

1400/1405

OPERATING INSTRUCTIONS

Tempe Pressure Cell

June 1995



Fig. 1a 1400 Tempe Pressure Cells with 3cm cylinders and 6cm cylinders) mounted on the Tempe Cell Stand

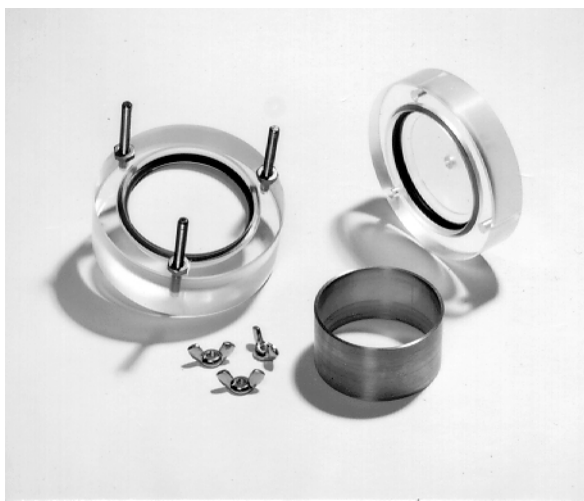


Fig. 1b Disassembled 1400 Tempe Pressure Cell



Fig. 1c Soil Core Sampler (Model 0200) shown with various sizes of brass cylinders for obtaining undisturbed soil cores.

1. YOUR TEMPE PRESSURE CELL

Unpacking

Both models of Tempe Pressure Cells have been modularized for your ordering convenience and are shipped partially assembled and individually boxed. All parts have been manufactured to the highest standards and, when packed, were in perfect working order. Unpack with care and be sure to remove all packing material. Follow the instructions carefully in order to assure long, trouble-free service.

Not Liable for Improper Use

Soilmoisture Equipment Corp. is not responsible for any damage, actual or inferred, for misuse or improper handling of this equipment. The Tempe Pressure Cell is to be used solely as directed by a prudent individual under normal conditions in the applications intended for this equipment.

ACQUAINT YOURSELF WITH THE PARTS

Figure 2 below shows a disassembled 1405 Tempe Cell and its components. A Tempe Cell is divided into 3 parts: The Top and Base Cap Assembly, the Brass Cylinder, and the Porous Ceramic Plate.

The Top and Base Cap Assemblies are made of plexiglass and permit unrestricted view of the internal parts and activity. The Buna-n "O" rings in the caps make the pressure seals.

The Tempe Pressure Cell accepts an undisturbed soil core, contained in the Brass Cylinder directly from Soilmoisture's Soil Core Sampler, Model 0200. The sample is not disturbed by unnecessary handling and the resultant curve will accurately reflect the true characteristics of the soil in the very important 0-1 bar range of soil suction where almost all of the soil moisture movement takes place.

The Porous Ceramic Plate can vary in bar rating as per the user's choice and type of application. Please refer to the back of these instructions on the various types of configurations that are possible for the Tempe Cells.

