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# Manometer Behavior Analysis using CATHENA, RELAP and GOTHIC Codes

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## 1. Introduction

Many codes are used for thermal hydraulic analysis of nuclear reactor. For example, RELAP, TRAC, COBRA-TRAC, CATHARE, ATHLET, DINAMIKA, SMABRE, APROS, TUF, RETRAN and CATHENA are used for the simulation of system behavior and the codes like CONTEMPT, CONTAIN, GOTHIC, JERICHO, RALOC and COCOSYS are used for the containment analysis [1]. The use of some codes among these codes is limited by user and some codes are not even open to general person. Thus, the use of alternative code is considered for some analysis.

In this presentation, simple thermal hydraulic behavior is analyzed using three codes to show the possibility of using alternative codes. We established three models of simple u-tube manometer using three different codes. CATHENA (Canadian Algorithm for Thermal hydraulic Network Analysis) [2], RELAP (Reactor Excursion and Leak Analysis Program) [3], GOTHIC (Generation of Thermal Hydraulic Information for Containments) [4] are used for this analysis. CATHENA and RELAP are widely used codes for the analysis of system behavior of CANDU and PWR. And GOTHIC code also has been widely used for the analysis of thermal hydraulic behavior in the containment system.

## 2. Methods and Results

### *2.1 Analysis method*

Figure 1 shows the nodalization of simple u-tube manometer.

The manometer is composed of two vertical pipes, which are separated 6 nodes, respectively. It is filled with water in node 2~6 of left side pipe and with nitrogen gas in node 1 of left side pipe and entire nodes of right side pipe. Two vertical pipes are connected by a trip valve, J350. C200 and C500 are modeled as the boundary conditions.

Model assumptions including the initial and boundary conditions are summarized in Table 1.

If the trip valve, J350, is assumed to be opened after 10 seconds, the water begins to flow from pipe C300 to pipe C400 at the valve opening time and would be slowly stabilized through the transient period.

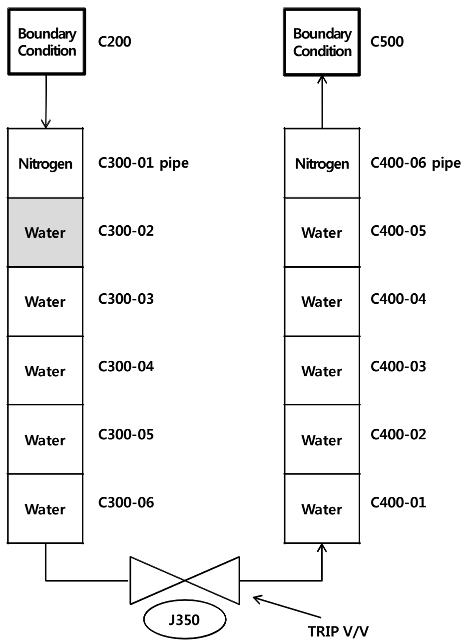



Fig. 1. Nodalization of u-tube manometer

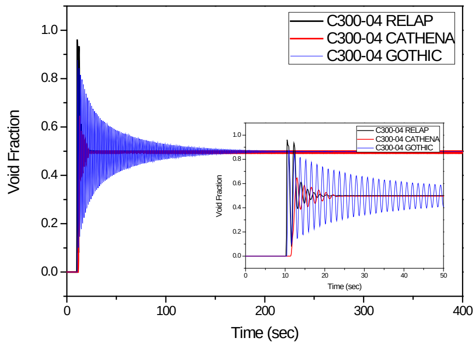
Table 1: Model assumptions

| Variable | | Value |
|---|---|---|
| Initial condition of gas and water | Temperature (K) | 330.3722 |
| | Pressure (kPa) | 101.325 |
| Boundary condition | Temperature (K) | 330.3722 |
| | Pressure (kPa) | 101.325 |
| Cross-sectional area ($m^2$) | Pipe (C300, C400) | 0.007851597 |
| | Valve (C350) | 0.007851597 |
| Node length of pipe C300 and C400 (m) | | 0.2 |
| Opening time of valve J350 (sec) | | 10.0 |

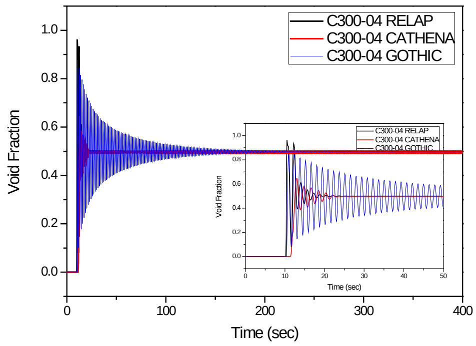
### *2.2 Analysis results*

We analyzed the final stabilized time and void fraction of each node using CATHENA, RELAP and GOTHIC codes.

Figure 2 shows the void fraction of node C300-04 and node C400-03.




(a) node C300-04




(b) node C400-03

Fig. 2. Node void fraction

Looking at the node C300-04, the transient phenomenon stops at about 25 second and the maximum peak of initial void fraction in the transient period rises up to 0.65 from initial 0.0 in CATHENA analysis result, where about 27 second and 0.95 in RELAP and about 200 second and 0.87 in GOTHIC, respectively.

The general transient behavior analyzed by GOTHIC is similar to the transient behavior analyzed by CATHENA and RELAP. However, the final stabilized time is significant difference. It would result from the characteristics that GOTHIC was developed in specialized in the containment, where CATHENA and RELAP specialized in thermal-hydraulic analysis for the rupture leakage of reactor.

The previous study reports "a good agreement for relevant physical parameters between RELAP and GOTHIC calculation for all the transient phases were obtained and the observed difference between the calculations of RELAP and GOTHIC is attributed to differences in spatial discretization and to different physical model used in the two codes" [5]. Another study reports "the GOTHIC simulations show a better agreement with the experimental results than the RELAP and COPTA and this study also reports that it was not clarified if the difference was due to an error in the input data, absence of water resources in the model or in the capability of the programs to predict the superheated steam" [6]. Therefore, the preliminary studies on whether each code is suitable for the analysis target would be needed.

## 3. Conclusions

In this paper, the internal behavior of u-tube manometer was analyzed using 3 codes, CATHENA, RELAP and GOTHIC. The general transient behavior is similar among 3 codes. However, the behavior simulated using GOTHIC shows some different trend compared with the results from the other 2 codes at the end of the transient. It would be resulted from the use of different physical model in GOTHIC, which is specialized for the multi-phase thermal hydraulic behavior analysis of containment system unlike the other two codes.

## ACKNOWLEDGEMENT

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