Example Operating Procedure for an Automation Concept of Electrochemical Process

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1. Introduction

Various ways to reduce the toxic waste in spent fuel has been extensively explored. Pyroprocessing has been studied as one option for compressing down the waste, by recycling 95 percent of Uranium from the spent fuel. The spent fuel is highly radioactive so that the treatment should be performed in a hot cell. The human operator is not allowed to access in the hot cell, thus he or she uses remote devices in order to manipulate material or equipment from outside of the hot cell. Until now, most operations in the hot cell were manually done, and mechanical MSM (master-slave manipulator) became the main tool. However, manual operation is inefficient. Moreover, it can cause human errors. An adoption of modern automation solution has been, therefore, considered for nuclear facility, and a preliminary automation concept for Pyroprocessing was proposed at KAERI [1].

In this research, operating procedures for the proposed preliminary automation concept is discussed in detail.

2. Automation concept of electrochemical process in Pyroprocessing

To make an outline for automated Pyroprocessing, the existing manual operation in processing cell was analyzed, and the requirements for changing the manual ways into automated method were deduced. Finally a preliminary automation concept for integrated Pyroprocessing was proposed [1], as shown in Fig. 1. The proposed processing cell was composed of 4 automation zones. In the automation zone, electro chemical equipment for Pyroprocessing and the automated handling devices cooperate dynamically, and finally an automation workflow can be achieved.

The most important thing in automation is to simplify and standardize the existing methods. A design guide for the electrochemical equipment was proposed. That is to help modularize the equipment for convenient handling by the automated handling devices. Each module attaches a standardized docking knob, which can be transported by the automated handling devices.

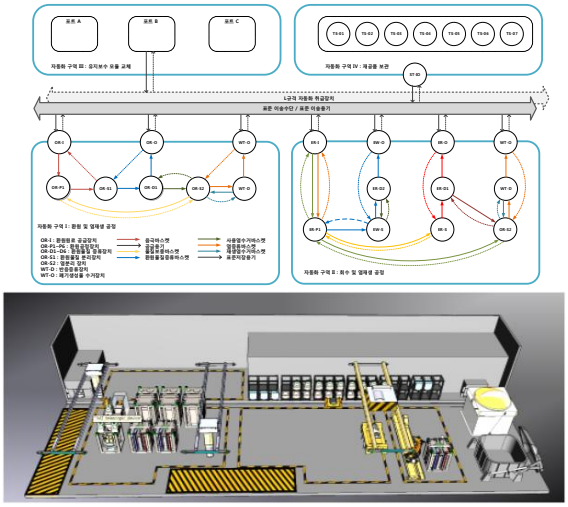

Fig. 1. Preliminary automation concept for Pyroprocessing.

Fig. 2 shows the example design of electro chemical equipment and the automated handling devices to handle the modules. Electrochemical process in automation zone I, most frequent operation is to replace basket and electrode. The basket and electrode are designed as modules which have standardized docking knob, and it can be easily replaced by using the automated handling device.

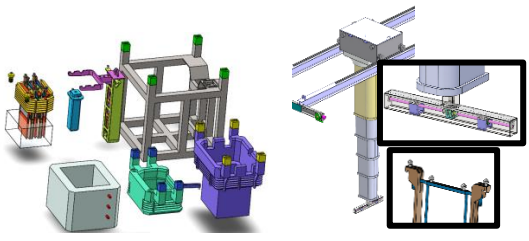

Fig. 2. Modular equipment and automated handling device.

In the proposed automation zone I, the core processes are proceeded by three pieces of equipment,

an oxide reductor, cathode processor, and the salt reprocessor. In between the core equipment, several supporting devices are located to transfer material from the previous crucible to the next crucible. Finally, 8 pieces of equipment are proposed to be located in the automation zone I. Fig. 3 shows the equipment list and the basket flow in the automation zone I.

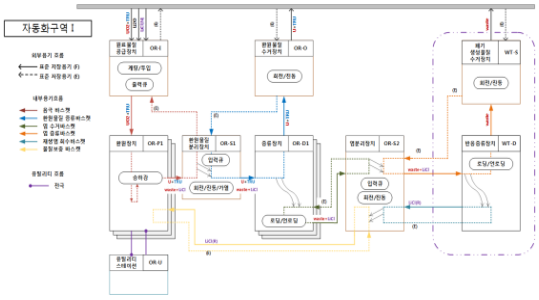

Fig. 3. Basket flow in automation zone I.

3. Example operating procedures in automation zone I

Six types of baskets are defined to transfer material in the automation zone I, as shown in Fig. 3. The basket A circulates among Equip I, II, III. The basket B successively moves from III, IV, V. and the empty basket is forwarded to III again. The basket C move the basket D. The basket D keep moving to VII, VIII continuously, then the empty basket D back to VI. The basket E carry the purified salt from VII to VI, then back to VII. The basket F get the purified salt from VII and put it into

The basket flow in Fig. 3 can be expressed as a flowchart form as shown in Fig. 4. Actually the operation of equipment happens in discrete time, and several operation is possible to proceed in parallel. Even though the flowchart does not matched in time line, it helps to figure out the causality among the operations. The detailed operation procedures in automation zone I are break down, and it is included in the flow chart.

4. Conclusion

An example operation procedure for an automation concept of electrochemical process was proposed in this research. The developed operation procedures were based on one automation zone, which was introduced in the preliminary automation concept for integrated Pyroprocessing. The example operation procedure was compiled as one flowchart form. The procedures will be utilized to develop control logics of automation system.

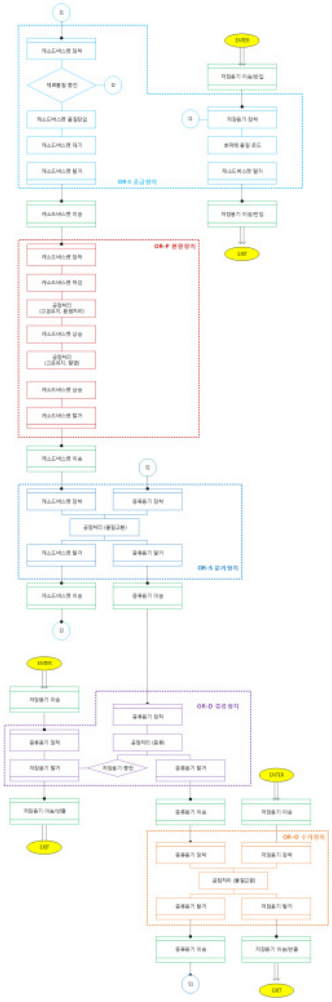

Fig. 4. Flowchart to show operating procedures in automation zone I.

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