Development of Workbench Programs for CUPID1.7 Code

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1. Introduction

A component-scale thermal hydraulic analysis code, CUPID 1.7 (Component Unstructured Program for Interfacial Dynamics 1.7), was recently distributed in an upgraded version. The most noticeable change of the CUPID1.7 compared to CUPID1.6 [1] is that a parallel calculation based on the Message Passing Interface (MPI) is supported. In addition, the workbench program for the CUPID1.7 (CUPID1.7 workbench) was developed. The CUPID1.7 code input is based on the text mode and not only needs pre-processing for grid generation but also post-processing for visualization of calculation results. Therefore, the integrated platform is required to deal with a series of work from pre-processing to post-processing in the manner of a graphical user interface (GUI).

2. CUPID1.7 Workbench

2.1 Purpose and Characteristics

Before the development of the CUPID1.7 workbench, users had to edit the input of the CUPID code with text editors and prepare the programs for pre- and post-processing by themselves. The CUPID1.7 workbench provides various functions to users in the GUI environment so that users may generate the grid file in the pre-process as well as the thermal hydraulics (T/H) input for the CUPID1.7 execution. The CUPID1.7 workbench is running on the project-based environment, and users can make multiple grids or run directories under one project folder.

2.2. Structure and Main Functions

The CUPID1.7 workbench consists of five main functions: 1) Pre-process, 2) T/H input generation and run, 3) Post-process, 4) User-defined function and 5) CUPID/MARS coupling [2]. Fig. 1 shows the overall structure of the CUPID1.7 workbench.

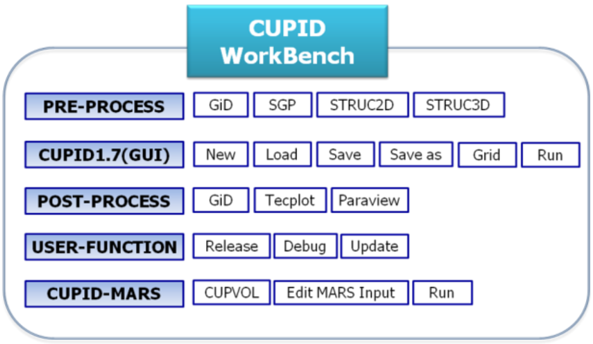

Fig. 1. Structure of CUPID1.7 workbench

2.3. Pre-Process

As the first step, users have to define the geometry and generate the grids. The CUPID1.7 workbench provides in-house pre-processors as well as links to the commercial grid generation programs such as GiD and Tecplot. Using in-house pre-processors, users can generate three types of geometry: a two-dimensional rectangular channel, a three-dimensional rectangular channel, and a steam generator by STRUC2D, STRUC3D, and CUPID-SGP pre-programs, respectively. In particular, the CUPID SGP has the capability to generate polyhedral grids so that it is possible to simulate a complex geometry inside a steam generator. Fig. 2 shows the GUI of the CUPID-SGP.

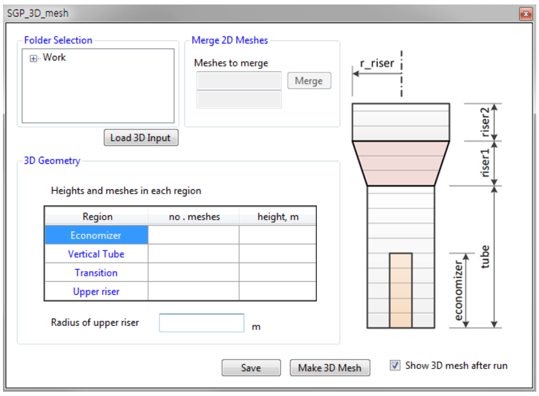

Fig. 2. GUI of pre-processor for SG (CUPID-SGP)

2.4. T/H Input and Run

Once the grid is generated, users should generate the T/H input. T/H input file includes information on the initial conditions, boundary conditions, and various options for models and correlations, as shown in Fig. 3. A numerical scheme and time step are also controlled in the T/H input file. If the T/H input is completed and the grid generated in the pre-process step is selected, CUPID1.7 can be executed.

