

Three tank transient blow down validation case

Introduction

The purpose of the volume blow down validation case is to validate the Flownex node transient pressure response. The nodes in Flownex are the endpoints of elements and serves to connect elements in the network. The nodes are also the centers of the control volumes in the network CFD approach employed in Flownex. This means that mass conservation is enforced on the nodes, and momentum conservation is applied across the elements.

This validation case therefore confirms that the mass conservation and the momentum conservation are correctly and accurately implemented in Flownex.

Validation Specification

Three inter-connected pressure vessels, initially at different pressures, are allowed to equalize. The pressure response of the system was measured experimentally and predicted by the Flownex model. The transient time response of the blow down process was regulated using square-edge orifices in the connecting pipelines.

Two blow-down cases are considered. The initial absolute pressures of the vessels for both cases are shown in Table 1.

Table 1: *Transient blow down validation case input data.*

Vessel	Initial Pressures Case 1	Initial Pressures Case 2
Vessel A	986.5 kPa	2.72 kPa
Vessel B	2.3 kPa	536.3 kPa
Vessel C	536.3 kPa	986.3 kPa

Benchmark

The experimental setup is illustrated in Figure 1.

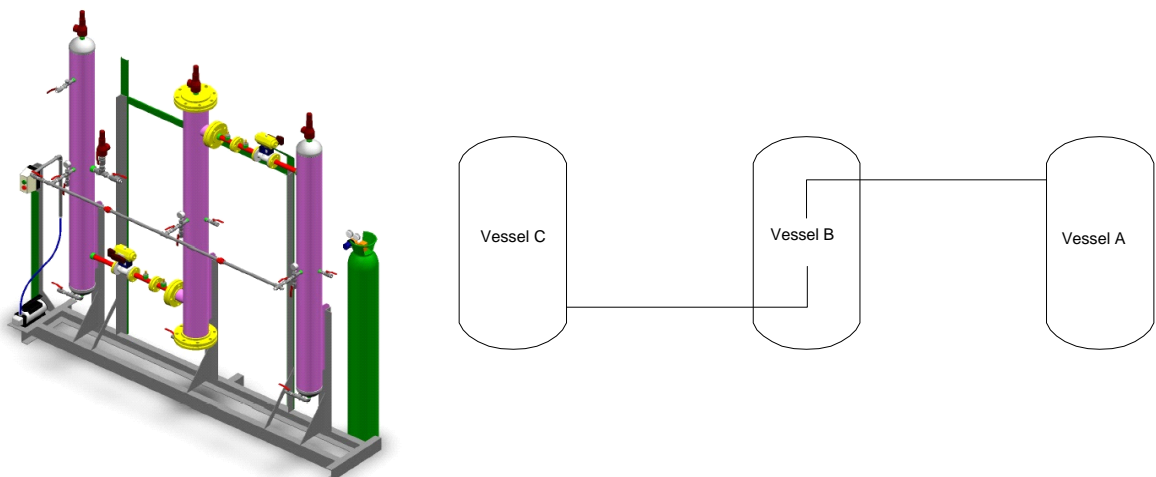


Figure 1: *Illustration and schematic layout of the blow down experimental setup.*

Flownex model

The Flownex tank blow down network is shown in Figure 2, with the vessels represented by the nodes numbered A, B and C respectively. The orifices were characterized by independent experiments, and are modeled in Flownex with user specified elements (elements number 103 and 106).

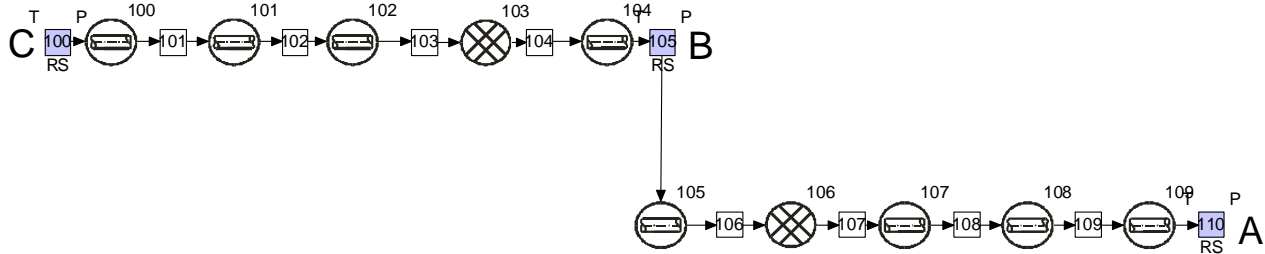


Figure 2: Flownex network used to model the tank blow down experiment.

