USING THE GAS PRESSURE EXTRACTOR

Water relations are among the most important physical phenomena that affect the use of soils for agricultural or engineering purposes. In the laboratory study of these many physical relationships, as well as the extraction of soil solution for chemical analysis, the Pressure Membrane and Pressure Plate Extractors have become eminently successful research tools.

Many methods, such as compaction, centrifugation, displacement, molecular absorption, and suction have been used to investigate the physical properties of soils as well as to remove soil solution for chemical analysis. In each of these methods the range of application is quite limited. In many instances the methods are cumbersome. In some cases the soil structure is destroyed in the process of making an extraction.

By contrast the Pressure Membrane Extractor and the Pressure Plate Extractors provide a convenient, reliable means of removing soil moisture, under controlled conditions, from soil samples throughout the whole plant growth range, without disturbing the soil structure. The method may be used on prepared samples or undisturbed soil cores.

Through the application of the Pressure Membrane and Pressure Plate Extractors the characteristic moisture retention curves may be developed for each soil type. These curves, such as shown in Fig. 1, relate the soil suction, at which moisture is held by the soil, to its moisture content. This relationship is important in studies of soil moisture movement and of quantity and availability of soil moisture for plant growth.

The Pressure Membrane and Pressure Plate Extractors are used in determining the permeability of undisturbed soil cores, and in studies of the hysteresis effect in soils. Soil solution may be extracted in increments at known suction values for chemical analysis. The versatile Pressure Extractors also find application in the calibration of various moisture-measuring equipment and in ultra filtration work, such as the separation of heavy protein molecules from dilute solutions.

The Nature of Gas Pressure Extraction

The principle involved in the operation of the Pressure Membrane and Pressure Plate Extractors is well known. For many years water has been removed from soil by suction wherein a porous ceramic wall serves as a connecting link and at the same time a means of maintaining a pressure difference between the liquid phase of the water in the soil and the water at lower pressure on the opposite side of the wall. The Pressure Membrane and Pressure Plate Extractors are a unique gas pressure modification of the suction procedure.

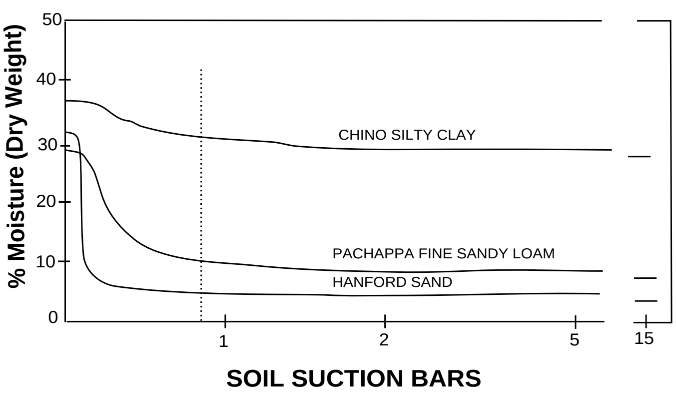

Fig. 1 Moisture Retention Curves are shown for three types of soils. The dotted line at .85 bars of soil suction represents the limit of tensiometer readings.

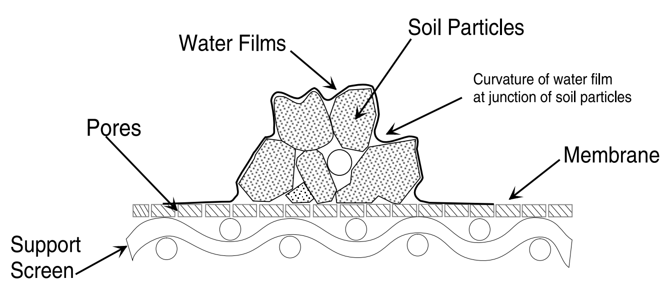

Fig. 2

The illustration in Fig. 2 shows a magnified view of soil particles in contact with the cellulose membrane inside the Pressure Membrane Extractor during an extraction run. A wetted cellulose membrane is supported by a fine mesh screen which also provides a passage way for the extracted solution. The wetted soil

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samples are placed directly on the membrane and subjected to air pressure in the extractor.

As soon as air pressure inside the chamber is raised above atmospheric pressure, the higher pressure inside the chamber forces excess water through the microscopic pores in the cellulose membrane. The high pressure air, however, will not flow through the pores since they are filled with water and the surface tension of the water at the gas-liquid interface at each of the pores supports the pressure much the same as a flexible rubber diaphragm. When the air pressure is increased inside the Extractor the radius of curvature of this interface decreases. See Fig. 3. However, the water films will not break and let air pass throughout the whole pressure range of the Extractor.

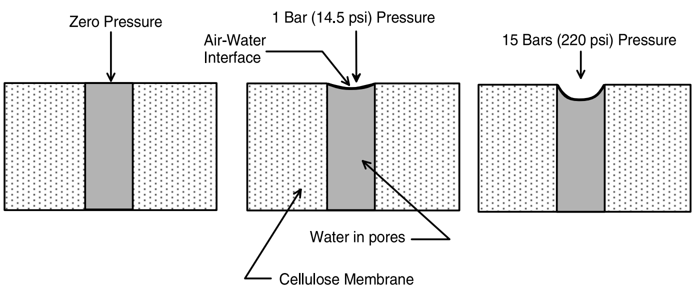

Fig. 3 Illustrated above is a pore in the membrane material showing how the radius of curvature of the air-water interface changes with pressure.

At any given air pressure in the chamber, soil moisture will flow from around each of the soil particles and out through the cellulose membrane until such time as the effective curvature of the water films throughout the soil are the same as at the pores in the membrane. When this occurs, an equilibrium is reached and the flow of moisture ceases. When the air pressure in the Extractor is increased, flow of soil moisture from the samples starts again and continues until a new equilibrium is reached. At equilibrium, there is an exact relationship between the air pressure in the Extractor and the soil suction (and hence the moisture content) in the samples. For example, if the air pressure in the Extractor is maintained at 1 atmosphere (15 psi), the soil suction in the samples at equilibrium will be 1 bar[1]. If the air pressure is maintained at 15 atmospheres (225 psi) the soil suction at equilibrium will be 15 bars, which is the approximate wilting point for all soils. The Pressure Plate Extractors make use of the sample principle of operation. In place of the cellulose membrane, porous ceramic plates are used. The pores in these ceramic plates are much larger than those in the cellulose membrane and hence the maximum pressure they can stand without leaking air is less. However, because of the relatively larger pore size the Pressure Plate Extractors are more efficient in removing soil moisture from samples in their range.

1 The "bar" is a standard unit for the expression of soil suction. By definition a bar is a unit of pressure equal to 10^6 dyne/cm^2. This is the equivalent of .987 atmospheres.

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