Royal Eijkelkamp
Meet the difference

Air pycnometer according to Langer

Manual

Meet the difference

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On these operating instructions

☞ **If the text follows a mark (as shown on the left), this means that an important instruction follows.**

If the text follows a mark (as shown on the left), this means that an important warning follows relating to danger to the user or damage to the apparatus. The user is always responsible for its own personal protection.

Text **Italic indicated text indicates that the text concerned appears in writing on the display(or must be typed).**

1. Introduction

The vacuum air pycnometer has been designed to determine porosity and density of solid material. Measuring data allow to calculate specific weight.

The air pycnometer is applied in various fields where calculation of specific weight is desired, such as soil research, powder- and granulate investigations for farmaceutic industry, road building, brick factories, food industry (coffee, leguminous plants, etc.). The apparatus is very suitable to measure volumes of irregularly shaped objects.

Admittedly volumes can be measured also with water: a measuring cylinder is filled to a certain level, the object is placed into the water after which the rise is measured. Of course this method is unfeasible for objects lighter than water. Apart from this in many cases accurate reading is difficult when the rise of water is minimal. The air pycnometer permits direct reading of volumes. Older types of air pycnometers are equipped with two mercury tubes the reading of which must be compared to find the difference. Working with these meters is furthermore complicated by a formula to calculate volumes. Working with the air pycnometer according to Langer is far more easy.

Air pycnometer according to Langer, complete apparatus inclusive calibration block, vacuum bells and protective covers (exclusive mercury - 1500 grams required technical pure). Suitable for amongst others: soil sample rings Ø 53 and 60 mm, maximal height 51 resp. 40 mm, contents 100 ml.

2. Principle of the air pycnometer according to Langer

The object to be measured is placed in the vacuum bell. By means of a mercury column a under-pressure is created in the bell. Depending on the volume of gas in the bell, more or less air will be withdrawn. The volume of air depends on the volume of the object to be measured. The mercury column in the glass tube will drop along with lowering the level vessel and will indicate the object's volume on the calibrated scale. The volumes between 0 and 115 cm^3 can be read direct from the scale. By dividing the mass weight (in grammes) by this volume, you know the specific weight in g/cm^3. 1 g/cm^3 equals 1000 kg/m^3.

3. Applications

The air pycnometer can be used to determine volumes of all solid matter. The most important application is determination of volumes, and with it densities, and porosities of soil samples. Powders and irregular shaped objects can be measured very well if not too big.

4. Preparing the air pycnometer for use

The air pycnometer is supplied with opened tube clamp. Before filling, the back plate of the apparatus must be unscrewed and removed. The tube is closed with the tube clamp.
Fill the air pycnometer with 1350 grs of (technical pure) mercury. Remove lid of vessel (3) by unscrewing. Keep the vessel at level with air release tap (11). Make sure that the air release tap is in position 0 during filling.

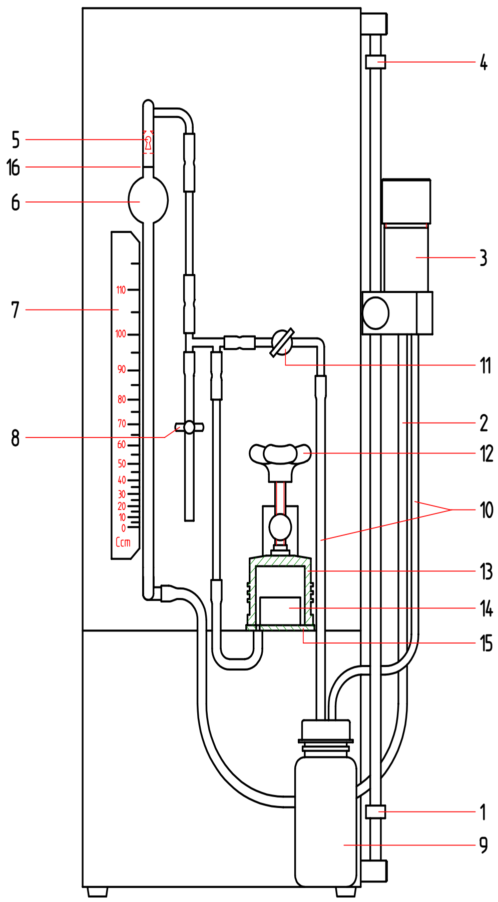
Take great care in filling; mercury fluid is not that dangerous, mercury vapours however are extremely poisonous. The pycnometer can best be filled above a high-rimmed reservoir to control mercury during filling. To prevent vaporization of mercury it is advised to pour 0.5...1.0 cm water on the mercury in the level vessel as well as in the glass tube with reservoir (6).

Avoid undue influences on measuring results; place the air pycnometer in a room with a stable temperature (avoid direct sunlight).

After filling, the level vessel is closed by screwing the cap. The vessel is connected by the overflow tube (10) to the overflow vessel (9) because the mercury level must move freely during measuring.
The vessel is now placed in the upper position.