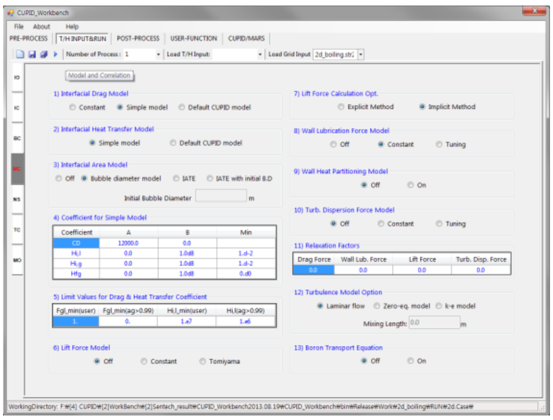

Fig. 3. GUI of T/H input generation

2.5. Post-Process

The CUPID1.7 workbench uses not only commercial programs such as GiD and Tecplot, but also public domain programs such as Paraview, as the post-processor. When users select the Paraview program, the CUPID1.7 workbench automatically converts the calculation results into the proper file format and executes the Paraview programs.

2.6. User-Defined Function

Because the CUPID1.7 workbench includes the source code of CUPID1.7, it is possible that users access and modify each subroutine except some closed subroutines, which are distributed in library file format. Thus, users can control the input and output. In addition, it is possible to modify implemented models and correlations or to implement newly developed models or correlations related to the heat transfer, the drag forces, non-drag forces, and so on. After the modification of the CUPID1.7 source, the execution file should be rebuilt using the Intel Visual Fortran program and then updated.

2.7. CUPID/MARS Coupling

To simulate a large-scale system, it is necessary to implicitly couple the CUPID1.7 code with a system T/H code such as the MARS code. It is well known that the trickiest part of code coupling is to generate the coupling cell for communication necessary information through the coupling cell to both codes. CUPID1.7 workbench provides the GUI for the generation of the coupling cell and the modification of the input files of the MARS code. After the series of works for the generation of the coupling cell, users can confirm the grid including the coupling cell with the Paraview program. As the next step, when the CUPID/MARS run button is pushed, the MARS code is started and calls the CUPID1.7 code.

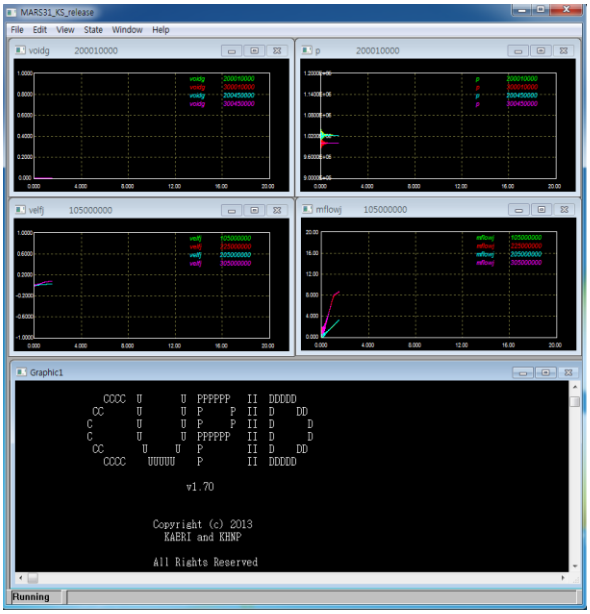

Fig. 4. CUPID/MARS coupled calculation

Fig. 4 shows the running status of CUPID/MARS coupled calculation. In the current version of the CUPID1.7 workbench, a CUPID/MARS coupling calculation is available in a two-dimensional case.

3. Range of Application and Update Plans

The CUPID1.7 workbench is a standalone program because it includes the in-house pre-processor and the public domain post-processor. Thus, the CUPID1.7 workbench can solve particular problems without extra programs. For instance, the CUPID1.7 workbench is applicable for boiling or condensation problems in a rectangular channel, and various transient problems in SGs. However, it is still necessary to develop an additional pre-processor to generate more various geometric grids. In addition, adaptation to various user' environments, such as computer hardware and OS, is necessary.

4. Conclusions

With the upgraded of CUPID1.6 to CUPID1.7, the workbench program was developed. Using the CUPID1.7 workbench, users conveniently perform a series of work for CUPID1.7 calculation from the pre-process to the post-process. Because the current version of CUPID1.7 workbench has some functional restrictions according to the hardware, OS, and problems, continuous updates will be conducted through the feedback from users groups.

ACKNOWLEDGEMENT

This work was supported by National Research Foundation of Korea (NRF) and the Korea Radiation Safety Foundation (KORSAFE) grant funded by the Korea government (MSIP & NSSC).

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