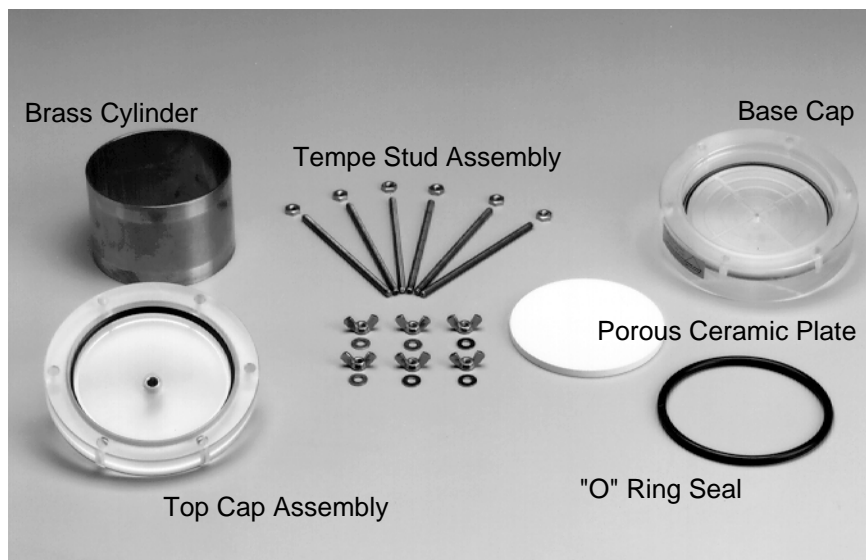


Figure 2 - 1405 Tempe Cell disassembled

OPERATING PRINCIPLES

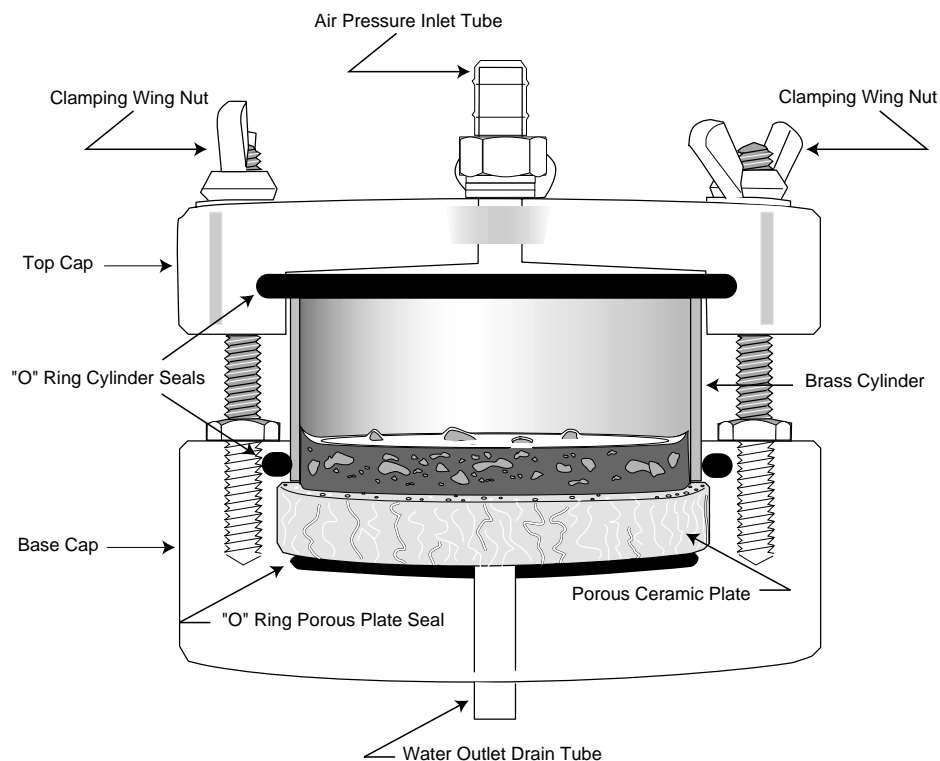


Fig.3 - Cross sectional view of Tempe Cell with sample

In order to use this type of extraction equipment effectively, it is important to understand the physical principles involved in its use. The Tempe Pressure Cell provides a simple method to determine soil moisture-retention curves or the "moisture characteristic" of undisturbed soil cores in the 0-1 bar range. This moisture characteristic of field soils is readily and very accurately determined by weighing the complete cell at pressure equilibrium points. Figure 3 above shows a cross-sectional view of the Tempe Pressure Cell with a soil core sample placed on the porous ceramic plate of the Cell. Prior to making a run, the soil sample - together with the porous ceramic plate - is saturated with water. Air pressure is then applied to the Tempe Pressure Cell to effect extraction of moisture from the soil sample under controlled conditions.

When air pressure inside the Tempe Cell is raised above atmospheric pressure, the higher pressure inside the Tempe Cell forces excess water through the microscopic pores of the porous ceramic plate and out through the Water Outlet Drain Tube. The high pressure air will not flow through the pores of the porous ceramic plate since they are filled with water. The surface tension of the water in the pores at the air-water interface supports the pressure, much the same as a flexible rubber diaphragm.

The radius of curvature of the gas-liquid interface decreases when air pressure inside the Tempe Cell is increased (Figure 4). The maximum air pressure that any given wetted porous ceramic plate can stand before letting air pass through the pores is determined by the diameter of the pore. The smaller the pore size, the higher the air pressure will have to be to allow air to pass through. There is an exact relationship between the amount of air pressure in the Tempe Cell and the radius of curvature of the air-water interface of the water in the pores of the porous ceramic plate. The pressure value that finally breaks down these water miniscuses is called the "bubbling pressure" or the "air entry value" for the porous plate. Porous ceramic plates must always be used at air pressure extraction values below the "bubbling pressure" or "air entry value" for the plate.

