Transactions of the Korean Nuclear Society Spring Meeting
Kwangju, Korea, May 29-31, 2013

Development of the Porosity Calculation Procedure using Pro/E and Pro/Toolkit

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1. Introduction

The governing equations for the thermal-hydraulic solver can be obtained through averaging process from the basic material transport principles. The volume averaging process gives rise to the concept of the volume porosity. Considering the structural complexity of the reactor internal design, one can imagine how much efforts should be put to get the proper porosity data. To overcome this problem, any one can imagine that the utilization of a CAD system such as Pro/Engineer [1] will be very much helpful. But some efforts have to be devoted to develop the necessary procedure for the porosity calculation.

In this paper, overall procedure to calculate the porosity is described.

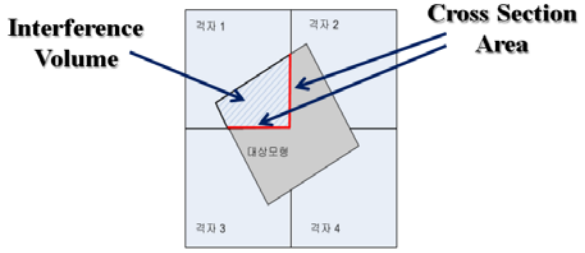
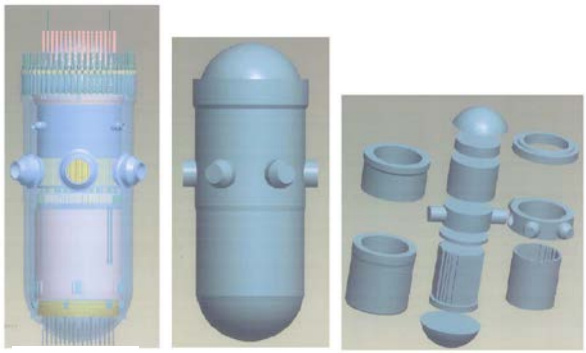


Figure-1 Schematics for Porosity Calculation



a) solid model b) enveloping model c) cells

Figure-2 Porosity Calculation for Reactor Vessel

2. Basic idea of porosity calculation

As shown in Figure-1, the basic idea of the porosity calculation is to use the interference evaluation in the Pro/E. A solid model can have the interference with the mesh cells. A mesh cell is also a solid model of Pro/E. Interference volumes and cross sectional areas between the parts and the mesh can be estimated by the Pro/E. As already presented earlier [2], porosity calculation procedure for the reactor vessel is depicted in Figure-2. An enveloping solid model b) is developed to produce the mesh cells like c). Individual cells are inserted into the reactor solid model a) and evaluate the interference to get the porosity. As the reasons discussed below, the fuel assembly are not inserted in the vessel.

As the number of mesh cells is increased, using the Pro/E GUI is very time consuming. Therefore, it is necessary to develop a automatic batch job with minimal user intervention. Pro/E allow user to do this objective by supplying the Application Program Interface (API). This process is called the customization in Pro/E. Following section will be devoted to describe how to implement the customization.

3. Customization of the Porosity Calculation Procedure

The whole procedure of the interference calculation has been developed using the Pro/Toolkit API's. As shown in the Figure-3, newly developed application called KopecTK is registered as an as an auxiliary application through auxiliary application knobs in Pro/E.

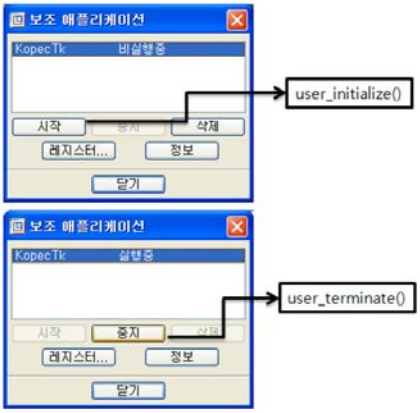


Figure-3 Registration of the KopecTK

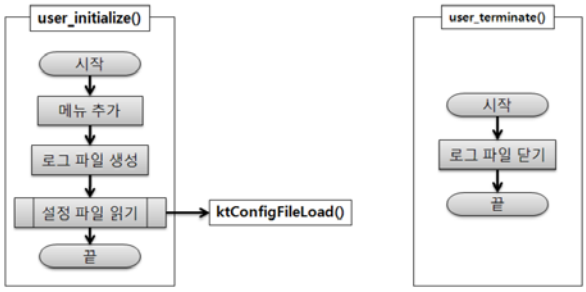


Figure-4 Role of user_initialize()/terminate()

As shown in Figure-3, pressing the button **"시작"** starts the routine user_initialize() that kicks off the whole procedure. Then, pressing the button **"중지"** terminates the KopecTK (Figure-4). When user selects the inserted menu, then, VertexPolyDataProcess() function is called (Figure-5).. This routine actuates kt_MainDlg() resulting in producing the dialog box like in Figure-6. When user press buttons in this dialog box, it actuates the relevant routines to perform the requested actions.