The pressures of the nodes numbered A, B and C was fixed initially in the Flownex model. In the transient the pressure distribution through the network are solved at each time step.

Results

Figure 3 shows the comparison of the transient pressure response in the respective vessels as predicted by Flownex (FNX), and measured in the experiment (EXP). It is clear that excellent correlation exists between the results.

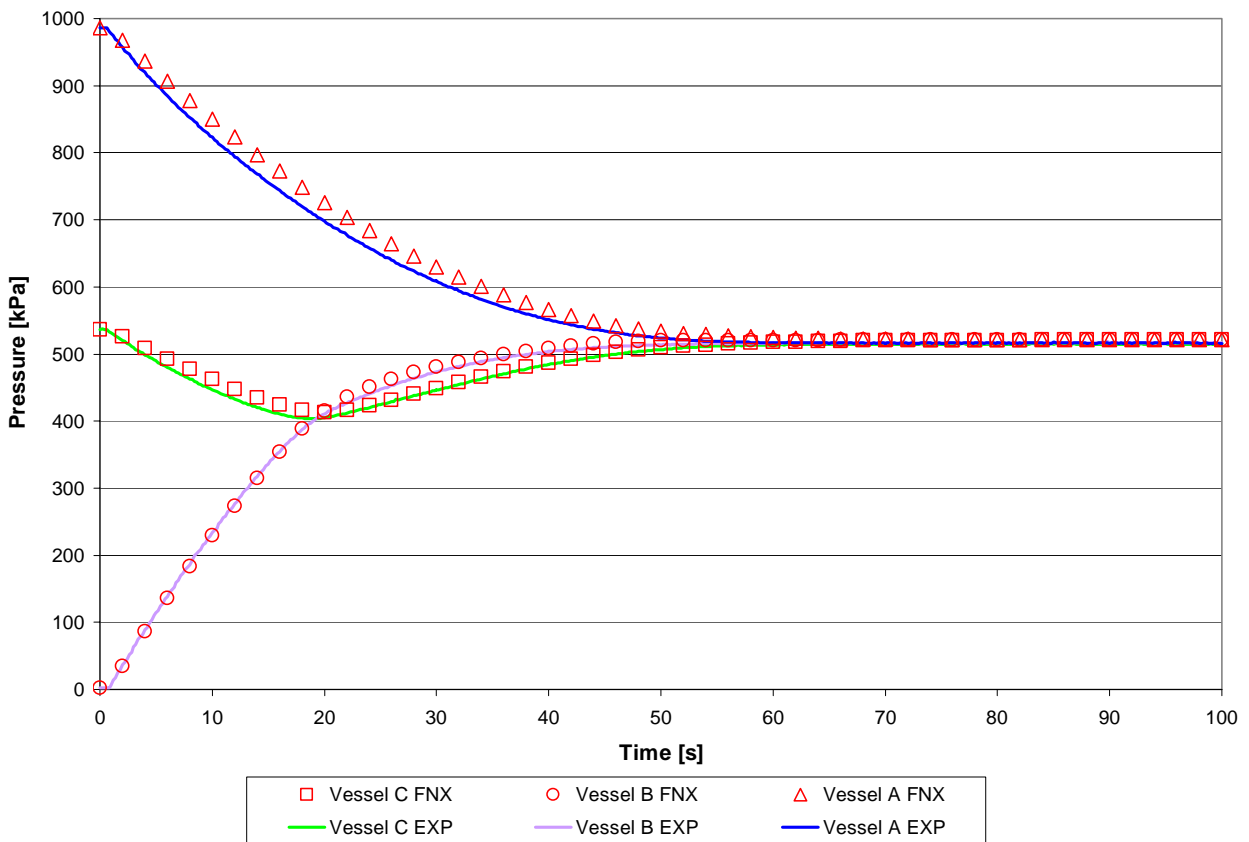


Figure 3: Vessel pressures for transient blow down validation case – Case 1.

