Water potential measurement

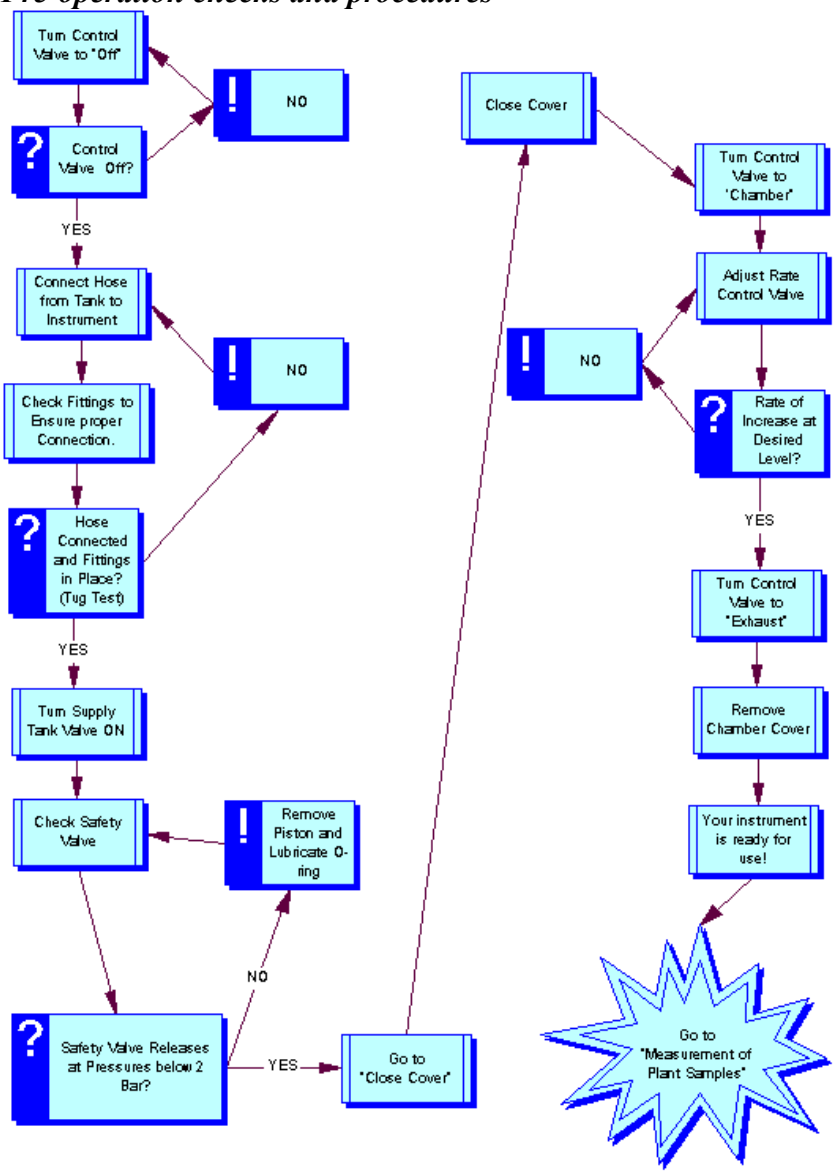
Principle of operation
When a leaf or shoot is cut, the column of xylem water retracts into the dislocated part. This sample is inserted into the chamber with only a small portion protruding through a rubber gland which is used to seal the chamber. The pressure inside the chamber is gradually increased by compressed air from a cylinder until the sap returns to the severed ends of the xylem vessels. The pressure inside the chamber is recorded, the pressure is released and the sample is removed.

Materials and Methods

Materials

- Pressure bomb (e.g. PMS 1000)
- Pressurized air or N_2 cylinder (i.e. BOC)
- Spanner
- Straps to secure pressure cylinder
- Razor blades or secateurs to sample leaves
- Marker pen to mark leaves (if necessary)
- Safety glasses
- Magnifying lens
- Torch or light (to illuminate petiole in pressure chamber)
- Zip lock plastic bags (if samples are not collected immediately prior to analysis)
- Esky (if samples are not collected immediately prior to analysis)

Pre-operation checks and procedures



- Check the chamber for cleanliness and proper lubrication. If necessary, wipe O-ring inside lid clean and lubricate it with petroleum jelly.
- Remove chamber lid and turn the control valve to OFF.
- Connect the supply hose to the instrument. Be certain that the quick-connect collar is pulled all the way back into its original position after the male hose end has been inserted. Check that the hose connection is secure by tugging gently on the hose.
- Slowly open the valve on the pressure tank.
- Test the safety valve. This brass valve is located on the side of the chamber, and MUST be tested before each measurement session. Insert a 'blank' solid rubber gasket into the inside of the lid or close the lid onto the chamber. Turn the lid clockwise to the stop and then back it off about 15 degrees to a position such that the cam on the cover does not depress the piston in the safety valve. Now pressurise the chamber slowly. The safety valve should pop open before the pressure reaches 2 bar

