Validation of the Edwards pipe blowdown experiment in the TASS/SMR code

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1. Introduction

TASS/SMR (Transient And Setpoint/Small and Medium Reactor) code [1] is a computer program developed for the performance and safety analysis of SMART (System-integrated Modular Advanced Reactor). Since the technologies used for the SMART design are different from existing reactors, the analytical capability of the TASS/SMR code has to be verified for its application to a system analysis of SMART. Also the reliability of the analysis results of the code need to be verified using proper experimental data. In this paper, the Edwards pipe blowdown experiment problem was analyzed by the TASS/SMR code and the results were compared with the Edwards pipe blowdown experiment data [2].

2. Methodology

Basic conceptual and analytical problems are selected to evaluate the fundamental numerical analysis capability of the TASS/SMR code. Sixteen problems including mass and energy conservation problems were selected [3]. The Edwards pipe blowdown experiment problem is one of them.

2.1 Edwards pipe blowdown experiment

Description of the test section

Figure 1 shows the schematic of the Edwards-O' Brien blowdown test. The Edwards-O' Brien experiments consist of fluid depressurization studies in a straight pipe 4.096m long with an inside diameter of 0.073m. A glass disk at one end of the pipe was designed to rupture with a single shot from a pellet gun to initiate the depressurization phase of the transient. The time for the disk to fully open was estimated to be about 1ms. Following the experiment, a small amount of glass was observed around the circumference of the opening. Based on this observation, the break flow area was reduced by 13% from the pipe cross sectional area. First response temperature and pressure measuring instruments were located along the length of the pipe. The detector locations (gauge stations) were identified as GS-1 through GS-7.

Description of the physical phenomena

The transient is initiated by bursting the rupture disk located at one end of the pipe. During the first phase of the transient, a depressurization wave is traveling inside the pipe towards its closed end on which it is reflected. Later in the process, the blowdown is controlled by the strong evaporation of the liquid, i.e. flashing.

Description of initial condition

The standard test case starts in the 2-phase region at pressure 6.99 MPa and temperature 502K.

2.2 TASS/SMR Code Input Modeling

The nodalization diagram is shown in Figure 2. The total length is 4.096m with an inside diameter of 0.073m. There are five nodes. The length of Node(1) through Node(4) is 1.024m. Table 1 shows the analysis condition. The node was initially filled with subcooled water at the temperature of 502 K and the pressure of 6.99 MPa.

3. Results

The transient calculation was carried out for 0.5 seconds using the TASS/SMR code. Comparisions were made between the measured and calculated void fraction at the gage station 5 as shown in Figure 3. Figure 4 shows the characteristics of the wave propagation at the gage station 5. As shown in the figures, the results of TASS/SMR code are in good agreement with the experimental data and TASS/SMR code was able to reproduce the physical characteristics of wave propagation.

4. Conclusions

TASS/SMR code has the modeling capability of major phenomena that occur in the Edwards pipe blowdown experiment.

Table 1 The initial conditions

	Value (Unit)
Pressure (Node1,2,3,4)	6.99 (MPa)
Water Temperature (Node 1,2,3,4)	502.0 (K)

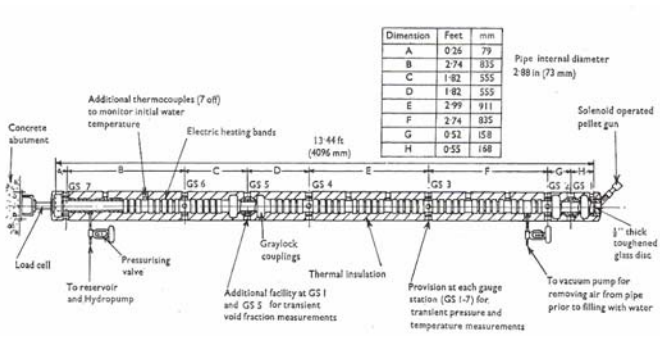

Figure 1 Schematic of the Edwards-O'Brien blowdown test

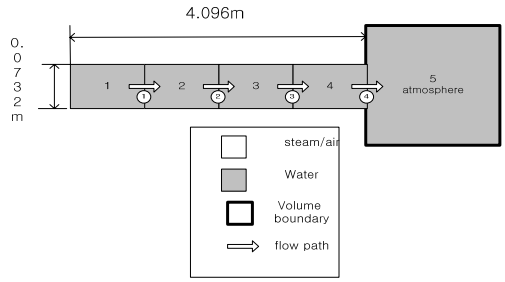

Figure 2 TASS/SMR nodalization for the Edwards pipe experiment

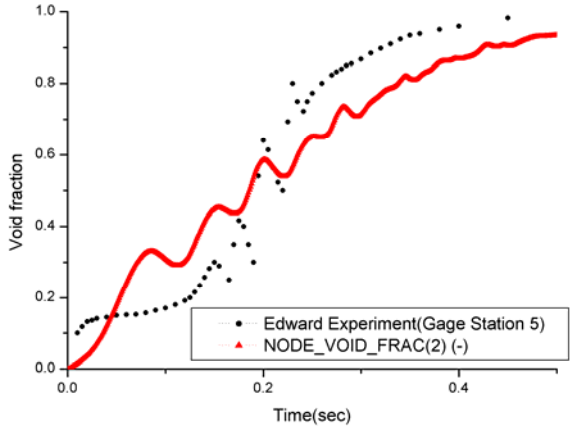

Figure 3 Comparison of the measured and calculated void fraction at the Gage Station 5

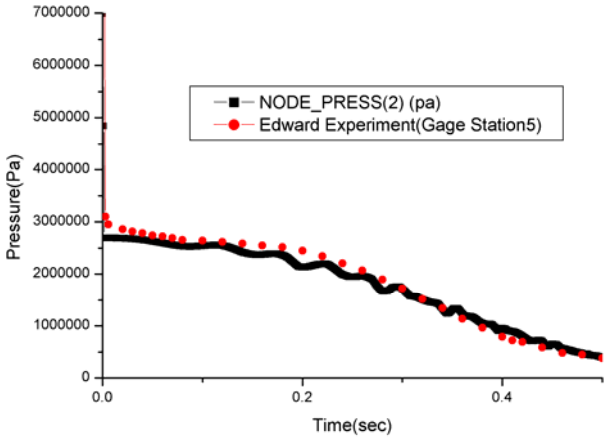

Figure 4 Comparison of the measured and calculated pressure at the Gage Station 5

Acknowledgement

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