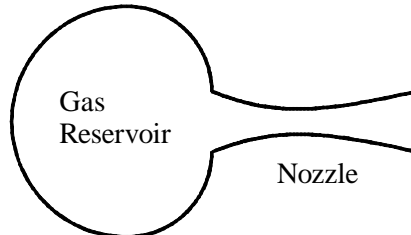


AerE 311L Experiment #1 Blowdown of a Pressurized Tank

A *cold gas jet* is a simple thruster device which is used for attitude control on many satellites. The device essentially consists of a tank (or balloon) of pressurized gas connected to a de Laval nozzle. Though it is inefficient when compared to conventional thrusters, producing on the order of 10 to 100 Newtons of thrust, it is simple and reliable.



In designing such a system the desire is usually to have the gas jet produce a certain amount of thrust for a given total duration. The design parameters in this case include among others the geometry of the nozzle, the initial tank pressure, tank volume and type of gas being used. In this experiment we will try to analytically predict the run-time of the system given the above parameters. If we could find such an analytical solution we can begin to estimate how varying the problem parameters will effect the run-time. For example, it is obvious that increasing the tank volume will lead to longer run-times, but we cannot say with certainty that doubling the volume will double the run-time.

In class we will derive or state the equations which give the tank pressure as a function of time for both an isentropic and isothermal expansion within the tank. We now want to experimentally examine the validity (or lack thereof) of these equations. Starting with a pressurized tank at some initial pressure, allow the tank to be de-pressurized, recording the tank pressure and temperature at ten second intervals. Also, record the time and pressure at which you observe third, second and first criticals. This experiment will be run in several increments so monitor the pressure and be prepared to shut off control valve at the appropriate pressure.

In your reports, be sure to plot the measured tank pressure with the predictions from the equations. Do the same for tank temperature. Based on these comparisons, does the tank expansion appear to be an isentropic or isothermal process or a combination of both? How well do the equations predict the time to first critical (i.e. run-time)? Solve the tank pressure equations for the time, t . Looking at these equations, what can you say about the effect of the various parameters on the run-time of the system? In particular, what properties of the gas will lead to longer run-times? How would the analysis given in class be different if the gas reservoir was a balloon instead of a rigid tank (you only need to qualitatively describe it)? Finally, how might the fact that the gas jet operates in the cold vacuum of space change anything? Submit figures and discussion in report form.

The volume of the tank is 2200 gallons and the area of the nozzle throat is 0.476 sq. inches.