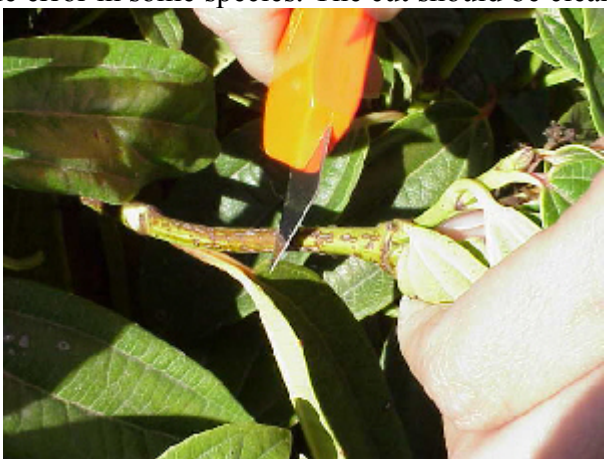
(0.2 Mpa). If it does not, turn the control to EXHAUST position then remove the nut and piston of the safety valve and lubricate the O-ring on the piston with petroleum jelly. Do not attempt to operate the instrument if the safety valve is malfunctional.

- Set the rate valve. With the solid gasket still in place and the lid securely in place on the chamber, turn the control to CHAMBER and open the rate valve so that the desired rate of pressure increase is observed. Errors in measurement caused by a rate of pressure increase that is too high or low tend to cause stress levels to appear higher than they actually are. Therefore adjust the rate valve such that the lowest measurements of water stress are achieved. EXHAUST the chamber before opening the lid.

Operation

Cut the sample from the plant-

Preparing a sample for the pressure chamber usually involves removing a leaf or a small lateral branch; if very small plants are used, the entire tip may be required. Removing the sample with a sharp knife or razor blade eliminates needless re-cutting, which can introduce considerable error in some species. The cut should be clean.



Because measurements should be taken as soon as possible after the sample is cut, it is advisable to take the instrument to the sampling site if possible. In many plants (especially new shoots and succulent plants) a delay in making a measurement may introduce significant error. For example, samples can be taken from dormant plants and stored for 20 minutes under cool, humid conditions before measuring with little error; however, succulent samples stored in warm, dry conditions for 20 minutes can experience an increase of 10 bar or more during that 20-minute delay. To avoid such errors, standardized measurement techniques based on sound physical and physiological principles must be used. As a general rule, a sample should be measured as soon as possible after being removed from the plant.

Seal the sample into the chamber lid-

Next you will need to seal the sample into the chamber this can be done by using a Compression Gland Cover or by using gaskets, inserts & insertion tools.

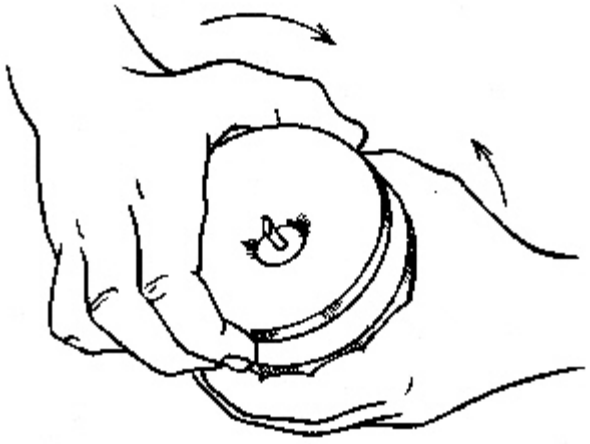
If your instrument is fitted with the Compression Gland Cover you can use this system or you can also use the standard system of various sized gaskets, inserts and insertion tools. The Compression Gland Cover allows the user to seal samples up to 1/4 inch in diameter quickly using the following method:

You have by now a cut sample and are ready to introduce it to the Compression Gland Cover

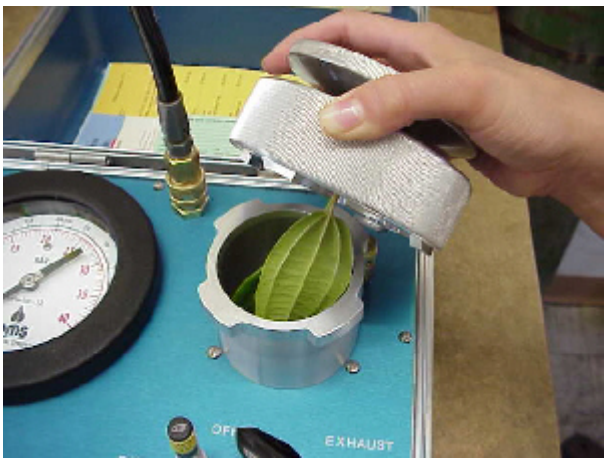
Insert the cut end of the sample from the bottom part of chamber lid