08.60 Air pycnometer

1. Lower adjusting ring
2. Level rod
3. Level vessel
4. Upper adjusting ring
5. Non-return valve
6. Manometer tube
7. Scale
8. Tube + tube clamp
9. Overflow vessel
10. Overflow tube
11. Air release tap
12. Clamp knob
13. Vacuum bell
14. Calibration block
15. Measuring plate
16. Red mark



5. Calibration of the air pycnometer

☞ **Always lower the level vessel slowly during calibration as well as during measurements described below. This will prevent mercury balls to remain in the glass tube. It will also prevent mercury to drop beyond zero and escape from the glass tube. Should mercury happen to flow away then place the vessel in the upper position again.**

Press the vacuum bell (13) on the rubber gasket (15) and turn the clamp screw (12). Make sure to turn the screw always to the same point (red dot). Place the air release tap (11) in zero position. The level vessel is in the upper position. Use the upper adjusting ring (4) to adjust the mercury level in the glass tube (6) with the red mark (16). If the level of the mercury does not reach this mark, some mercury must be added to the level vessel until mercury level can be set equal to the red mark.

After five seconds when mercury is at rest, place the air release tap in position 1 and replace carefully the vessel from the upper position to the lower one (1). Set the mercury column equal to zero on the scale (7) beside the glass tube by adjusting the lower adjusting ring.

Having done this the level vessel can be placed in the upper position again after which the air release tap is put in position 0. Loosen the clamp knob (12) and place the calibration block (14) of 60 cm^3 under the measuring bell, fasten clamp knob.

Place air release tap in position 1 when mercury is at rest and replace level vessel with care from the upper to the lower position.

Now there are three possibilities:

The mercury column:
- ❒ indicates exactly 60 cm^3 on the scale.
- ❒ indicates more than 60 cm^3 on the scale.
- ❒ indicates less than 60 cm^3 on the scale.

If the mercury column indicates exactly 60 cm^3 the level vessel can be placed upwards followed by choosing position 0 of the air release tap after which measuring can be started (see chapter 5).

If the mercury column indicates "more" or "less" then follow the procedure given below.

After having placed the vessel in the upper position and the air release tap in position 0, the calibration block must be removed and the vacuum bell closed. The back plate of the apparatus must now be unscrewed and removed. If the indicated volume was too large (too small), the room above the mercury must be enlarged (reduced).
This is done by moving the tube clamp (8) 1-2 cm from (to) the tube (8) end and refasten same. Consequently the red marking and zero point are now adjusted as described above. Then the calibration block must be measured again.

If it is not possible to reach the zero point with the lower adjusting ring (1), it is possible to adjust the scale (7) by unscrewing both screws on the front (or by unscrewing the both screws on the backside).
Calibration is completed when 60 cm^3 volume is indicated, the back plate can now be put in place. If however the volume indicated is too small or too large then repeat the procedure as long as necessary to achieve the right value of 60 cm^3.

Following possible effects must then be checked:
- ❒ The air release tap (11) is in position 0 instead of in position 1.
- ❒ The vacuum bell has not been closed properly; something on the rim may prevent air-tight closing of the bell.
- ❒ The tube clamp (8) is insufficiently turned on so that the air can escape.
- ❒ There may be a leak in the system which has to be traced and repaired.

6. Measuring procedure

After calibration measuring can be started. The level vessel is in the upper position, the air release tap (11) is in position 0. Place sample on the measuring plate (15) and close the vacuum bell with clamp knob (12). After stabilization of mercury put air release tap in position 1.
Lower the level vessel slowly to the lower position. As soon as the mercury level is stable, the value can be read. The level vessel is placed again in the upper position, the air release tap in position 0. Now the object measured can be taken away to make place for the next one when the procedure described above is repeated.

☞ **On the clamp knob (12) is a dot marking; use the marking to take care that measurements are done at the same spot.**

7. Example: Determination of density and porosity of soil samples

A soil sample is chosen as an example since other volume measurements usually are less complicated. For convenience sake use numbered sample rings (contents 100 cm^3) to take soil samples.

Soil sample rings are weighed in grammes (Mr, r from ring, M from mass); the volume of rings exclusive contents is determined in cm^3 with the air pycnometer (Vr, V from volume, r from ring).
Soil samples are taken in the field and weighed (in grs.) (Mt, t from total: ring + soil).
The mass soil and moisture in rings (Ms+w, s from soil and w from water) can now be calculated:

$$Ms+w = Mt - Mr \text{ (in grams).}$$

Drying process at 105°C of soil samples takes 10 hours at least. After that soil samples are weighed (Ms+r).

The quantity of water in a sample with mass Ms+w is

$$Mw = Mt - Ms+r.$$

The mass percentage of water is: $100 \times Mw/Ms+w$.

Volumes of soil samples are now established by means of the pycnometer (Vs+r). The volume of pores (Vp) can be calculated as follows:

$$Vs = (Vs+r) - Vr;\ Vp = 100 - Vs$$ (100 stands for contents of soil sample rings).

This is right away the volume percentage to pores since the total is 100 cm^3.

The density of soil samples can now be calculated:

The volume of soil (Vs) is: $Vs = (Vs + r) - Vr$
The mass of the soil is: $Ms = (Ms + w) - Mw$
The density of soil is: Ms/Vs in gr/cm^3, $1\ gr/cm^3 = 1000\ kg/m^3$