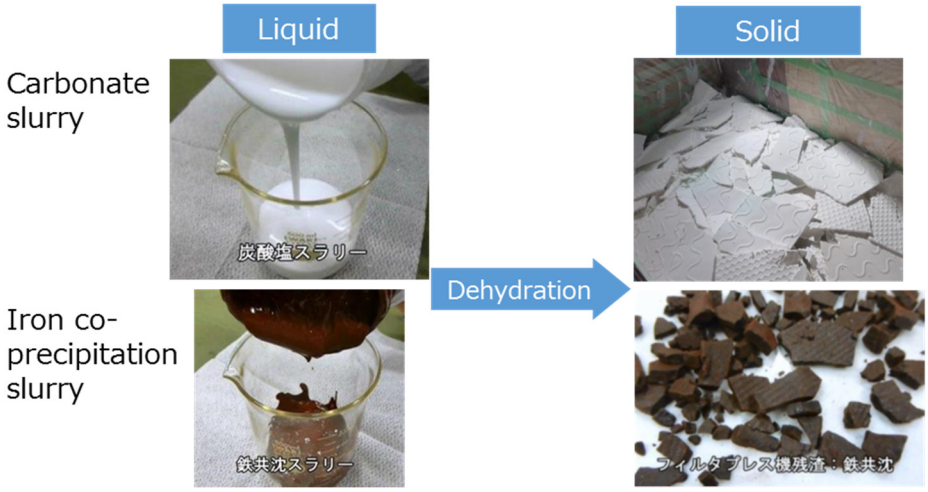
We plan to extract the slurry stored in HICs and dehydrate it, thereby turning it from a liquid into a solid that can be stably stored in an indoor waste storage facility.
The risk of slurry leakage is eliminated if the slurry is in a solid state. In addition, the risk associated with the degradation of waste storage containers due to radiation can be reduced since the container used for storing this solid waste after dehydrating the slurry will be made from metal and therefore not affected by radiation (See diagram on the right).



Storage container for dehydrated waste (proposed)

This process of extracting the liquid slurry stored in HICs, dehydrating it, and converting it to a solid state is called, "stabilization".

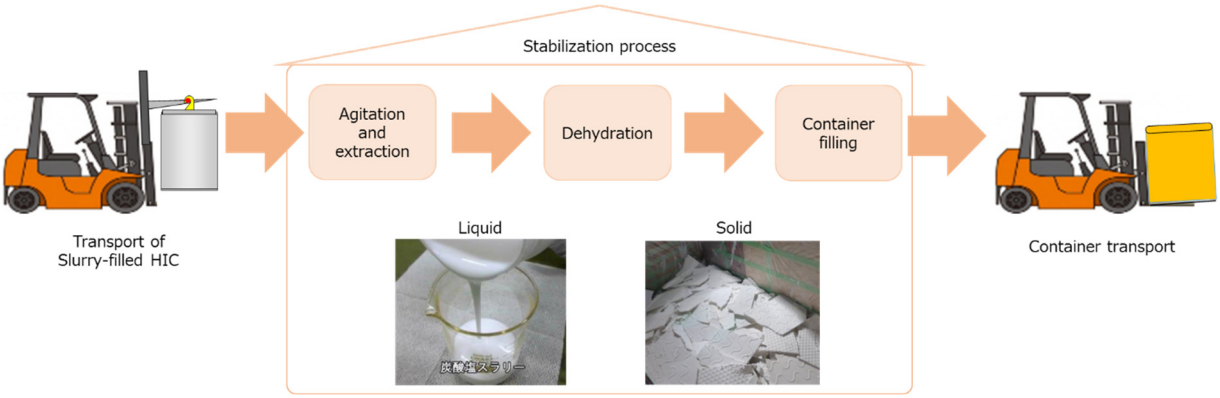
<”Stabilization" of liquid slurry (iron co-precipitation and carbonate) through solidification>



3. Slurry stabilization process (To commence in FY2022)

Slurry stabilization equipment employs the filter press method, which is widely used to treat sludge, to dehydrate the liquid slurry into a solid state. Since the equipment is used to treat radioactive materials, we have decided to use models[*3] that can be easily operated remotely thereby reducing worker radiation exposure.

