Transactions of the Korean Nuclear Society Spring Meeting
Jeju, Korea, May 10-11, 2007

A Qualification for GOTHIC Efficiency Input Model of Component Cooling Water System with FlowMaster II program

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1. Introduction

In these days, unexpected climate fluctuation and the ocean current changing are becoming a conspicuous issue. For that reason, we must plan to maintain a normal operation of nuclear plant and guarantee the operation margin. A temperature limit resetting of the Final Heat Removal Source is needed to analyze the influence on safety and performance of related system that is affected with the rising of sea water temperature [1].

GOTHIC Network model is used for analyzing Component Cooling Water (CCW) system and it needs various Thermo-hydraulic data as a Basic input data. On the same line, in this study, we accomplished a Comparative Qualification between Hand calculating method and Flowmaster II program calculating method.

2. A Reference Theory

In this section basic theory of calculating equations and GOTHIC program are described.

2.1 Network equations and Theory

To minimize the computational work required to solve for the network flows and node conditions, the entire collection of nodes and links is divided into isolated networks. Each of these isolated networks have no nodes in common with other networks.

The force balance solved for the link velocities is

$$P_1 - P_2 = \frac{L}{\Delta t}\rho_l (V - V^n) + \frac{1}{2}\left(k + \frac{fl}{D}\right)\rho_l V^2 - g\rho_l (el_1 - el_2)$$

where P_1 and P_2 are the pressure at ends 1 and 2 of the link, L is the initial length, Δt is the time step, ρ_l is the upstream density, V is the fluid velocity through the link, k is the specified loss coefficient, f is the friction factor, l is the friction length, D is the hydraulic diameter, g is the gravitational constant and el_1 and el_2 are the link end elevations [2].

2.2 GOTHIC networks

Many applications of GOTHIC involve the analysis of a collection rooms served by a heating, ventilating and cooling system. Networks can be model with standard volumes and junctions but that approach is cumbersome and can result in small time steps for the simulation because of the large flows through the small duct volumes. The network model simplifies the modeling of HVAC systems. It can also be used to model piping systems.

A flow network diagram consists of a set of nodes joined by flow links as shown in fig.1

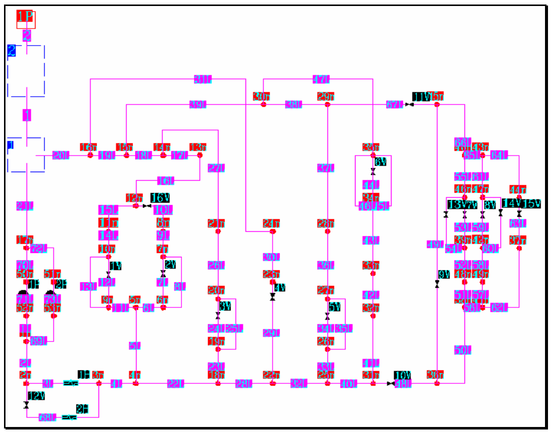

Figure 1. Component Cooling Water (CCW) System Modeling with GOTHIC network program

In this diagram, the dashed boxes represent rooms or regions that are modeled with the existing volume components. The solid circle represents network nodes. Typically, these are used to model branches or joints in the duct or piping network. The lines connecting the nodes and volumes represent the pipe runs.

3. Methods and Results

3.1 Hand Calculation Methods

Based on each setting value, design data and ISO drawings of nuclear plant, we extracted effective diameter, friction length, inertia length and loss coefficient. Pressure drop of each link was the final data in this procedure. Loss coefficient of each link's elements is used with a general value and the total inertia length is derived from the method by a series. When there is no enough base data for the calculation procedure, we used general value and marked it besides [3, 4].

3.2 Qualification of Element loss coefficient Methods

After hand calculation procedure, we executed simplifying of CSHx system as shown in Fig. 2 and comparing the final data to know that if there is a significant effect between form loss coefficient and pressure drop.

