Experiment 3

Calibration of Pressure Gages

Purpose

The objective of this experiment is to assess the accuracy of a pressure gage with a dead weight gage tester.

Apparatus

Figure 3.1 is a schematic of a dead weight tester. There are three primary components of this device: a fluid that transmits the pressure, a weight and piston used to apply the pressure, and an attachment point for the gage to be calibrated. The weight applies a force over a precisely known area, thereby applying a known pressure to the fluid. The fluid is an oil that is essentially incompressible. Since a dead weight tester is relatively compact the effect of elevation changes on the pressure are negligible. The pressure at the piston face, therefore, is equal to the pressure throughout the oil in the tester.

Secondary components of the dead weight tester are a reservoir and an adjusting piston. The reservoir accumulates oil displaced by the the vertical piston during tests when a large range of weights are used for a given gage. The adjusting piston is used to make sure that the vertical piston is freely floating on the oil.

Procedure

1. Attach the gage to the stem, B.

2. Select a weight and place it on the vertical piston, A.

3. Move the handle of the adjusting piston C to insure that the weight and piston are supported by oil, not the bottom stop.

4. Spin the vertical piston to insure it is floating freely.

5. Record the gage reading and the weight.

6. Repeat steps 2 through 5 for increasing and decreasing weights for each gage. Be sure to cover as much of the range of the gage that can be achieved with available weights.

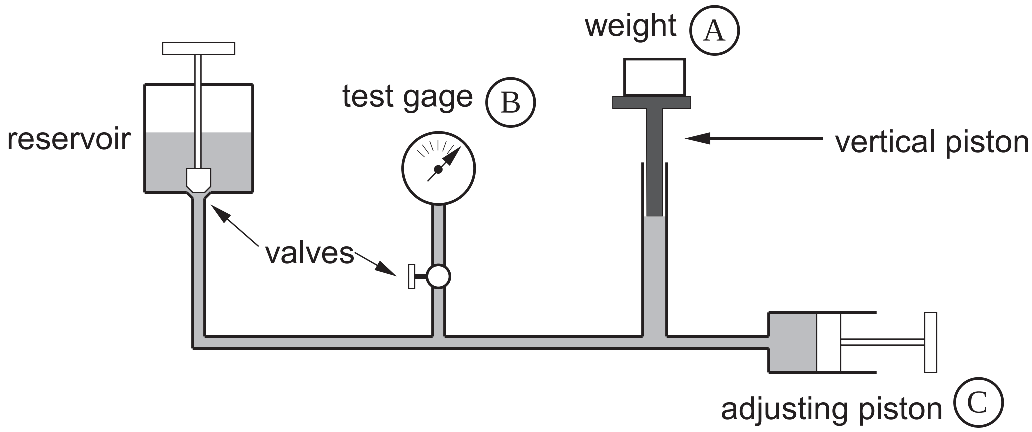

Figure 3.1: Dead weight gage tester.

Data Reduction

For each gage tested, draw two curves like those in Figure 3.2 and Figure 3.3. Figure 3.2 is a plot of the pressure indicated on the gage versus the pressure of the oil in the dead weight tester. Figure 3.3 is the discrepancy between the pressure gage reading and the pressure applied by the weight on the dead weight tester.

A difference plot like that in Figure 3.3 is a good way to compare two quantities that have nearly the same value. The data in Figure 3.2 suggest that the calibration is quite good, but there is no indication of the magnitude of the discrepancy. Figure 3.3 clearly shows the magnitude of the discrepancy between the indicated reading of the pressure gage and the dead weight tester. Furthermore, by plotting the calibration data as in Figure 3.3 one sees that the indicated pressure tends to be lower than the calibration standard (more points fall below the line $p_{\text{indicated}} - p_{\text{dwt}} = 0$).

Report

- Briefly explain the principle involved in the deadweight gage tester. How is the pressure generated? How is it transmitted to the gage? How is the pressure level controlled?
- Based on your calibration results, what is the maximum error to be expected when this gage is used to measure pressure? Is this error more likely to happen at low or high pressures? Is there a range of pressures for which the gage gives significantly more (or less) accurate readings?
- Is there any difference in the calibration errors between the data taken in order of increasing pressure, and the data taken in order of decreasing pressure? If so, give a plausible explanation for this error.
- Conceptually, could you use this apparatus to calibrate a vacuum gage? Practically? How?
- The dead weight tester is just a standard to which the pressure gages are compared? How do you imagine the dead weight tester was calibrated?

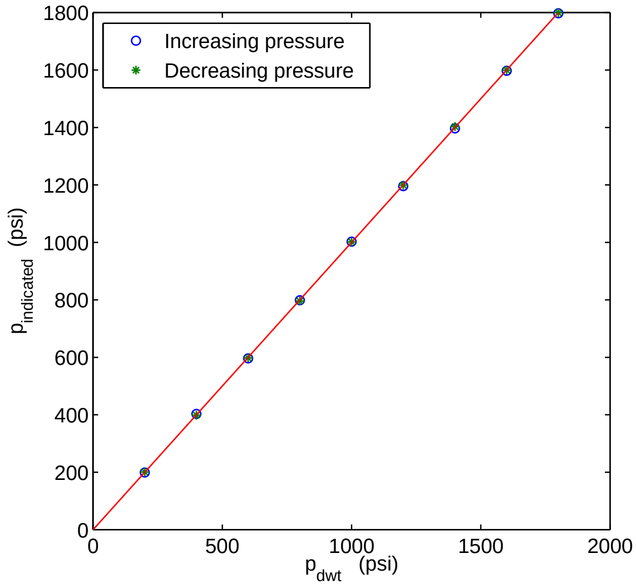

Figure 3.2: Calibration results for model XYZ gage.

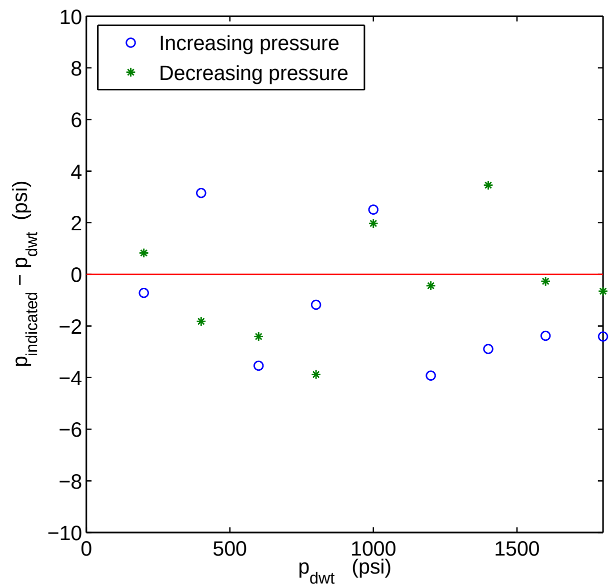

Figure 3.3: Discrepancy between the gage and dead weight tester for model XYZ gage.