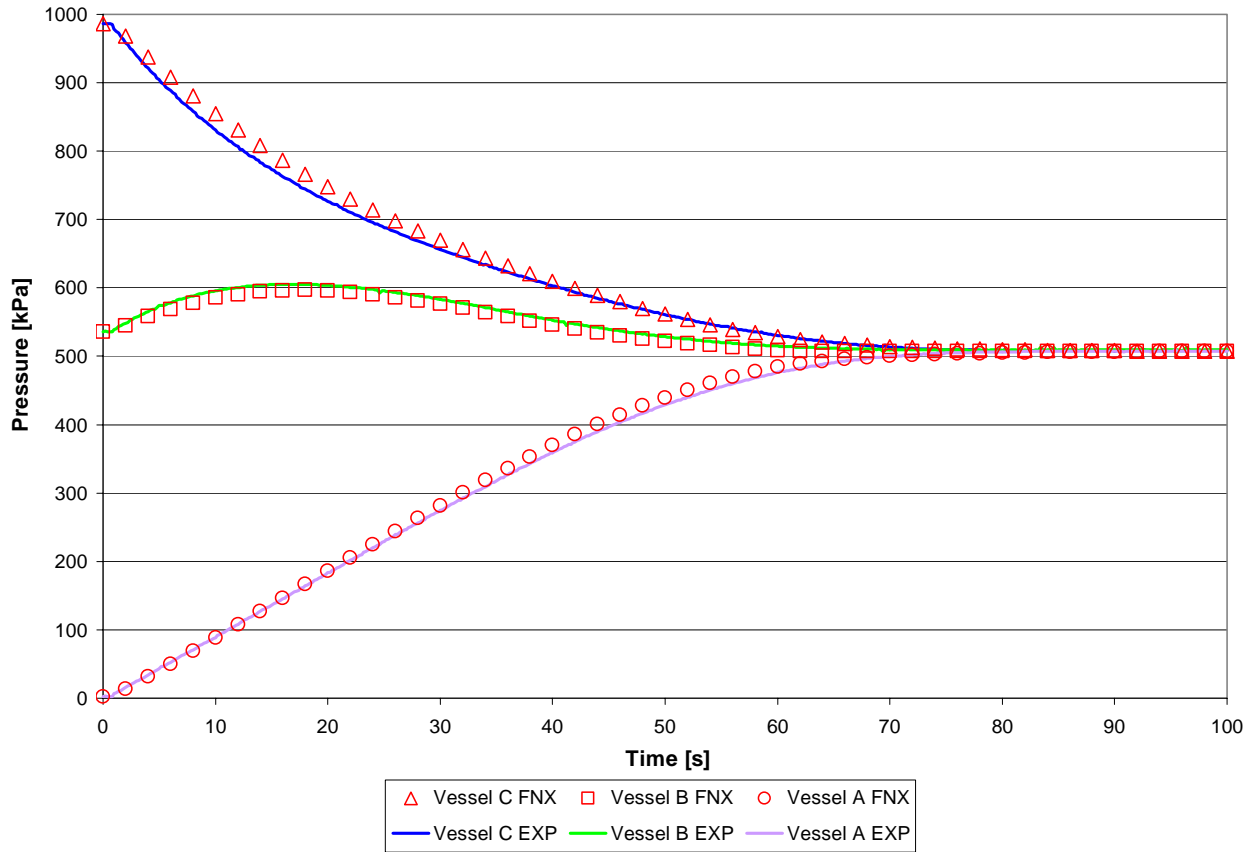


Figure 4: Vessel pressures for transient blow down validation case – Case 2.

Conclusion

From the results shown it is clear that the Flownex model accurately describes the experiment. It is concluded that the node model is correct and that the mass- and momentum conservation as implemented is applicable and physically realistic.