Application Note 99

Evaluating Catalyst Substrates with the GeoPyc® 1360

Critical factors in operating catalytic reactors are the envelope density and porosity of the catalyst itself. These properties are quickly and easily assessed with Micromeritics' new GeoPyc 1360 in conjunction with Micromeritics' AccuPyc™ 1330.

Envelope density (sometimes called bulk density) is simply the weight of a quantity of catalyst divided by the volume (including the pores) of the same quantity. It may be envisioned as the density that results from using a volume measured with a zero-thickness but impenetrable film stretched over the exterior of each and every catalyst pellet. It is thus different from the absolute density (variously termed skeletal, true, or real density) which excludes pore spaces. Porosity can be directly calculated from a measure of both envelope and absolute density.

The GeoPyc 1360 measures volume displacement of the catalyst with a free-flowing dry medium — called Dry*Flo*® — that conforms to exterior features but is unable to penetrate pores. Unlike other methods such as mercury displacement and hot-wax dipping, the dry medium technique neither contaminates nor destroys the tested sample.

The following table presents results for a variety of catalyst substrates. The first is Micromeritics' standard reference sample (an extruded catalyst support, P/N: 004-16822-00). The remainder is from other sources as are the mercury data offered in comparison. These substrates varied in shape from extrudates about 1 mm in diameter, through round beads to nearly spherical tablets 5 mm in diameter. The GeoPyc 1360 permits calibration for shape with nonporous reference objects; short pieces of wire were used to simulate the extrudate, and glass beads of appropriate sizes were used to simulate the other materials.

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Table 1. Comparative Data on Catalyst Substrates

Sample Number	GeoPyc 1360		Mercury Porosimetry	
	Envelope Density (g/cm^3)	Porosity (%)	Envelope Density (g/cm^3)	Porosity (%)
1	1.171	61.98	1.178	64.99
2	0.814	63.73	0.807	64.08
3	0.974	60.06	0.934	61.71
4	0.925	65.75	0.917	66.07
5	0.836	75.93	0.873	72.92
6	0.845	75.99	0.884	74.41
7	0.815	66.74	0.756	70.63
8	0.728	79.41	0.767	75.03
9	0.760	78.84	0.802	74.53

The greatest disparity in tabulated values amounts to 5.8%. Having tested sample No. 1 by mercury porosimetry numerous times on different instruments with different operators, it is amply established that these values are subject to variations as great as 3%. The table shows equally reliable results for the GeoPyc.