Slide sample through hole so that it sticks out other side of lid

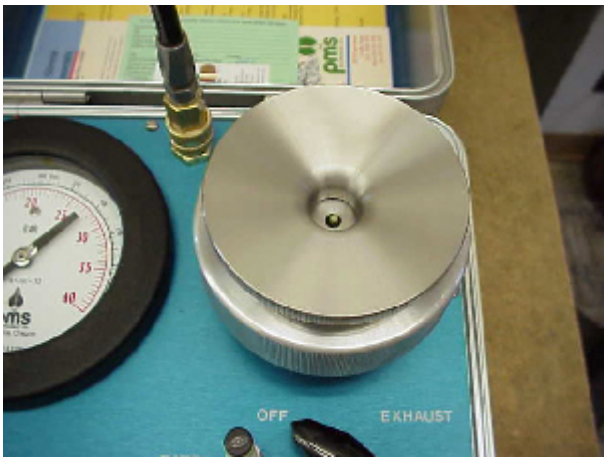
Sample should pass through lid by about 1-2 cm



Twist the Compression Screw so that the rubber squeezes and hold the sample
(do not overtighten as it can damage sample)



Slide leafy side of sample into chamber



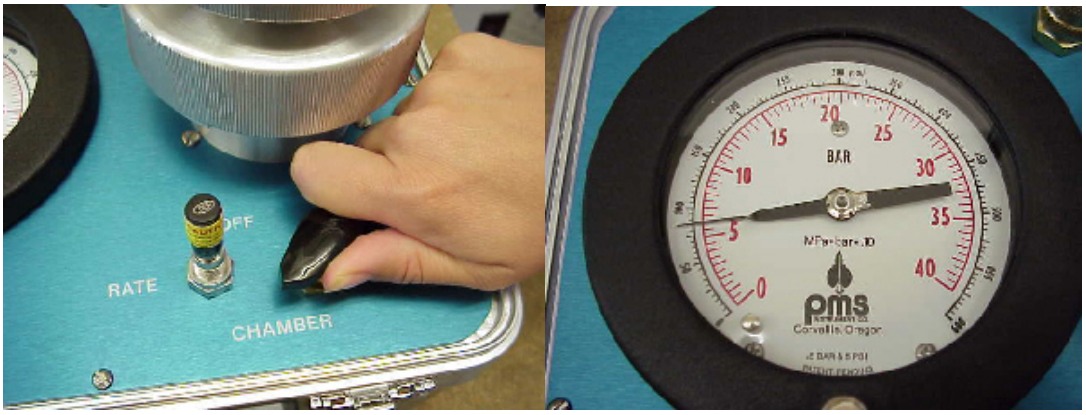
Push down and turn to lock lid onto chamber

An erroneous measurement may result if a large proportion of a small, succulent sample (e.g. conifer needle, grass blade, new shoot, etc.) is squeezed by the gasket. For example, PMS can be successfully measured with a fascicle of pine needles, but substantial (5 to 10 bar) errors can occur in measuring needles from Douglas fir, even with a very thin gasket. So long as no more than 10% of the sample protrudes through or is squeezed by the gasket, this type of error should be negligible.

Making the measurement-
The control valve is turned to CHAMBER to increase the pressure inside the chamber. MNake sure the pressure inside the chamber increases at a slow rate. Rapid rates of pressurization lead to more negative values of leaf water potential than slow rates of pressurization. Make sure leakage from the chamber is prevented. Tighten the lid

The cut surface of the plant sample which protrudes through the chamber cover is observed carefully. When water appears at the cut surface the control valve is turned to OFF immediately, and the pressure indicated on the gauge is recorded. The control valve is then turned to EXHAUST and when the chamber pressure reaches zero (indicated by

the gauge), the chamber cover and sample can be removed. The instrument is ready for the next measurement.



The endpoint, or pressure at which water appears on the cut surface, is sometimes difficult to recognize. A bright light directed on the cut surface is probably the most important aid in recognizing the endpoint. A good quality hand lens (about 10 power) may also be useful, particularly for samples which are small in diameter.

When the endpoint is determined and pressurized air turned off with the control valve, there is a slight decrease in pressure even if there is no leak. This phenomenon is particularly noticeable at high stress levels with a rapid rate of pressure increase. It is caused by temperature changes inside the chamber and can be minimized by adjusting the rate of pressure increase.

Resin can obscure the endpoint and may be bothersome in certain species, particularly with pines. Resin forms bubbles which break and can be wiped away to allow observation of the true endpoint. Resin usually appears at very low pressures and need not interfere with accurate measurements. With experience, resin can be dealt with satisfactorily.

CAUTION! Never place any part of your body directly over the chamber when the chamber is pressurized. It is possible that the sample may be forced out of the chamber at high velocity!