PV-Pyc 200 Accessories

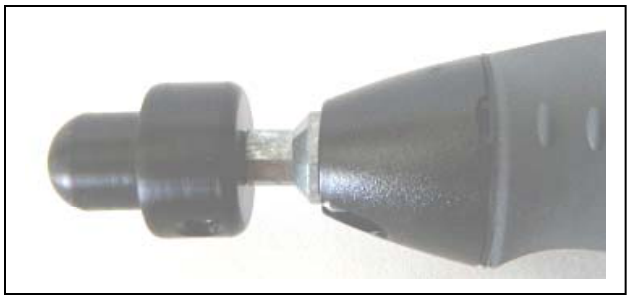
Density and Porosity Kit for Packed Beds

The photo below shows the basic kit that is used for determination of porosity and density of packed beds. The presented hardware consists of a special sample holder with flat bottom, airtight cover with metal filter, and a bed-forming tool. The internal diameter of the sample holder (and the bed) is about 61 mm and the maximum height of the bed when using the cover is about 55 mm.

Typically the sample holder is weighed with the cover installed and the initial mass **Mi** is recorded. The sample holder with the cover can be inserted into the pycnometer sample chamber to carry out volume measurement without sample. When this part of experiment will be done and the WAIT tag encountered, the software will pause until the user is ready for the next part.

Next the cover is removed and the distance between the top edge of the sample holder and the bottom is measured using a suitable measuring device, e.g. a caliper. The sample is added to the sample holder and the forming tool is inserted into the sample holder to form a flat bed. Measuring again the distance between the edges of the sample holder and the forming tool, and knowing the thickness of the tool base, the thickness of the bed can be easily determined. Knowing the height of the bed and bed diameter, which is the internal diameter of the sample holder, the geometrical volume of the bed, **Vg**, can be easily calculated.

The height of such bed may differ slightly depending on how tightly the bed was formed, from free-flown material to the hard-pressed bed. Additional packing and more repeatable results can be achieved by using vibrations. A similar solution to the one presented earlier for work with cements in other pycnometers, the HumiPyc Model 1 and 2, can be used here too.



As shown on the photo above, a round adapter with semi-spherical end can be inserted over an engraving tool tip and fastened using the two setscrews. Similar adapters can be easily machined to utilize other sources of vibration that the user has. The sample holder has a concave spherical cutout at the bottom to facilitate engagement with the vibrations source. While holding the sample holder and pressing down the forming tool, the engraver or any suitable source of vibrations can be turned on for a few seconds (perhaps more then once). The result is a fairly well packed bed. The spherical contact allows for easy maneuvering of the setup to provide vibrations in different directions. See the photo below.

Once the stable height is reached, it can be compared with the initial value of loosely formed bed. After removal of the forming tool and installing the cover, re-weighing will produce the mass of the bed and the sample holder. Subtracting the initial mass Mi from the currently measured mass will yield mass of the sample (packed bed). The sample holder with the sample can be inserted again into the sample chamber and the second part of the run determines the true volume of the bed by pycnometer, **Vp**, and its true density.

The difference between the Vg and the Vp gives the void volume **Vv**. Dividing the Vv by Vg and multiplying by 100 yields the **porosity** of the bed expressed in percents.

It should be noted, that the PV-Pyc 200 allows for such measurements using pressurized conditions and vacuum conditions. Assuming that the miniature vacuum pump can achieve about 8 kPa absolute pressure, the difference between the standard atmospheric pressure and this level of vacuum is about 93 kPa. Using pressurization pressure of 93 kPa above atmospheric pressure, creates symmetrical (pressurized) conditions for evaluation of the sample density. Comparison of results obtained under vacuum and pressure can provide additional characterization information about samples, especially for the ones that can deform relatively easy under pressure or vacuum and have internal closed pores (cells), e.g. foams. Since the calibration of reference chamber should be carried whenever experimental conditions change (pressurization pressure, gas, substantial temperature change, etc), it is highly recommended to carry out calibrations of the reference chamber for the measurements at vacuum and pressurized conditions.

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