Analysis and Design of the Input and Output Attributes of the Dynamic Simulation code for the H_2SO_4 distillation process

Jiwoon Chang, Youngjoon Shin, Cheung Youn*, Jihwan Kim, Kiyoung Lee, Wonjae Lee, Jonghwa Chang
Korea Atomic Energy Research Institute150 Dukjin-dong, Yuseong-gu, Daejeon, Korea 305-600
**Chungnam National University, 220 Gung-dong, Yuseong-gu, Daejeon, Korea 305-764*
E-mail;jwjang73@kaeri.re.kr, Tel; +82 42 868 8369, Fax; +82 42 868 8549

1. Introduction

The dynamic simulation code for the H_2SO_4 distillation process was developed by the KAERI research group in 2007 [1].

The analysis and design of the input and output attributes are usually required for the effective compilation of the dynamic simulation program. The Data Flow Diagram (DFD) and the class diagram have been used for the analysis and design of the input and output attributes.

In this paper, the data flows for dynamic simulation of the H_2SO_4 distillation process have been embodied by using the DFD and the input and output attributes have also been defined by using the class diagram.

2. Methods and Results

DFDs show the flow of data from the external entities into a system, how the data is moved from one process to another, as well as its logical storage. So, a DFD gives information for input and output data flows.

Class diagrams show the classes of the system, their interrelationships (including inheritance, generalization, aggregation, and association), and the operations and attributes of these classes. Class diagrams are used for a wide variety of purpose, including both conceptual/ domain modeling and detailed design modeling [2].

2.1 Data flow diagram

The level-1 DFD of the dynamic simulation for the H_2SO_4 distillation process is presented in Figure 1. As shown in Figure 1, circle representing process for the H_2SO_4 distillation. This process received three input data such as the feed temperature, the feed amount and the column pressure from an external entity. Also, the process outputs data such as the stage temperature, the top products and the bottom products.

The arrows in Figure1 represent the data flows for input and output in the process 1.

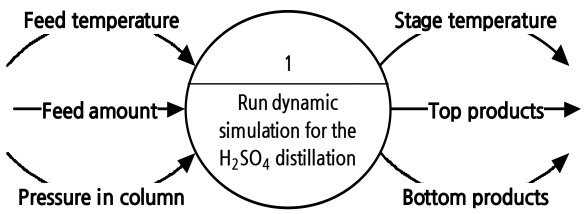

Fig. 1. Level-1 DFD of the dynamic simulation for the H_2SO_4 distillation process.

Figure 2 presents a level-2 DFD of the dynamic simulation for the H_2SO_4 distillation process. As shown in Figure 2, there is one external entity, four processes and two data storages in the level-2 DFD. The function of the processes in Figure 2 represents Table 1.

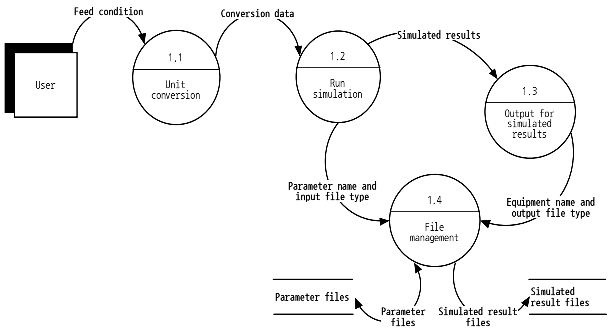

Fig. 2. Level-2 DFD of the dynamic simulation for the H_2SO_4 distillation process.

Table 1. Function of the processes in the Figure 2

Process No.	Name	Function
1.1	Unit conversion	Unit conversion of data inputted from external entity.
1.2	Run simulation	Running dynamic simulation for the H_2SO_4 distillation process.
1.3	Output for simulated results	Classification and writing of the simulated results.
1.4	File management	Classification and saving of the input and output data files.

2.2 Class diagram

As mentioned above, the analysis and design of input and output attributes are important for the effective compilation of the dynamic simulation program. Generally, distillation columns have a number of stages and have various phases of materials in column.

The figure 3 presents a class diagram for the H_2SO_4 distillation column. As shown in Figure 3, the class diagram shows the classes of the H_2SO_4 distillation system, their interrelationship and the attributes of the classes. In the case of the H_2SO_4 distillation process, it can consist of the five classes such as the H_2SO_4 distillation, the stage, the phase, the phase composition and the material stream. Also, the class attributes which are listed on the bottom of the rectangle box in the Figure 3 can correspond to class member variables. Generally, class member variables offer information of input and output data to us.

