



Designation: D4641 – 17

Standard Practice for Calculation of Pore Size Distributions of Catalysts and Catalyst Carriers from Nitrogen Desorption Isotherms¹

This standard is issued under the fixed designation D4641; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ϵ) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This practice covers the calculation of pore size distributions for catalysts and catalyst carriers from nitrogen desorption isotherms. The computational procedure is particularly useful for determining how the pore volume is distributed in catalyst samples containing pores whose sizes range from approximately 1.5 to 100 nm (15 to 1000 Å) in radius. It should be used with caution when applied to isotherms for samples containing pores both within this size range and pores larger than 100 nm (1000 Å) in radius. In such instances the isotherms rise steeply near $P/P_o = 1$ and the total pore volume cannot be well defined. The calculations should begin at a point on the isotherm near saturation preferably in a region near $P/P_o = 0.99$, establishing an upper limit on the pore size distribution range to be studied. Simplifications are necessary regarding pore shape. A cylindrical pore model is assumed, and the method treats the pores as non-intersecting, open-ended capillaries which are assumed to function independently of each other during the adsorption or desorption of nitrogen.

NOTE 1—This practice is designed primarily for manual computation and a few simplifications have been made for this purpose. For computer computation, the simplified expressions may be replaced by exact expressions.

1.2 The values stated in SI units are to be regarded as standard. No other units of measurement are included in this standard.

1.3 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

¹ This practice is under the jurisdiction of ASTM Committee D32 on Catalysts and is the direct responsibility of Subcommittee D32.01 on Physical-Chemical Properties.

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2. Referenced Documents

2.1 *ASTM Standards*:²

D3766 Terminology Relating to Catalysts and Catalysis
D4222 Test Method for Determination of Nitrogen Adsorption and Desorption Isotherms of Catalysts and Catalyst Carriers by Static Volumetric Measurements

3. Terminology

3.1 *Definitions*—Consult Terminology D3766.

3.2 *Symbols*:

i	= numerical index representing each successive data point, with $i = 1, 2, \dots, n$.
$P_4(i)$	= pressure after equilibration during desorption, torr.
$P_o(i)$	= liquid nitrogen vapor pressure, torr.
V_{de}	= Quantity of gas desorbed (cm ³ STP/g); see 12.4.10 and 12.5 in Test Method D4222.
$r_k(i)$	= radius of inner core calculated from Kelvin equation, Å.
T	= boiling point of nitrogen, K.
V_L	= liquid nitrogen molar volume at T , cm ³ /mole.
γ	= liquid nitrogen surface tension at T , mN/m.
$t(i)$	= average thickness of the nitrogen film adsorbed on the pore walls, Å.
$r_p(i)$	= radius of cylindrical pore given by $r_k(i) + t(i)$, Å.
Q	= volume correction factor defined as $(\bar{r}_p/\bar{r}_k)^2$.
$\Delta V_T(i)$	= decrease in the amount of nitrogen adsorbed caused by a lowering in relative pressure, mm ³ /g.
$\Delta V_f(i)$	= volume of liquid nitrogen desorbed from pore walls during thinning of the film, mm ³ /g.
$\Delta V_k(i)$	= liquid volume of the inner core in which capillary condensation of the nitrogen occurs, mm ³ /g.

² For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.