

Introduction to Pressure, Stress and Sound Measurement

Perhaps the first measurements of pressure were attempts to measure the atmospheric pressure. A **barometer** is simply a device used to measure the absolute pressure in a gaseous environment. Some of the earliest barometers consisted of an evacuated chamber or vessel equipped with a lever system attached to one side of the container as sketched in Figure 1. As the external pressure changes, the dial gauge measures that change.

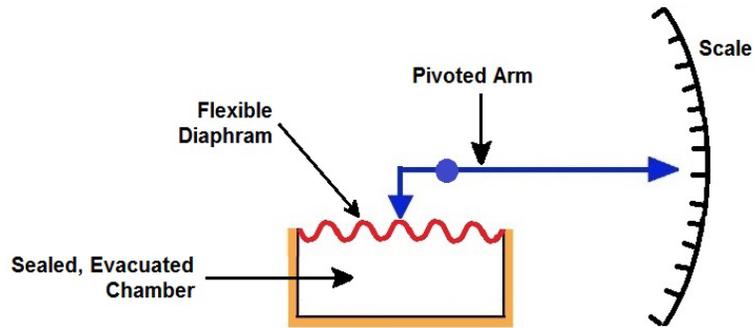


Figure 1: A simple barometer.

Note that the same principle was applied for the measurement of the relative pressure of a pressure source as depicted in Figure 2. Today most pressure gauges that one encounters are of this type.

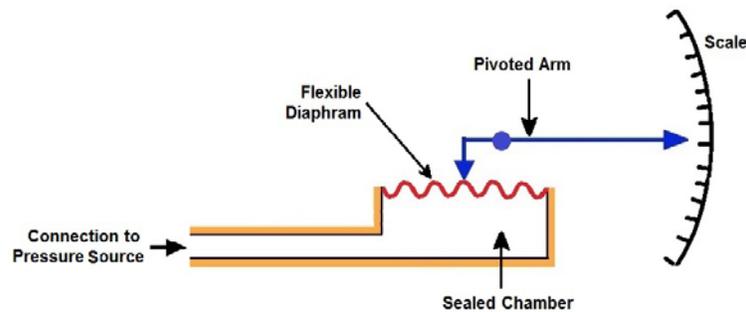


Figure 2: A simple pressure gauge.

Another common type of barometer is a manometer one side of which is exposed to a vacuum as sketched in Figure 3. Care is taken to completely fill the closed-topped, right-hand side of the manometer with the liquid (usually mercury) so that when the left-hand side is lowered and the pressure at the top of the right-hand side is decreased below the vapor pressure of mercury, mercury vapor is formed to take up the space above the liquid on the right. It follows that the atmospheric pressure, p_A , outside the open left-hand side is given by

$$p_A = \rho gh + p_V \quad (\text{Kdda1})$$

where ρ is the density of the mercury liquid and p_V is the vapor pressure of mercury at the ambient temperature. Looking these mercury properties up in tables and measuring h allows calculation of the absolute value of the atmospheric pressure.

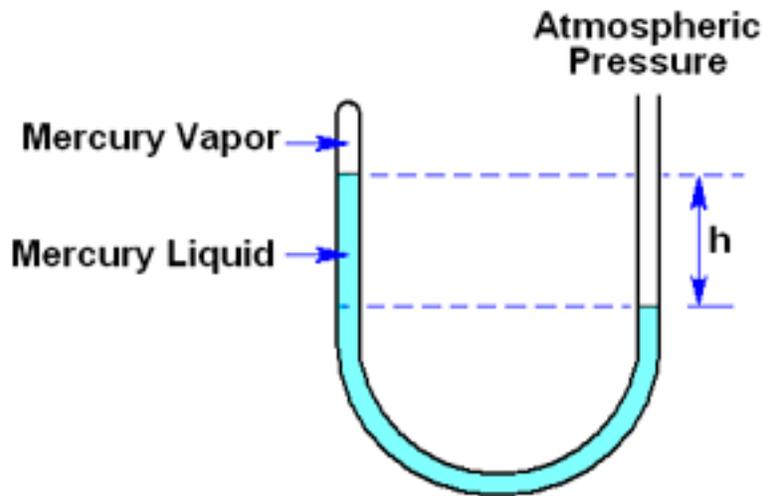


Figure 3: A mercury barometer.

There are, however, a number of ways of measuring pressure and some of these are outlined in the sections which follow. The experimenter needs to carefully consider all these limitations and/or advantages in choosing a particular pressure or sound instrument. There are two or three broad categories of instrument for measuring pressure. Manometers come in a range of configurations that are described in section (Kddb). Transducers are usually a more convenient option and these are described in section (Kddd). Transducers for the measurement of high frequency pressure oscillations and sound are more specialized instruments that are covered in section (Kdde). However, all these transducers require calibration and, to obtain this calibration, many of these instruments require comparison with a simple manometer. Even those designed to measure fluctuating pressures are calibrated using hydrostatic pressure gradients as described in a section that follows.

Because there are so many options, the experimenter needs to carefully consider the requirements of his/her particular experiment and make an informed choice of the most appropriate measuring device. Often several instruments may be needed, for example one for the measurement of steady pressure and another for the unsteady pressure or sound measurements.