A Study on the Improvement of Process Operation Through Logistics Control

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1. Introduction

Pyroprocessing technology has been developed at Korea Atomic Energy Research Institute (KAERI) as an alternative for management of spent nuclear fuel [1-2]. Each fundamental unit process of pyroprocessing has been developed successfully up to the lab-scale so far [3-4], while treatment performance, duration and organic operation between unit processes for massive fuel have not been investigated up to now. Thus modeling and simulation studies for integrated pyroprocessing have been challenged up to now[5-6] and the prototype model IOMP(Integrated Operation Model for Pyroprocessing) was finally developed. This model implements the current flowsheet of pyroprocessing and covers the up-to-date process operation schedules.

2. IOMP

IOMP had been introduced at the previous conference[Fig. 1]. This program has been invented with ExtendSim, being implemented with model file(.mox), library file(.lib) and EXCEL import file for user-defined conditions. At the previous study it gave the basic information such as the concentration behavior of high-heating nuclear element in the molten salt and the bottle-neck points over the whole processes, and waste streams. Because IOMP includes a calculator based on the chemical reaction for tracking mass. Thus it can track the dynamic concentration variation according to the feed material.

The objective of this study is to analyze logistics of products and wastes, total operation days according to the WIP (Work In Process) control for establishing optimization strategy. However the safeguards restriction condition was not applied except for the head-end cell.

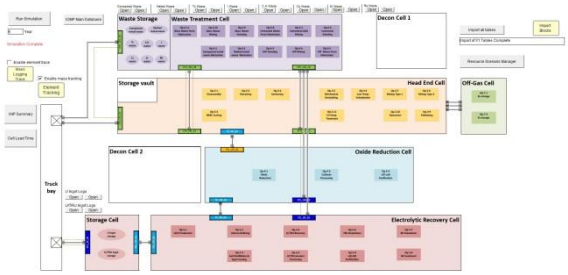

Fig. 1. Conceptual diagram of the pyroprocessing.

3. Assumption

3.1 Assumptions

The assumed amount of fuel is 70 assemblies per SF conditioning year. Here 1 SF (Spent Fuel) conditioning year does not mean the real 365 days, but the duration for consuming the total 70 assemblies. Simulation starts from charging procedure of spent fuel. After being satisfied with accountancy condition at the head-end cell, the fuels can be transferred into the next oxide reduction process. WIP (Work In Process) exists between individual unit process. The initial capacity of WIP is set to unlimited. The main process parameters and procedures are based on the flowsheet of Pyroprocessing[7].

4. Result and Conclusion

In order to check the transient duration the long-term simulation (over 10 years) was operated and the result shows the trend of operation days[Fig. 2]. SF

conditioning year means that the 1 year is defined as the operation days to treat spent fuel 70 assemblies.

Fig. 2 shows that even though operation year increases in the beginning (up to 4th year), it converged to a slight larger value (~ 1.2 times) under the unlimited WIP conditions. The cause of the increase is presumably due to accumulated fuel in the WIP or storage point.

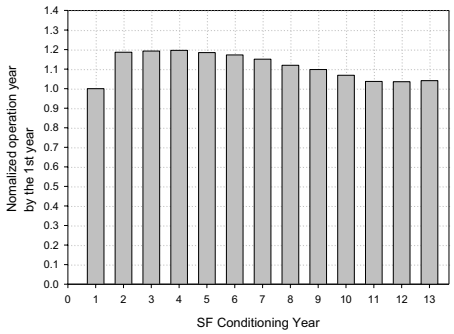

Fig. 2. Normalized operation year by the 1st SF conditioning year.

Fig. 3 shows the distribution of WIP amount compared to each own process batch size in the waste treatment cell. "1" is defined as the batch capacity. The case of less "1" means that WIP maintains the amount of products under the batch size. On the other hand WIP can accumulate products up to 8~9 times more than the batch size under the unlimited WIP condition.

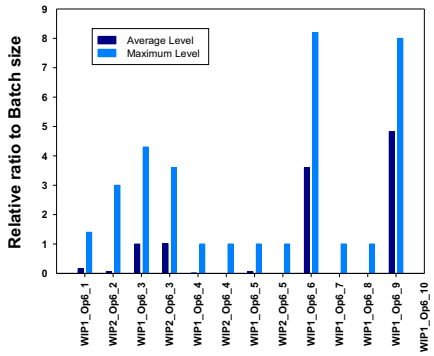

Fig. 3. Relative WIP size ratio to Batch size.

The effect of these unbalanced distribution on the WIP balance has not been identified clearly so far. However it is predicted that WIP can be built up due to the long waiting time for the next process or transfer into the next cell. Study for efficient configuration of WIP size have to be investigated.

In addition to WIP size, many parameters affect process operation and a phased approach is also required. All organic and coherent analysis would be induced from the unified operation model including design requirements for unit process and operation.

The analysis results would be reflected into the strategies of the advanced operation model. Several scenario of operation model based on the separation ratio, process capacity and WIP capacity can be simulated as well and it helps to find the optimized operation strategy. Various database related to mass flow according to the individual scenario will be accumulated and used for highly reliable operation as well. We will propose strategies forward for optimization of process operation and material flow through stepwise computer simulation

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