Development of Scenario Generation Program for Operating SDS Bed Simulator

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1. Introduction

The tritium storage and delivery system (SDS), one of main systems in the ITER tritium plant, has been developed [1] and its unit process will be verified in an experimental facility named as SPOVE (SDS Process Verification Experiment) [2]. An SDS bed is needed to test SPOVE. Since in reality SDS beds operate in wide range of operation schemes including normal and abnormal conditions, it is hard to express the various operation scenarios using real SDS beds. Thus, an apparatus simulating the SDS bed will be employed into the SPOVE instead of real SDS bed. This apparatus can be used in the ITER SDS bed simulator [3]. In this study, a program generating scenarios needed to operate the SDS bed simulator is introduced.

2. SDS Bed Simulator

Fig. 1 shows an experimental apparatus integrated as a prototype of the SDS bed simulator [4]. This SDS bed simulator is comprised of two mass flow controllers, two auto pressure regulators, a vacuum pump, a metal bellows pump, a program logic controller and some instruments. The auto pressure regulators simulate the vapor pressure of fuel gas at equilibrium and the mass flow controllers simulate the delivery rate of fuel gas from the SDS bed to the fuelling reservoir. The vacuum pump is used to evacuate all the system before loading the fuel gas.

Fig. 1. SDS bed simulator.

The program controlling the SDS bed simulator can load operating scenarios with pressure-composition-temperature (PCT) curves. It can also monitor the operating variables such as pressure, flow rate and gas inventory during the operation. All control variables can be simulated according to a given operating scenario, which is generated by the scenario generation program introduced in this study.

3. DB of PCT curves

PCT curves of hydrogen isotopes vs. ZrCo were collected and converted into the numerical format to simulate bed conditions at the points on the PCT curves. Fig. 2 shows the DB interface of the PCT curves converted into DB format used in this simulator program. Up to now 11 PCT curves has been collected from journals and saved into the DB. When a PCT curve is selected from the DB, the properties of the PCT curves can be seen in a pop-up window as shown in Fig. 2. Names of authors, the title of journal referred, hydride material (ZrCo or Uranium), the kind of hydrogen isotopes, and some comments, which users added previously, were included in the property of the PCT curve.

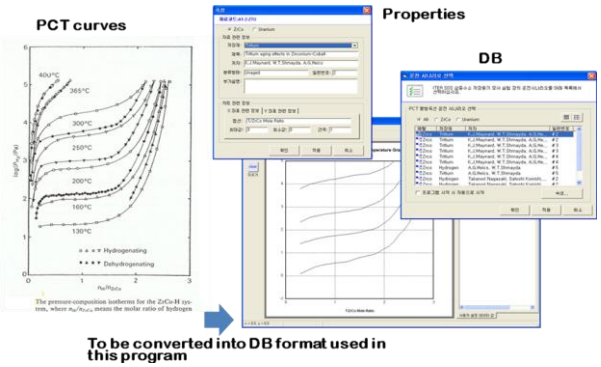

Fig. 2. PCT curve data base

4. Generation of Operating Scenarios

Fig. 3 shows the procedure of the operating scenario generation step by step. Firstly one of the PCT curves is loaded from the DB in order to generate an operating scenario. All turning points in the scenario are selected on the PCT curve by just the clicks of mouse button, and then the properties of 'routes' connecting turning points are adjusted in detail. Finally, after confirmation, all the control variables concerning this route are

converted to the numerical values as a function of time and saved as a CSV file in order to be used in the operation of the SDS bed simulator.

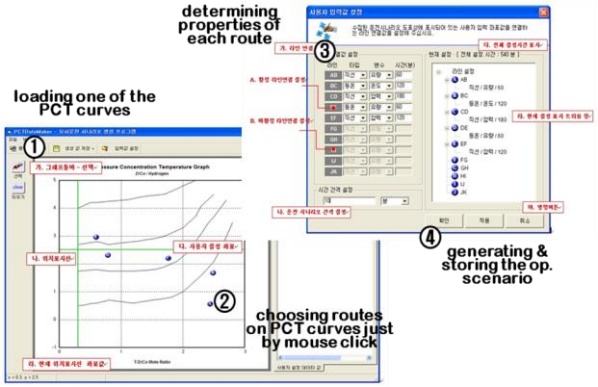

Fig. 3. Procedure to generate an operating scenario through the selected 'routes' on a PCT curve.

In Fig. 4, the whole operating path on the PCT curve for the loaded operating scenario is shown conceptually and the control variables are shown as a function of time.

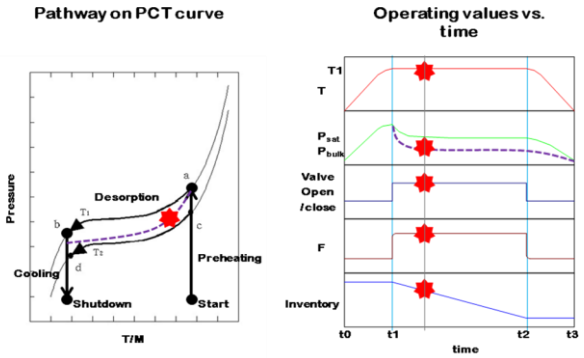

Fig. 4. Operating path on PCT curve and operating variables vs. time.

5. Operation of Simulator

During any operation of the SDS bed simulator, the status of most control variables such as flow rate, pressure, valve position, pump on/off, etc. can be monitored in real time as shown in Fig. 5. The operating path on the PCT curve according to an operating scenario loaded can be also tracked in real-time in another mode. The graph windows of pressure, flow rate, temperature and tritium inventory vs. time can be popped up in this mode according to user's choice. Current position and remaining operating path during the operation of the SDS bed simulator can be also confirmed in this mode.

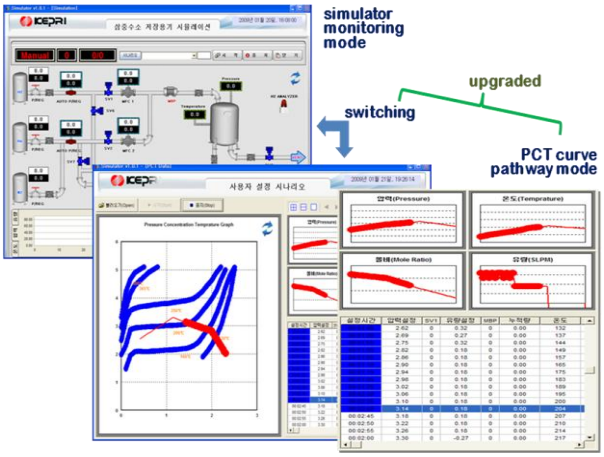

Fig. 5. Simulator monitoring mode and PCT curve operating path mode during the operation.

6. Conclusion and Future Plan

A program generating the operating scenarios used in the SDS bed simulator has been developed. This program can generate various operation scenarios under normal and abnormal conditions of the SDS beds. The SDS bed simulator can be operated according to the operating scenarios generated by this program. Ultimately the SDS bed simulator will be developed as a transportable type and applied to the SPOVE for the SDS unit process tests.

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