Analytic Approach to Simulate Vacuum Drying for Canister

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1. Introduction

Drying process of spent nuclear fuel must be required when spent nuclear fuel is transferred from wet storage to dry storage because oxidation composition could be bad effect of fuel cladding and long-term integrity of fuel cladding could not be guaranteed. Vacuum drying method is widely used in nuclear industry. In vacuum drying process, dryness criteria is that internal pressure is less than 3 Torr for 30 min without vacuum pump operation.

Analytic approach to simulate vacuum drying was suggested. Simple vacuum drying process and repeated vacuum drying process were analyzed.

2. Concept of analytic calculation

2.1 Simple drying process

In simple drying process, only pressure change from 760 Torr to 3 Torr is focused. Dryness criteria is not considered. The purpose of simple drying process is to check possibility of vacuum drying simulation. Vacuum drying is based on pressure change in canister due to vacuum pump and water evaporation. The modeling of vacuum drying process is consisted of 2 parts. One is pressure evacuation by vacuum pump and the other is pressure increase by water evaporation.

2.2 Repeated drying process

In repeated drying process, dryness criteria was considered. To meet dryness criteria, vacuum pumps operated until pressure went down under 3 Torr. Even if pressure was less than 3 Torr, pressure could rebound more than 3 Torr because very few residual water could evaporate and it led to increase pressure. This phenomenon is called as pressure rebound. To avoid pressure rebound, drying process should be performed several times.

3. Results and discussion

Assumptions of calculation are below as

- Temperature inside canister was constant.
- Residual water only naturally evaporated.
- Initial pressure is 101.325 kPa.
- Initial residual water at bottom was 50 g.

3.1 Simple drying process

To check the effect of residual water, case with residual water and case without water were compared. Required time until pressure was less than 0.4 kPa (3 Torr) is 111 s for result without water and is 35907 s for result with water. It took much longer time for vacuum drying of case with residual water.

3.2 Repeated drying process

Fig. 3. is calculation result of repeated drying

process. To meet dryness criteria, vacuum drying process was repeated 24 times and it took 26.5 hour. Pressure rebound could be found at each drying stage.

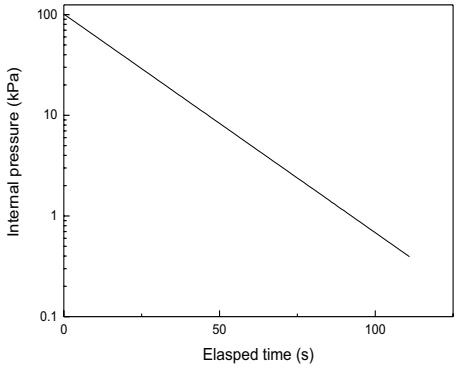

Fig. 1. Result of pressure change without residual water.

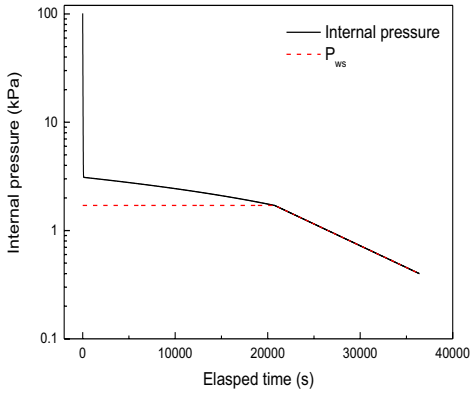

Fig. 2. Result of pressure change with residual water.

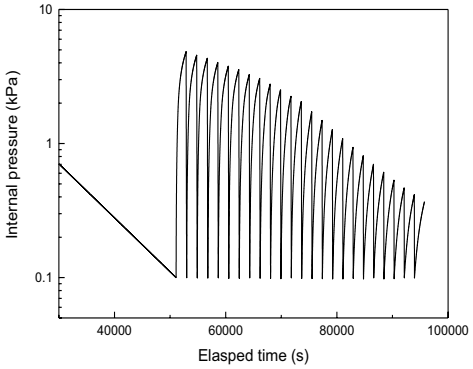

Fig. 3. Result of repeated drying process.

4. Conclusion

The calculation program of vacuum drying was developed to analyze analytically vacuum drying process. The effect of residual water and temperature on vacuum drying was compared. As the temperature increased, required time for vacuum drying decreased due to faster evaporation of residual water. To meet vacuum dryness criteria, vacuum drying process should be repeated

ACKNOWLEDGEMENT

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