2.672 Project Laboratory
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6. Peak Pressure in Nuclear Containment Vessel

Every nuclear reactor is surrounded by a containment vessel designed to prevent the release of radioactive products if there is a catastrophic break in the reactor pressure vessel. The containment vessel must be strong enough to contain the steam and water released but must not be grossly over designed since it is a major element in the overall cost of the power plant. The purpose of this investigation is to develop and confirm a method of calculating the peak pressure in such a containment vessel after a sudden release of liquid and vapor into it.

The experimental apparatus consists of a small tank simulating the reactor and a larger tank simulating the containment structure. The reactor tank can be filled with liquid water and pressurized with steam; ~20% to 70% liquid by volume is appropriate. The water in the reactor vessel can be discharged into the containment vessel by opening a valve at the bottom or the top, simulating a break at the steam side, or at the liquid side of the water in the reactor. (You should make sure that the liquid water and the steam in the reactor tank are equilibrated before the discharge.) The pressure versus time response in the containment vessel and several other temperatures and pressures can be measured routinely.

You should propose and verify a method of calculating the peak pressure in the vessel including, at least, the variation of the peak pressure with initial reactor pressure and liquid volume. The calculation will involve the solution of a set of nonlinear simultaneous equations by iteration. For your convenience, Matlab functions are available to determine the saturation properties of water as a function of pressure (or temperature). Using this function in a program you write, you could solve the set of equations for the peak pressure. See the Matlab write up for details of using the functions.

In your report, you should use your method to examine the peak pressure dependence on the various parameters, especially the ratio of the volumes of the containment and reactor vessels. Arrange your results intelligently so that they can be readily used in engineering design.