USE AND CALIBRATION OF 1 PSI PRESSURE TRANSDUCERS FOR TENSION INFILTROMETERS

Use **of the 5305 Transducer**

The 5305 Pressure Transducers used for infiltrometers have a narrow range (+/- 0-1 psi, or +/- 67 mbar) for greatest sensitivity. However the transducer can be used beyond this range, because the output from the transducer is nearly linear to 250 mbar. The narrow range of the 1 psi transducer is optimal for tension infiltrometers.

The 1 psi Transducer is a differential transducer, which can be used to measure the pressure relative to atmospheric pressure (this is the most common use). However, it can also be used in differential mode. In this mode both ports are connected to water, or one to water and the other one to air at a different pressure than atmospheric pressure. The millivolt output from the transducer now represents the difference in pressure between two water lines, or between a water line and a pressure line, connected to the two ports of the transducer. The transducer was designed to have water contacting either or both sides of the transducer.

In the "normal" mode the transducer is placed on top of the water tower, and the falling water level inside the water tower is recorded as a function of time with a data logger. To do this remove the 1/4" NPT plug from the top of the water tower, and replace it with the tubing connector with attached pressure transducer.

Use 4-conductor 20-gage wire to connect the pressure transducer to the datalogger. Pin 1 (Vs(+)) of the transducer connects to the red wire. Pin 1 is notched and/or marked red. Pin 2 is to the left of Pin 1, and should connect to the white wire. Pin 3 (Ground (-)) should connect to the black wire. Pin 4 connects to the green wire.

If a Campbell Scientific CR10 data logger is used, the transducer wires are connected as follows: red wire to CR10 EX1; green wire to CR10 1H; black wire to CR 10G, and white wire to CR10 1L. If a second transducer is used it should be connected as follows: red wire to CRIO EX1; green wire to CR10 2H; black wire to CR10 G, and white wire to CR10 2L.

In the differential mode the pressure difference between two points ofthe water tower, one near the bottom and one near the top, are recorded (for details see: article by Francis X. M. Casey* and Nathan E. Derby, Dep. of Soil Science, North Dakota State Univ., Fargo, NO *58105 Soil Science Society of America Journal* 66:64-67 (2002)). The falling water level in the water tower is now measured at the bottom of the water tower, and referenced not with respect to atmo-

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spheric pressure, but instead referenced to the air pressure in the top of the water tower. According to Casey and Derby measurement precision is much improved with this method using a differential pressure transducer.

Calibration

The transducers need to be calibrated. The calibration depends on the excitation voltage applied to the transducer. Generally a 5 to 12 volt constant voltage needs to be used to excite the pressure transducer. Many data loggers, such as the Campbell data loggers, provide a constant voltage. The Campbell CR-IO datalogger provides 2.5-volt excitation. Although this is a lower excitation voltage than is generally provided, this still works very well.

The output from the transducers is in millivolts (mV). Typically with 5 Volts excitation, the output ranges from 0 to 50 mV.

If one uses 10 Volts excitation, the output ranges from 0 to 100 mV.

If you do not have a constant power supply, you can still test the transducer using a standard 9 Volt battery as the power supply. For example, by connecting a 9 Volt battery to Pins 1 and 3 of the transducer (see spec sheet from Honeywell), and the applied vacuum to the transducer outlet is 250 mbar, one measures approximately 56 mV across Pins 2 and 4 for the 1 psi Transducer. The transducer output for the 1 psi Transducer may no longer be linear above 250 mbar. The output values vary slightly with each transducer, but vary much more with different excitation voltages. Note, that if you have a digital multimeter with mV scale, this is an easy way to check a transducer.

Calibration of the single transducer using the water tower

Screw the tubing adaptor with attached pressure transducer in the cap of the water tower. Attach a section of 1/4 inch (or smaller ID tubing) clear tubing to the large tube with the black valve at the lower end of the water tower.

Close the black valve in the large tube. Also close the tubing between the water tower and the bubble tower with a clamp.

Fill the water tower with water till near the top. Slowly open the black valve, and let some water run out till the large tube and 1/4 inch tube are full with water. Then close the valve. Close the water tower with the cap with attached pressure transducer.

Slowly open the black valve.

The weight of the water in the water tower will cause a negative pressure in the air space above the water in the water tower. This negative pressure is equal to the vertical distance from the top of the water in the water tower, and the outlet of the 1/4 inch tube (provided the latter is filled with water).

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Record the vertical distance in cm, as well as the transducer reading. This is the highest point of the calibration curve of the transducer. Because the output from the transducer is linear, a high point and a zero point (when the transducer is exposed to atmospheric pressure, i.e. when the cap is removed from the water tower) are all that are needed for a good calibration. However, if additional calibration points are needed, just open the cap on top of the water tower and let some water run out. Then replace the cap and determine the vertical distance between the water levels, as well as the output from the transducer, etc.

Calibration of the single transducer with a manometer

Attach the open end of the to be calibrated transducer to a 20 cm section of flexible tubing. Attach a tee to the other end of the tubing. Attach a source of vacuum to the tee. Attach a inanometer (water or mercury type), or calibrated pressure transducer to the remaining open end of the tee.

Take a reading of the transducer using a digital voltmeter, or a datalogger. This is the output at zero pressure. Apply a small amount of vacuum (20 cm or 20 mbar) to the tee. Take the read out from the pressure transducer. Increase the vacuum in steps of about 20 em or 20 mbar and at each step record the output from the transducer. The maximum vacuum needed is 100 em water pressure or mbar.

Regress the transducer output versus the manometer reading. This is your calibration curve.

Calibration of multiple transducers

When many pressure transducers need to be calibrated, it is advantageous to construct a manifold. This can consist of a 50 cm length of thick walled plastic pipe. Using a #9 drill bit (0.1950 inches; 4.96 mm) drill holes along the tube spaced 5 cm apart. Push the transducers with their stem into the holes. Add some vacuum grease to the transducer ports, if needed, to ensure an airtight fit. Connect all transducers to a datalogger.

Connect one end of the calibration tube to a source of vacuum, and the other end to a manometer. Now proceed as above for the single pressure transducer.

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