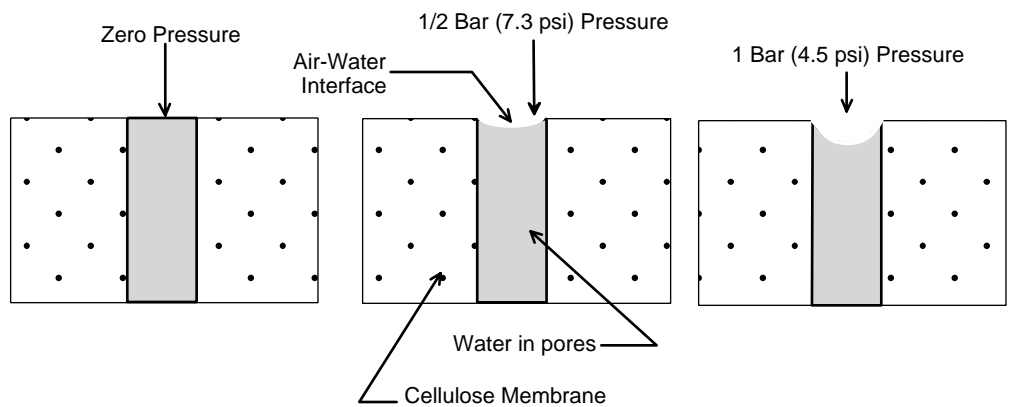


Fig. 4

When soil samples are placed on the porous ceramic plate of the Tempe Cell and are saturated with water, and the air pressure inside the Tempe Cell is raised above atmospheric pressure, water will flow from around each of the soil particles and out through the pores of the Porous Ceramic Plate until the curvature of the water films at the junction of each of the soil particles is the same as in the pores of the porous ceramic plate and corresponds to the curvature associated with that pressure (Fig. 5).

For example, if the air pressure in the Tempe Cell is maintained at 1/3 Bar (4.8 psi), the soil suction in the samples at equilibrium will be 1/3 Bar.

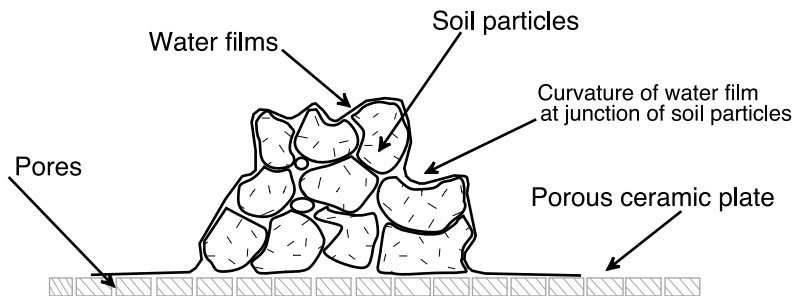


Fig. 5

Note:

Please note, however, that the bar value of the porous plate influences the flow of moisture and, therefore, the time required to reach equilibrium. Always use a porous plate with the lowest rated bar value possible for your application in order to maintain the time to reach equilibrium to a minimum. If you need to work in the extended operating range of 0-1 bar, it is, of course, necessary to use a porous ceramic plate that has a bubbling pressure in excess of 1 bar. Such plates, because of their relatively small pore size require more time to reach equilibrium when used at very low pressures such as 1/10 bar.

