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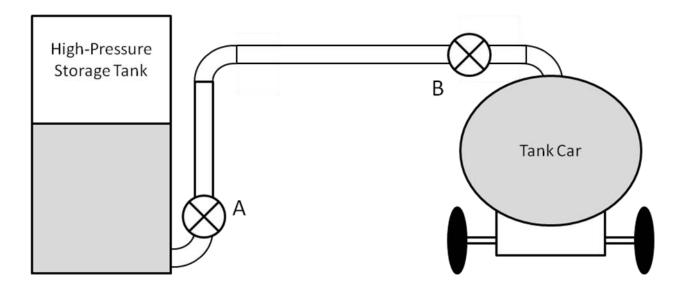

2.672 Project Laboratory
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2. Transfer Line Dynamics

A major chemical company has hired your firm to evaluate the safety of their chlorine handling operations after an industrial accident seriously injured 3 of its employees. At the time of the accident, the employees were loading liquefied chlorine gas onto a railroad tank car from a pressurized storage tank, as shown in the figure below. The standard operating procedure for this task calls for the transfer hose to be connected (between valves A and B), valve B (on the tank car) to be opened, and finally for valve A (at the storage tank) to be opened. During the accident, sensors indicate that valve A was opened before valve B, and that there was a massive pressure surge at the tank car. This pressure surge caused the transfer hose to rupture and release several hundred kilograms of chlorine gas into the atmosphere[1].

To study this phenomenon, you have constructed a simulated tank-car-loading system. The storage tank contains tap water pressurized with air, and the transfer line initially contains only air. A pressure sensor near valve B can be used to monitor the pressure surge. Two different transfer lines are available (with different lengths and piping features) for comparison.

In order to prevent future accidents of this type, your client would like you to determine the magnitude of the pressure surge that occurs if valve A is opened first, so that equipment with a suitable pressure rating can be provided. To do this, you will need to develop a model for the pressure surge as a function of line length, storage tank pressure, and other system parameters, and to describe a procedure for the use of this model in calculating the peak pressure. You should also use your model to examine the conditions during the accident: liquid chlorine under its own vapor pressure at 20° C was to be transferred through a 25-foot hose with an inside diameter of 1.5".

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[1] For a sample chlorine accident, see www.csb.gov/safety_publications/docs/CSB**Chlorine**ShutdownBulletin.pdf