Browse button actuates the routine kt_MainDlgCBBrowse() to select mesh cell data file. Once it fix the cell data file, the button "Calculate" can be pressed to start the most important

routine kt_MainDlgCBCalculate(). In this routine, first of all, cell data are read from the input file. Then, cell part is called in to assemble to the existing model. During this process each coordinate system matches (Figure-7, and 8). Routine kt_CalculateVolumeAndCSArea() is called to estimate the interference volume and face area (Figure-9)

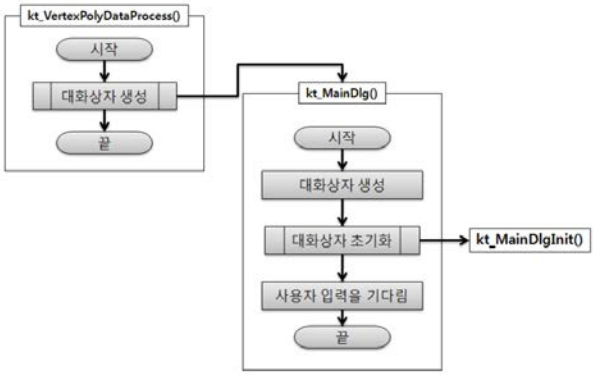


Figure-5 Role of VertexPolyDataProcess()

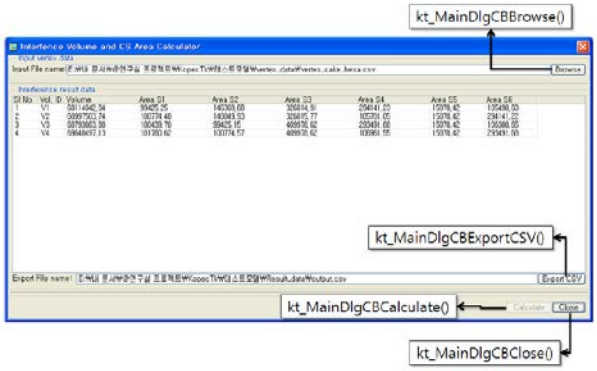


Figure-6 Routines to be actuated through buttons

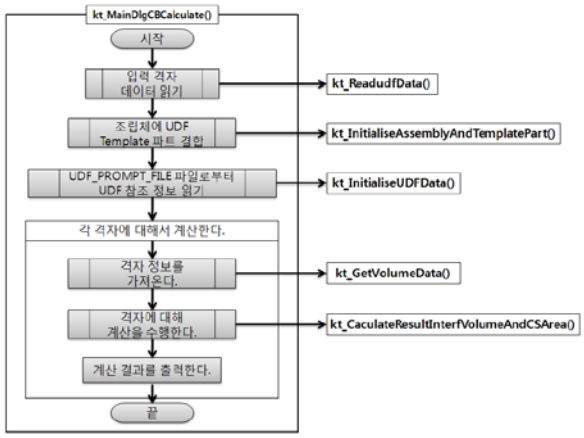


Figure-7 Role of kt_MainDlgCBCalculate()

Routines that have prefix "kt_" calls necessary API routines from the Pro/Toolkit libraries to perform the objectives. The final results are output to the table in the dialogue box in Figure-6. If user wants them to be saved in the file, press the knobs "ExportCSV" at the bottom right corner of the box. Pressing the "Close" button terminate the process.

4. Conclusion and Further Works

When the number of cells is greater than several hundreds, and/or, the complexity of the system is very high like the reactor system, there may be some problems that have to be solved for the successful customization.

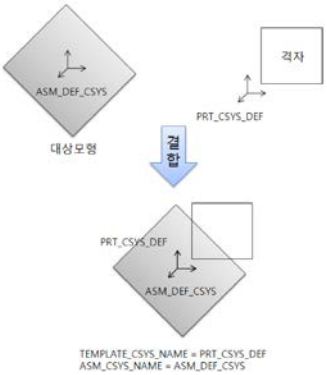


Figure-8 Role of kt_MainDlgCBCalculate()

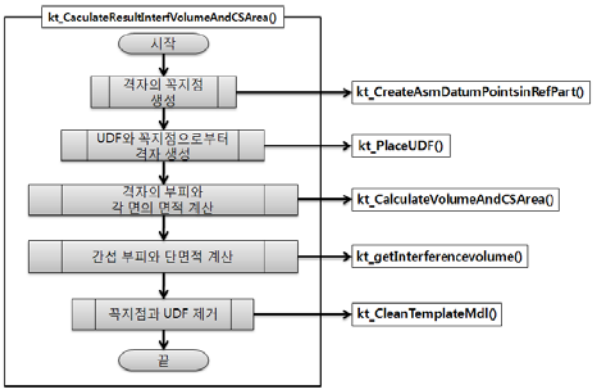


Figure-9 Role of kt_CaculateResultInterfVolumeAndCSArea()

The first problem that comes with large number of mesh cells is the time to finish the calculation is too long. The second problem that comes with the complex system, which means that the data base of the solid model is too big, and prohibits this approach altogether. The reason for this is that simply the Pro/E cannot handle too complex geometry. For example, a desktop workstation that has a 3.3 Ghz CPU and a Quadro FX 5600 graphic card cannot handle a system that has more than 150000 solid parts because it takes too long time to regenerate model data and it takes to long time to manipulating graphic data by graphic processor. Another problem is identified with the Pro/Toolkit API routines. The maximum memory size of the array that can be handled by the API is 4 mega bytes. Therefore, a limited number of solid parts can be handled in one time.

Some more efforts should be exercised to solve these problems to get a powerful porosity calculation procedure.

REFERENCES

[1] http://www.proengineer.com/
[2]. KNS 2009 spring. Jeju, Korea, May 22, 2009 "Status and Perspective of the Pre/Post Processing for Thermal-Hydraulic Code", Sang Yong Lee, Chan Eok Park, Eun Ki Kim