REQUIREMENTS PRIOR TO USE

Pressure Supply and Control

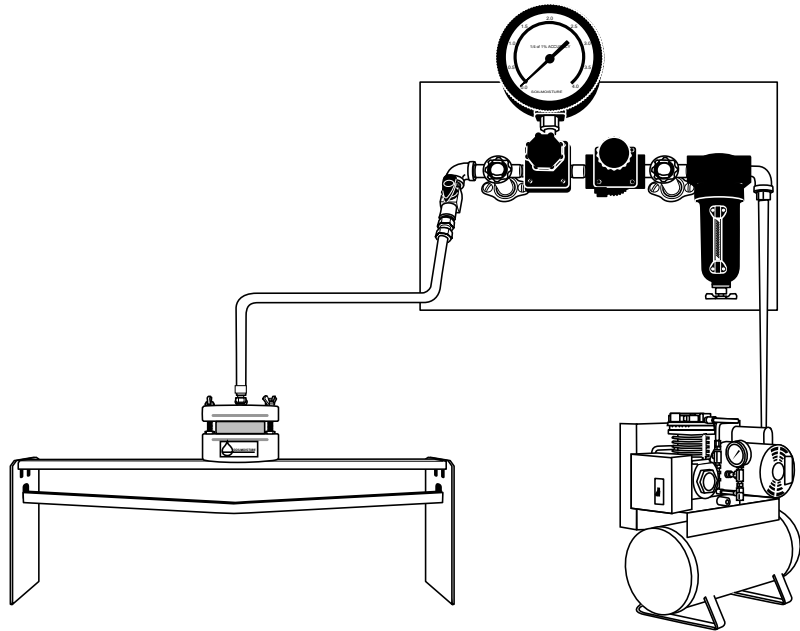


Fig. 6 - 0700CG3 Manifold and 0500 Series Compressor

A source of regulated gas pressure is required for all extraction work. Compressed air from a compressor or compressed air or nitrogen in high pressure tanks can be used. If the Tempe Cell is to be used extensively, compressed air from a compressor is the most satisfactory source of supply. Our PM compressor, Model 500FG3 (120 V) or 500FG4 (220V), is ideally suited for use with this type of extractor, as well as for all of our other extractors and is available in a variety of voltages and cycles to meet any application.

Accuracy of equilibrium values will be no more accurate than the regulation of the air supply. For work in the low suction range and particularly for determination of 1/10 Bar and 1/3 Bar percentages, it is essential to have excellent pressure regulation. We recommend the 0700G3 Manifold as a pressure control for this extractor. This Manifold makes use of a low pressure regulator in series with a “nullmatic” type regulator to provide double regulated pressure regulated to within 1/100 psi throughout the range from 0-60 psi.

Fig. 6 shows a diagrammatic view of the laboratory setup for the Tempe pressure Cell provided with regulated air pressure from the 0700G3 Manifold and the 0500F PM Compressor as a pressure source. The Manifold is frequently incorporated in combination manifolds such as the 0700CG13, 0700CG23, or 0700CG123, where several different types of extractors are being run independently from the same pressure source.

If a laboratory compressed air supply line is available, the 0700G3 Manifold can be conveniently attached to the laboratory wall adjacent to the extractor and connected directly to the supply line. Maximum input pressure to this manifold is 300 psi.

The 0700G3 Manifold is not suitable for operation from compressed tank gas since it “bleeds” a small amount of air continuously from the air source in the process of regulation. This amount of air is readily replaced by a compressor, but it would drain a tank of compressed gas in about a day.

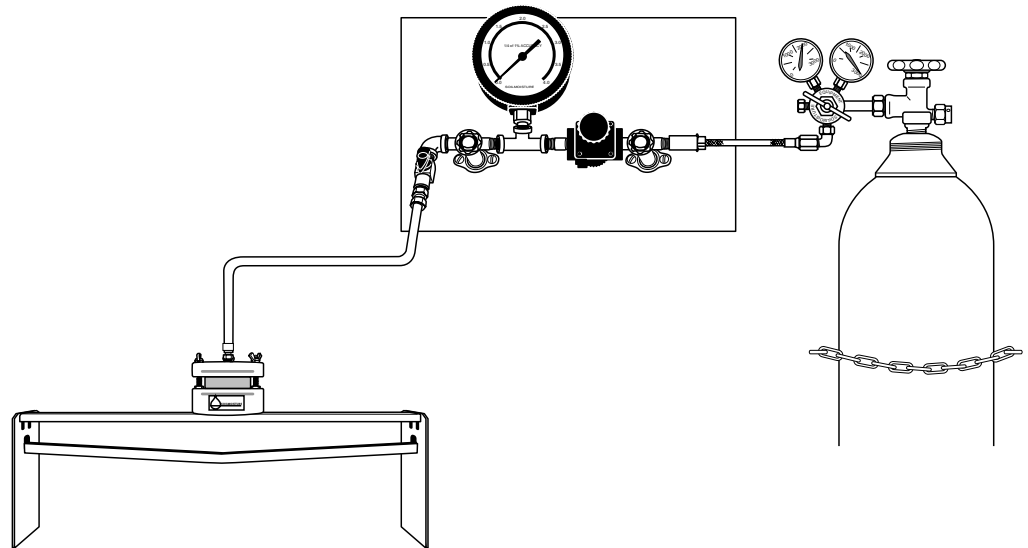


Fig. 7 - Tempe Cell shown with 0750G3 Manifold and tank of compressed gas

The Tempe Pressure Cell can be operated from compressed air or nitrogen in tanks. Our 0750G3 Manifold (Fig. 7) is designed for use with water-pumped nitrogen in tanks (approx. 2,000 psi). This manifold has a pressure range from 0-125 psi with an accuracy of regulation of approximately .2 psi.

