



APPLICATION NOTE 185

CONSOLIDATION FORCE ON THE GEOPYC WHEN MEASURING FOAMS

One of the biggest challenges with density analyses involving foams is compression. Determining the skeletal and envelope density of a foam must be performed in a manner where material compression is not significant. ASTM D6226 requires foams to be analyzed, with a gas pycnometer, at a pressure of 2.9 PSIG (20 kPa) and it is common practice to go up to 3.5 PSIG (24.13 kPa). The GeoPyc compresses DryFlo around the sample with a specified force called the consolidation force. The default consolidation force changes with each chamber size: 12.7mm, 19.1mm, 25.4mm, 38.1mm, and 50.8mm.

The AccuPyc pressure is written in terms of PSIG. This can be converted to N/cm^2 by using equation (1).

$$\frac{N}{cm^2} = \frac{PSIG \cdot 6894.75728}{10000} \quad (1)$$

where 1 PSIG is equal to 6894.75728 N/m^2 , and dividing by 10000 converts m^2 to cm^2 .

The pressure exerted by the plunger on the contents within the sample chamber for the GeoPyc is given by equation (2).

$$\frac{N}{cm^2} = \frac{4F}{\pi d^2} \quad (2)$$

Where F is the consolidation force, and d is the chamber diameter in centimeters.

If equations (1) and (2) are set equal to each other and then solved for the consolidation force, we get equation (3).

$$F = \frac{PSIG \cdot 6894.75728 \cdot \pi d^2}{40000} \quad (3)$$

Equation (3) allows a consolidation force to be calculated based on GeoPyc chamber size and the pressure that was used to calculate the skeletal density.

Table 1 shows the five GeoPyc chamber sizes with both 2.9 PSIG and 3.5 PSIG pressure that is applied to foams and the consolidation force that is calculated with the equation above.

Geopyc Chamber Size (cm)	Accupyc Pressure (PSIG)	Accupyc Pressure (kPa)	Calculated Consolidation Force (N)	Default Consolidation Force (N)
1.27	2.9	20	2.53	28
1.27	3.5	24.13	3.06	28
1.91	2.9	20	5.73	38
1.91	3.5	24.13	6.91	38
2.54	2.9	20	10.13	51
2.54	3.5	24.13	12.23	51
3.81	2.9	20	22.80	90
3.81	3.5	24.13	27.51	90
5.08	2.9	20	40.53	145
5.08	3.5	24.13	48.91	145

Table 1. Calculated and default consolidation force for all GeoPyc chamber sizes using both 2.9 and 3.5 PSIG

Each sample chamber size was tested to determine the minimum force required to allow the plunger to overcome the frictional forces of the chamber wall. The measured consolidation force was only tested on one chamber of each size so the required force might change slightly between chambers of the same size.

Geopyc Chamber Size (cm)	Minimum Consolidation Force (N)	Calc Consolidation Force 2.9 PSIG (N)	Calc Consolidation Force 3.5 PSIG (N)
1.27	5	2.532878	3.056922
1.91	5	5.728931	6.914227
2.54	7.25	10.13151	12.22769
3.81	15	22.7959	27.5123
5.08	37.5	40.52605	48.91075

Table 2. Minimum consolidation force required to overcome plunger and chamber frictional forces

When performing envelope density measurements on foam material, the 25.4mm, 38.1mm, and 50.8mm chambers should be used with a calculated consolidation force. The 12.7mm and 19.1mm chambers should be avoided due to possible compression.