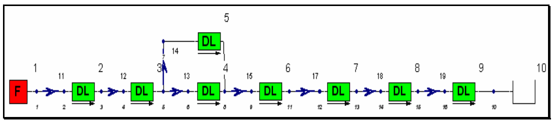

Figure 2. Simplified model of Containment Spray Heat Exchanger (CSHx) with Flowmaster II program

3.3 Flowmaster II Methods

Flowmaster II, the professional thermo-hydraulic analysis program, already has equipped variety sets of ready to designed general component modes. We composed the Component of Spray Heat Exchanger (CSHx) as in fig. 3 below, for the purpose of comparative qualification [5].

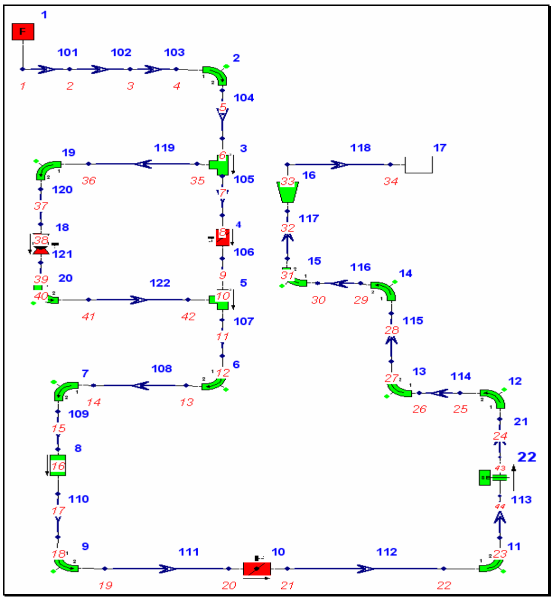

Figure 3. Containment Spray Heat Exchanger (CSHx) Part Modeling with Flowmaster II program

3.4 Comparison Results

The comparison result graph of each calculation method is presented in Fig. 4 and Fig. 5.

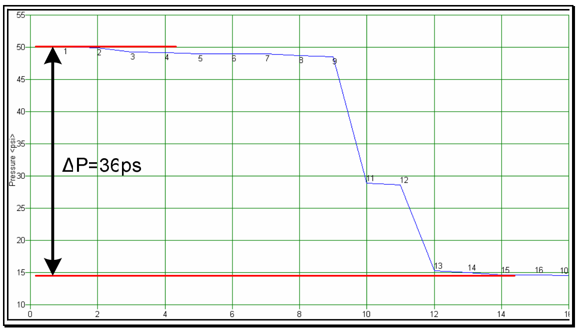

Figure 4. Pressure drop with hand calculation method

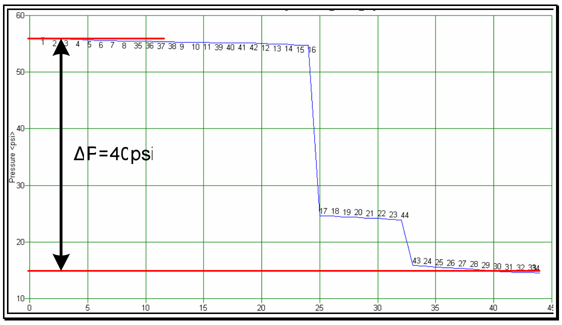

Figure 5. Pressure drop with Flowmaster II method

X axis indicates the number of flow sequence that it also related with each element's original number. Y axis let us know not only the total pressure drop but also pressure drop of each element and node. The total elevation data of each node was contained in these graphs. As shown in these figures, each pressure drop by some element (i.e. elbow, pipe, valve and so on) was insignificant contrary with the example of orifice and heat exchanger.

4. Conclusion

1. The difference of total pressure drop between each method was up to 10%, but the effect of loss coefficient on almost of the component was insignificant.
2. It is assumed that the total pressure difference is come from the loss coefficient setting of orifice and heat exchanger and also is needed to be studied more for finding an acceptable reason.
3. This study could be used as a practical data for the following study which model and analyze the overall CCW system.
4. It could contribute to the future study on CCW flow balance setting for each accident mode.

REFERENCES

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