Application Note 102

The Role of Calibration When Using the GeoPyc 1360

During the initiation of an analysis, the GeoPyc® 1360 prompts the user to enter a conversion factor. The GeoPyc Operator's Manual and Quick Reference Guide give an adjusted conversion factor for each chamber. Using these conversion factors should yield reliable and reproducible results for most sample types. To obtain closer agreement with established methods, however, you must perform a calibration run to obtain the best conversion factor for the specific shape(s) of sample you are analyzing.

Performing a calibration run is simple, and it only takes about the same amount of time as performing a single sample analysis. If you record the resulting calibrated conversion factor, you do not need to repeat the calibration run frequently.

To understand the importance of performing this simple procedure, it is helpful to understand how the conversion factor is used, what is the role of calibration, and which types of samples benefit most from calibration.

What is the conversion factor?

Analysis with the GeoPyc involves placing a quantity of a dry-fluid medium — called Dry*Flo*® — in the sample chamber. The volume of Dry*Flo* in the chamber is measured (blank data), then the sample is immersed in the Dry*Flo*. The displacement volume of the sample is measured (the sample run), and calculations are performed to yield data such as envelope density and porosity.

The actual measurement taken by the GeoPyc is the number of units of movement (either millimeters of plunger motion or steps of the motor) traveled by the plunger without the sample present, then with the sample in the chamber. The difference between these two measurements is the number of units of movement caused by the presence of the sample.

To determine the sample's volume, this number of units must be converted to volume. The conversion factor is the volume per unit of movement (cm^3/mm or cm^3/step).

As a starting point, a conversion factor based on the chamber's geometry is mathematically derived. But the sample's presence (especially if it is irregular) can cause disturbances in the Dry*Flo* consolidation that make it necessary to alter this strict, geometric volume per unit of movement. Adjusted conversion factors are listed in the operator's manual. These values are based on extensive sample testing, and they provide accurate results for most samples.

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What is the role of calibration?

Dry*Flo* performs very well as a dry fluid, but no dry material can flow as perfectly as a liquid. When a force is exerted upon a liquid, it is transmitted equally in all directions. When a force is exerted upon a powder, compaction is greater in some areas than in others. During GeoPyc analysis, this effect is minimized by the agitation of the chamber and the composition of the Dry*Flo*.

In theory, 100% of the volume difference after the sample is introduced should be the sample's volume. But in reality, some portion of this difference is caused by the disruption of the Dry*Flo*'s consolidation.

Calibration alters the conversion factor to account for this disruption when the sample's volume is calculated. So:

- less disruption = less volume error = less deviation from the adjusted conversion factor

and

- more disruption = more volume error = greater deviation from the adjusted conversion factor

As a general rule, the disruption of the Dry*Flo* consolidation increases with the size of the sample (in proportion to chamber size) and the irregularity of the sample's surface.

What kinds of samples really benefit most from calibration?

While data are more accurate for ALL samples after calibration, it is especially important for:

- Objects with highly irregular shapes or surfaces
- Objects with through-holes
- Objects with large dead-end-holes
- Multi-piece samples
- Samples that take up large amounts of space in the chamber. (Smaller samples don't benefit as much from calibration because they usually do not cause as great a disruption of the Dry*Flo*)

Tips for calibration

Refer to the GeoPyc operator's manual for complete instructions on performing a calibration.

Calibrated conversion factors are specific to each chamber. You must not use a conversion factor that was calibrated for one chamber when you perform analyses with any other chamber.

If you use multiple chambers, or if you are analyzing multiple sample types, it is highly recommended that you keep a record of the conversion factors you obtain (such as a notebook). For each calibration run you perform, record the resulting conversion factor, along with a description of the calibration object(s) used. If you have more than one chamber, be sure to identify which chamber was used. During subsequent sample runs, simply select the conversion factor that was calibrated using the calibration object most appropriate for that sample type.

Ideal calibration objects are reference samples of the material you are analyzing or non-porous models of your sample object. However, you can substitute a variety of non-porous objects. Your goal in selecting a calibration object is to match your sample as closely as possible in size, shape, complexity, and number of pieces. We suggest using items such as glass beads, broken or whole glass rods, metal balls, and irregularly or cleanly cut pieces of wire.

For highest accuracy, you can perform three or four calibration runs, eliminate any extreme results, and average the calibrated conversion factors. The resulting conversion factor will provide accurate results for that chamber and sample type.