The 0750G3 Manifold may also be incorporated in combination manifolds such as the 0750CG13, 0750CG23, or 0750CG123 Manifolds, where several different types of extractors are being run independently from the same pressure source. The 0750G3 Manifolds all incorporate a regulator designed to mount directly on tanks of water-pumped nitrogen with a coupling fitting. This coupling fitting is designated as a CGA No. 580 and is standard for nitrogen tanks and air tanks in the United States.

If a pressure control setup is built by the laboratory technicians, take care in the selection of the proper components. Proper pressure regulators, test gauges, valves, and miscellaneous adapters are available at Soilmoisture Equipment Corp. and the current price list should be consulted. In general, the type of pressure regulator required will depend on the type of pressure source and on the accuracy required for the studies being conducted. Accuracy of regulation is dependent on the construction of the regulator and also on variations in the pressure from the source.

With regulators suitable for use with this extractor, one can expect variation in the source pressure to be reflected in the regulated pressure in the ratio of about 1/12 to 1/25. In other words, a change in the pressure from the compressed air source of 25 psi will change the regulated pressure by 1 to 2 psi, depending on the make of regulator. Where greater accuracy is desired, this variation can be eliminated by the process of "double regulation". This is done simply by putting two regulators in series. The first regulator is set at a somewhat higher pressure than the second in order to supply reasonably constant pressure to the second regulator. Pressure from the second regulator in turn will be very constant with source pressure variations reduced in the ratio of 1/100. Some regulators, such as the nullmatic regulator, require minimum inlet pressure to operate properly. The minimum inlet pressure of the nullmatic regulator is 15 psi.

Where extreme accuracy of regulation is required, nullmatic regulators which bleed a small amount of air continuously, are necessary. Because of this feature, however, they are not suitable for use with tank gas and must be used where a compressor is available as a source of pressure.

Running Several Tempes At One Time

Soilmoisture's manifolds can also be configured in such a way that several Tempe Cells can be functioning at one time. By adding a repeatable section to the manifold setup, several valves can be added depending on your requirements. Below is a diagram (Fig. 8) of a modified manifold with 2 repeatable valve sections added to accomodate 3 Tempe Cells.

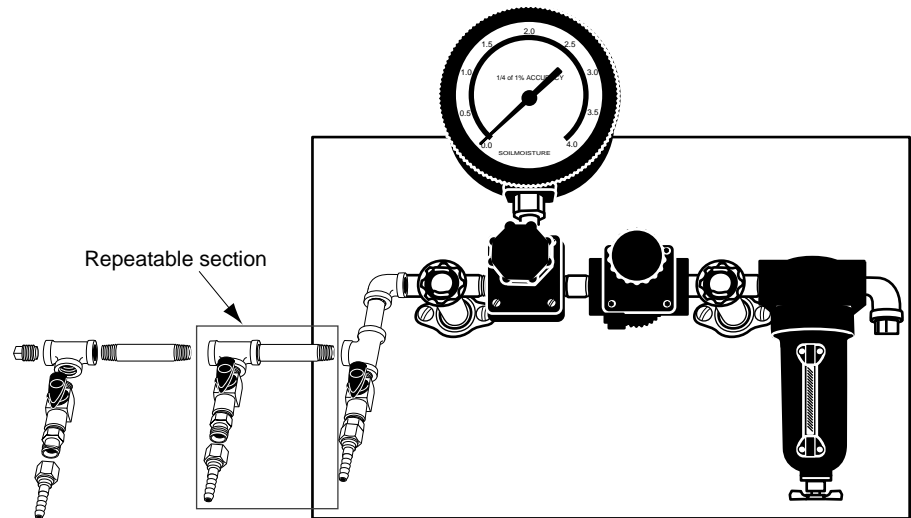


Fig. 8 - 0700CG3 Manifold with repeatable sections for operating 3 Tempe Cells at one time

HOW TO OPERATE THE TEMPE PRESSURE CELL

Making A Run

It is essential to fully saturate and deaerate the porous plate before placing the Tempe Cell in operation. This is best accomplished by saturating the plate in a vacuum desiccator with deaerated distilled water. Remove the porous ceramic plate from the cell by first removing the "O" Ring Cylinder Seal. The drain tube of the Tempe Cell is then connected to a leveling bulb, and the height of water in the bulb adjusted to the same height as the bottom of the cell. The saturated porous plate is now reinstalled. Once the plate is in place, the leveling bulb is raised so the water level is just at the top of the porous plate. There should be no free water on the plate.

