Overhead Gantry System and Basket Handling for the Pyroprocessing Automation Verifying Mock-up

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The more spent fuel has been stacked in the nuclear power station, the higher apprehension has been growing. Pyroprocessing, one option to recycle the spent fuel, has been studied in Korea Atomic Energy Research Institute. Processing cells were prepared, and various experiments were carried out using surrogate. One salutary lesson from the experiments was the trouble usually comes from the molten salt, rather than radioactivity of the material. Molten salt is highly corrosive, and even worse Pyroprocessing requires to regulate high temperature. Another difficulty from the experiments was the remote handling. For engineering scale experiment, the target objects to handle, such as crucible, material, or electrode, were about 10 ~100 kg, and they usually exceed the payload of the mechanical MSM (master salve manipulator) capability. Simplification of handling operations should be considered in the equipment design, and motorization or automation of equipment were desirable.

As mentioned above, mechanical reliability and remote handling does matter to achieve economic feasibility of Pyroprocessing. To break through the mechanical engineering problem in Pyroprocessing, KAERI tried to resolve the troubled mechanical issues in separate experimental space. The Pyroproccessing Automation Verifying Mock-up (PAVM) was planned to address the mechanical reliability and automation of processing equipment. The figure 1 shows the conceptual drawing of the PAVM.

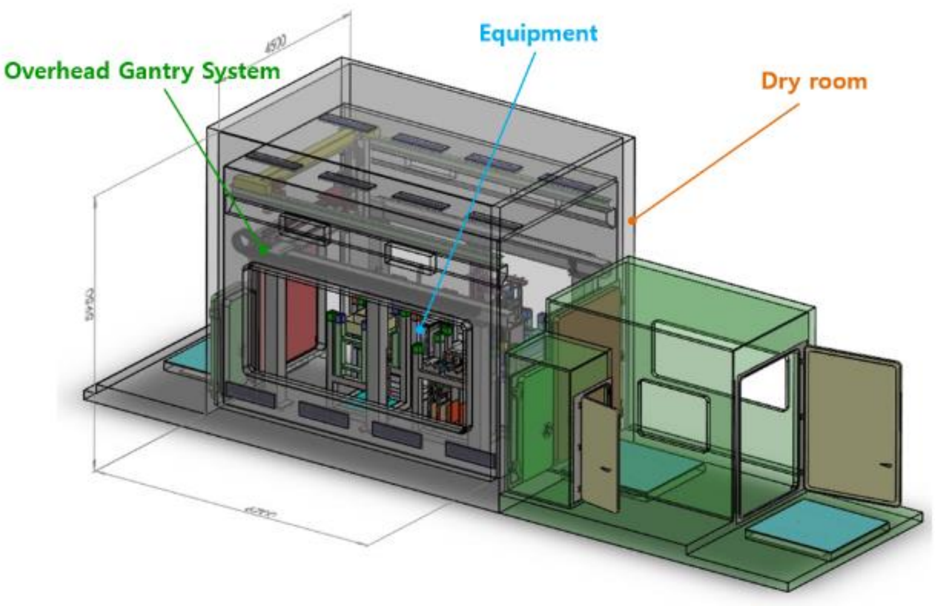

Figure 6: Conceptual drawing of the PVAM.

The main space of the PVAM is a dry room, which would be maintained under the dew point -40 degree Celcious. The size of the dry room was determined as enough to locate two pieces of processing equipment. As the estimated base size of equipment is about 1200 mm by 1200 mm for engineering scale process, then, the dry room size was designed as 4000 mm by 6000 mm. A human worker is allowed to access the dry room through a vestibule, where would be a buffer zone between dry room and atmospheric outside. A crane was installed on ceil of the dry room, and it help to move heavy equipment or material. A precision overhead gantry system was also equipped for automation experiment.

Overhead gantry system in PVAM

Purpose and requirements. The main purpose of the PVAM is to find reliable solutions using molten salt, and it will also be utilized to explore effective ways to simplify the handling operation and automation method. The operations of equipment could be roughly depicted as like preheating, loading material, installing electrode, processing, unloading material, or replacing electrode. The most frequent operation is loading material, and that is top priority to make automation. To load material, a basket should be handled, inserted on a slot, and immersed into molten salt. The requirements of the overhead gantry system are brought to accomplish the sub task of the material loading operation. The requirement are listed below;

- 3 DOF motion (X-Y-Z traveling)
- Work space 3200 (mm) x 4300 (mm) x 1400 (mm)
- X-Y direction force 1000 N
- X-Y direction max speed 1.8 m/s
- X-Y direction linear motor drive
- Z direction max load 50 kg
- Z direction two stage telescopic mechanism
- Precision of each direction is sub mm.
- Various end-effectors are replaceable on the installed tool changer

By adopting industrial precise gantry solution, the overhead gantry system in PVAM was designed as shown in Figure 7.

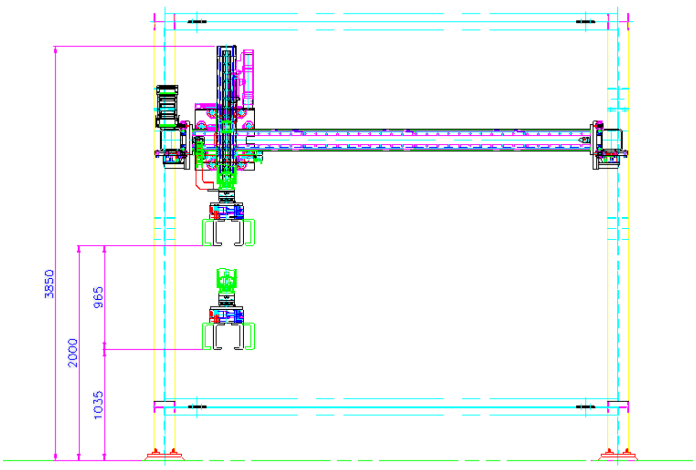

Figure 7. Design of the overhead gantry system in the PVAM.

Installing gantry system and basket handling in a dry room

To minimize the dry volume, two stage telescopic mechanism was installed for z-directional motion. The workspace of the gantry system is shared by the crane system. While the crane is located parking position, the gantry system moves the rail for automation work. On the other hand, the gantry system should be located on the opposite corner to use the crane. Each system is interlocked not to be activated on the same time. A linear motor drive the gantry system, and magnetic scale was utilized for precise position feed-back.

Figure 8. Precise gantry system driving by linear motor.

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