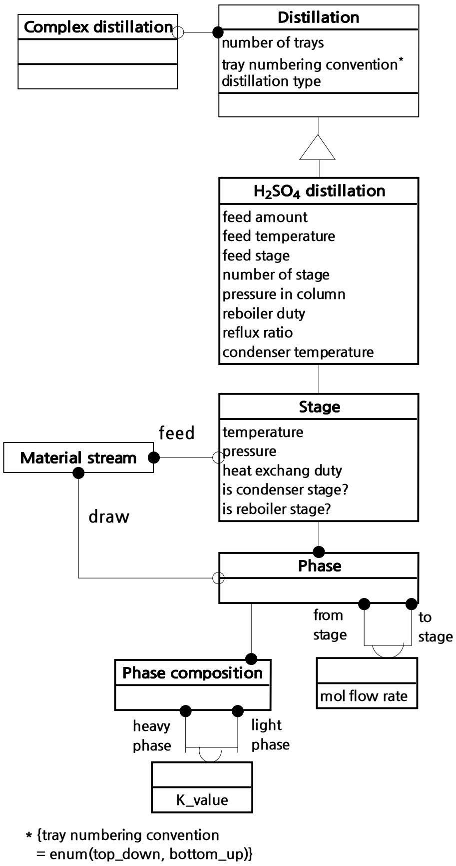

Fig. 3. Class diagram for the H_2SO_4 distillation process.

2.3 Input and output attributes

The lists of input and output attributes by using the DFDs and class diagrams are represented in the Table 2 and Table 3. As shown in Table 2 and Table 3, the items have been defined as the class member variables for the H_2SO_4 distillation process.

In the case of the output attributes, we have defined many items to offer various output formats for a user.

Table 2. Input attributes for the dynamic simulation code of the H_2SO_4 distillation process

Item (member variables)	Description	Type	Unit	Default value
pres0_SADistil	Pressure in the column	Double (10, 2)*	bar	0.10
inSA0_SADistil	Feed flow rate of the H_2SO_4	Double (10, 2)	kg/hr	159959.90
inH2O_SADistil	Feed flow rate of the H_2O	Double (10, 2)	kg/hr	36463.70
fTemp_SADistil	Feed Temperature	Double (10, 2)	°C	158.28

* : (x, y) Here, x is a total digit number including decimal point, y is a digit number after decimal point.

Table 3. Output attributes for the dynamic simulation code of the H_2SO_4 distillation process

Item (member variables)	Description	Type	Unit
uHold/lHold/rHold	Holdup in each stage	Double (10,2)	kg
feedWT_SADistil1	Total feed flow rate	Double (15,2)	kg/hr
fH2OWF_SADistil1	H_2O feed concentration	Double (15,2)	weight fraction
xH2OMF_SADistil1	H_2O feed concentration	Double (15,2)	mol fraction
yTotwc_SADistil1	Total flow rate in the top products	Double (15,2)	kg/hr
yH2Owc_SADistil1	H_2O flow rate in the top products	Double (15,2)	kg/hr
ySO4wc_SADistil1	H_2SO_4 flow rate in the top products	Double (15,2)	kg/hr
yTopWF_SADistil1	H_2O concentration in the top products	Double (15,2)	weight fraction
yH2OMC_SADistil1	H_2O concentration in the top products	Double (15,2)	mol fraction
xTotwr_SADistil1	Total flow rate in the bottom products	Double (15,2)	kg/hr
xH2Owr_SADistil1	H_2O flow rate in the bottom products	Double (15,2)	kg/hr
xSO4wr_SADistil1	H_2SO_4 flow rate in the bottom products	Double (15,2)	kg/hr
xBotWF_SADistil1	H_2O concentration in the bottom products	Double (15,2)	weight fraction
xH2OMR_SADistil1	H_2O concentration in the bottom products	Double (15,2)	mol fraction
xTempK_SADistil1	Temperature in each stage	Double (15,2)	°C
xH2OWF_SADistil1	H_2O concentration in each stage	Double (15,2)	weight fraction

3. Conclusion

Analysis and design of the input and output attributes for the dynamic simulation code of the H_2SO_4 distillation process have been carried out by using the DFDs and the class diagram.

As results of this, debugging and error tracing can be easily performed.

Acknowledgments

This study has been performed as one of the mid-and-long-term Nuclear R&D projects.

REFERENCES

[1]Heesung Shin, Youngjoon Shin, Kiyoung Lee, Development of a dynamic simulation code for the H2SO4 distillation process, Calculation Note (NHDD-KA07-HP-002-00), 2007.

[2]Cheung Youn, Software Engineering, saeng-nung publishing company, pp. 150 - 200, 2006.