Placing Soil Samples in the Tempe Cell

Next, place the soil core, in its brass cylinder, on the bottom of the cell. Gently twist the cylinder as it is being pushed down past the "O" ring and then firmly press the core onto the porous plate to insure good contact. To saturate the core with water, raise the bulb to the same height as the top of the sample. The time required for saturation depends on the conductivity of the soil and of the porous plate. Once the core has been saturated, reattach the top part of the Tempe Cell and tighten the wing nuts. Connect the Tempe Cell to the pressure supply manifold and raise the pressure in the cell to the desired level as indicated on the pressure gauge.

Weighing the Samples

Immediately before weighing the cell for the first time, expel any air present below the plate using a syringe filled with water. To do this, hold the cell upside down and inject water into the drainage tube. Some tilting of the cell and repeated shots of water are usually required. This filling procedure may be necessary before each weighing so that the weight of the water in the bottom of the cell is constant. Inverting the cell has no effect on the equilibrium status of the sample. The cell can be weighed at any time by wiping off any droplet hanging from the drain tube and inserting a clamp over the drainage tube to prevent air from being pulled through the drain tube into the drainage grooves when the air supply hose is disconnected. When using a porous plate of low conductivity, the clamp may not have to be used. Weighing can be done on an automatic, direct reading balance with a capacity of 800 g and a sensitivity of 0.03g. The total weight of a cell with soil is approximately 500 g. Equilibrium is reached when weight remains constant.

The weighing process may then be repeated at higher pressure values. By noting the difference in weight, you will know the change in weight from one soil suction value to another. At the end of a run, the sample can be dried at 105 degrees Celsius. The changes in weight can be interpreted in terms of moisture content by weight of soil. Since the volume of the soil sample is well defined by the dimensions of the brass retaining ring, the moisture content can also be related to the volume of soil. By plotting the change in moisture content at each equilibrium value against the soil suction in bars for that equilibrium value, you develop the fundamental relationship of soil suction versus moisture content for each soil. The graph obtained is called the moisture characteristic for the soil.

Precautions

Take care to keep soil particles away from the pressure seals and sealing areas. It is also very important to avoid scraping or banging the metal surfaces on which the pressure seals are made. Damage to these sealing surfaces may cause air to leak from the Tempe Cell. This leakage is called "ventilation" and it can result in erroneous equilibrium values since any flow of air will also carry off soil moisture and reduce the equilibrium moisture content value below actual values.

One should never attempt to remove the lid of the Cell until all pressure is released. Equal care should be taken to see that the lid is securely fastened in place before air pressure is applied.

GENERAL CARE AND MAINTENANCE

The Tempe Cell parts are ruggedly constructed for maximum use. Little attention is required except for removing excess moisture and soil particles from the interior surfaces after a run. Replacement "O" Ring Seals are available for immediate shipment from stock.

Handle the Porous Ceramic Plate with care to prevent damage or cracking. If the Plate is cracked it will not function properly and must be replaced.

HOW TO CONFIGURE THE TEMPE CELL WHEN ORDERING

Configuring a Tempe Cell is as easy as A,B, C. There are three important parts to a Tempe Cell: A) the cylinder size; B) the bar value of the plate; and C) the size brass cylinder. Here we will show you how to indicate on an order a 1405 Tempe Cell configured with a 1 bar, high flow plate and a 6 cm tall cylinder.

First, we select the correct size Tempe Cell needed (either the 1400 or the 1405).