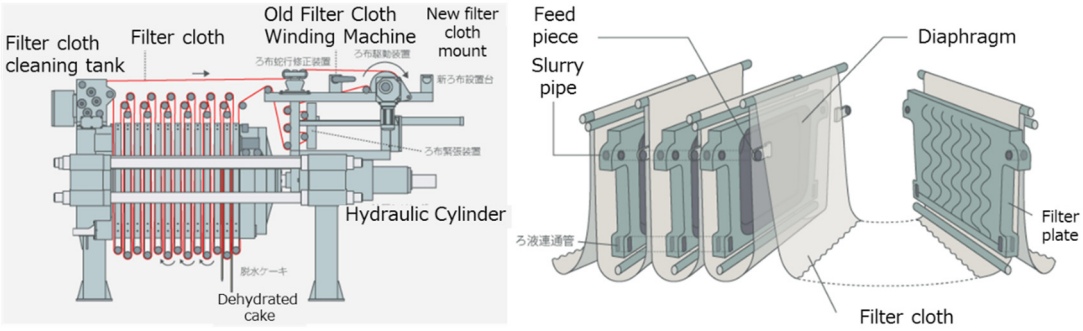
<Overview of stabilization equipment >



The stabilization process consists of the following three main steps during which the slurry is dehydrated into a solid state that can be stably stored.

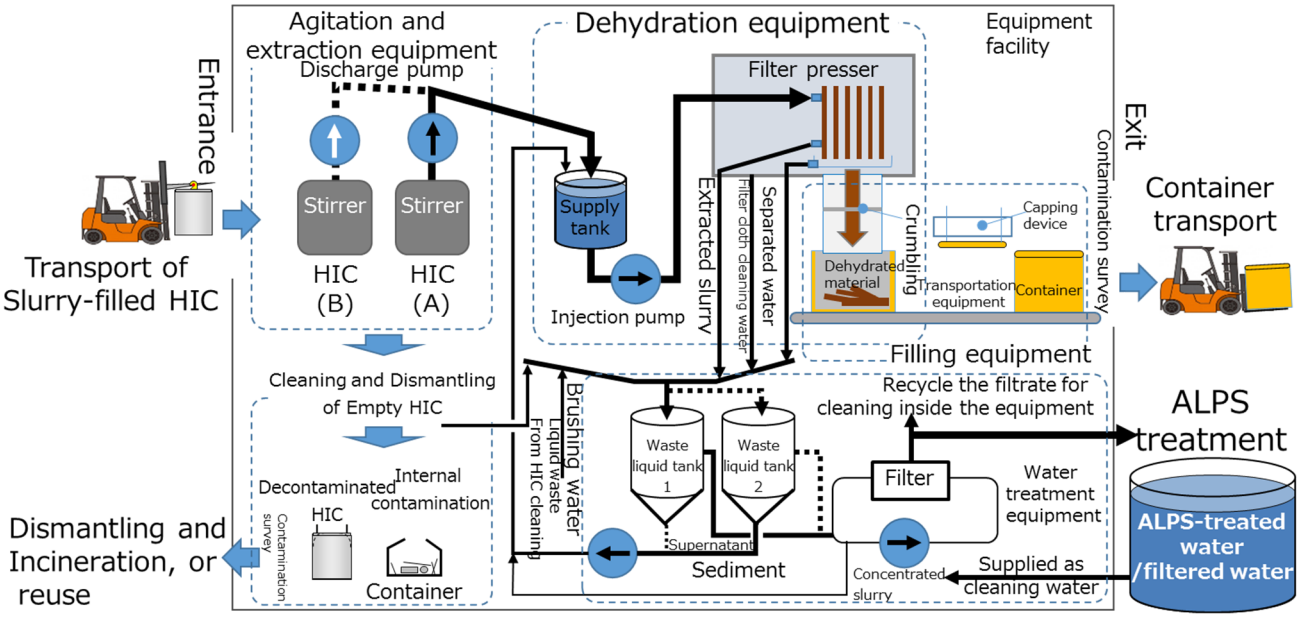
Step 1: The solids that have settled in the HIC during storage are agitated to return them to a liquid state after which they are extracted.
Step 2: The liquid slurry is dehydrated in a filter press to convert it into a solid.
Step 3: The solid, dehydrated material is filled into a storage container and the lid is closed in preparation for transport.

* 3 ”Endless filter cloth” filter press



In the filter press, the slurry is injected into a closed space where the filter cloth is held taught against a filter plate and further compressed by a diaphragm to squeeze out the water. After this process, the filter cloth is loosened to allow the dehydrated solid material to fall under its own weight. The equipment is also designed to feed the filter cloth through the machine thereby ensuring that all the dehydrated solids are discharged.

<Slurry stabilization process flow>



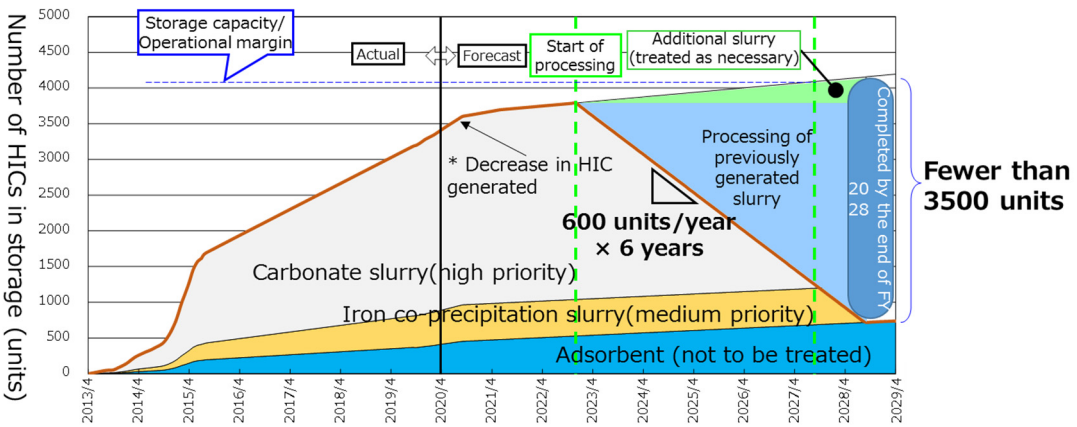
In addition to the **dehydrated material, which is** stored in storage containers, the stabilization process also generates empty **HIC**, **water** that has been separated from the slurry during dehydration, and liquid waste generated during the cleaning of the equipment and filter cloth.

Most of the empty HIC will be dismantled and incinerated, but some will be considered for reuse. Some separated water and liquid waste will be recycled after filtering to remove the solids, and the excess will be transferred to multi-nuclide removal equipment for purification.

<The stabilization process is scheduled to begin in FY2022>

Slurry stabilization equipment is currently being designed and is scheduled to be put into operation in FY2022. After the stabilization process begins, the slurry in approximately 600 HICs will be extracted and dehydrated annually. Since the slurry generated by multi-nuclide removal equipment will also be stabilized at the same time we will be able to eventually eliminate the temporary storage of liquid slurry altogether.

<HIC storage volume>



As of April 2020

Approximately 28 HICs are generated each month in conjunction with contaminated water purification (as of February 2020). From the summer of 2020, the amount of water to be treated with multi-nuclide removal equipment will decrease in conjunction with the expected completion of the treatment of strontium-treated water currently stored in tanks. Once this is completed only about 10 HIC will be generated each month.

Although more than 80% of HICs generated contain liquid slurry, we have enough storage capacity for liquid slurry to last for six to seven years even if the current storage method continues to be employed.