1400
A B C

Next, you select which bar value rating your application requires. There are 3 different porous ceramic plates to choose from:

| | |
|-------|---------------------------|
| B.5M2 | 1/2 bar high flow ceramic |
| B1M1 | 1 bar standard ceramic |
| B1M3 | 1 Bar high flow ceramic |

Since we need a 1 Bar, high flow porous plate, we write in section B:

1400 B1M3
A B C

Last, we choose the cylinder height needed (either 3 cm or 6 cm tall designated as -3 or -6 respectively). Since we need a 6 cm tall cylinder our completed order now looks like this: 1400B1M3-6.

SPARE PARTS AND ACCESSORIES

Spare Parts and Accessories

| Description | Model 1400 | Model 1405 |
|------------------------|------------------------|-----------------------------|
| Top Cap Cylinder | 1400-100 | 1405-100 |
| Base Cap Cylinder | 1400-200 | 1405-200 |
| 3 cm Brass Cylinder | 0206L03 | 0206L03 |
| 6 cm Brass Cylinder | 0206L06 | 0206L06 |
| 1/2 Bar Ceramic Plate | 1430B.5M2 | 1435B.5M2 |
| 1 Bar Ceramic Plate | 1430B1M1 | 1435B1M1 |
| 1 Bar, High Flow Plate | 1430B1M3 | 1435B1M3 |
| Cylinder "O" Ring | M802X331 (order 2 ea.) | M802X341 (order 2 ea.) |
| Ceramic Plate "O" Ring | M802X227 | M802X237 |
| Stud Set Kit (3 cm) | 1400-001L03K1 | 1400-001L03K1 (order 2 ea.) |
| Stud Set Kit (6 cm) | 1400-001L06K1 | 1400-001L06K1 (order 2 ea.) |

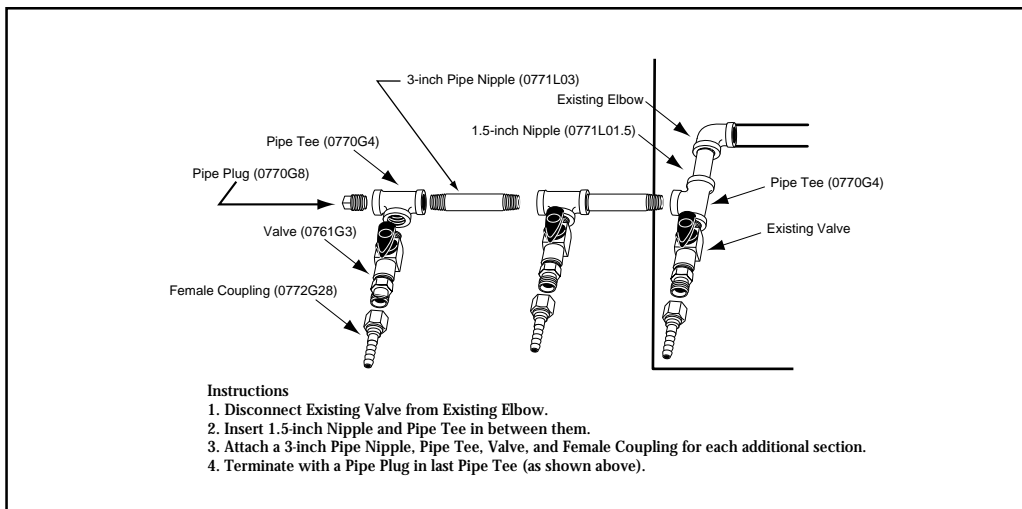
Other Accessories used for either Model:

| | |
|--------|-----------------------------------------------------------|
| 1425 | Tempe Cell Stand |
| MRT003 | Neoprene Tubing, 3/16" I.D. x 1/8" wall, sold by the foot |
| 0700G3 | Manifold |
| 0750G3 | Manifold |

For Repeatable Section for running several Tempes at one time, please order:

| | |
|-----------|---------------------------------------------------------------------------------------|
| 0761G3 | Valve, 1/4-inch male pipe - both ends (1 for each additional section) |
| 0770G4 | 1/4-inch Galvanized Pipe Tee (order 1 to add section + 1 for each additional section) |
| 0770G8 | 1/4-inch Galvanized Pipe Plug (1 only to close off section) |
| 0771L01.5 | 1/4-inch x 1.5-inch Galvanized Pipe Nipple (1 only to add section) |
| 0771L03 | 1/4-inch x 3-inch Galvanized Pipe Nipple (1 for each additional section) |
| 0772G28 | Female Coupling, brass 9/16-inch-18 (1 each for each additional section) |

See drawing below for proper connection.



0898-1400/1405



