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Pore size distribution and porosity of solid materials by mercury porosimetry and gas adsorption —

Part 2:
Analysis of mesopores and macropores by gas adsorption

Distribution des dimensions des pores et porosité des matériaux solides par porosimétrie au mercure et par adsorption de gaz —

Partie 2: Analyse des mésopores et des macropores par adsorption de gaz

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

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ISO 15901-2 was prepared by Technical Committee ISO/TC 24, *Sieves, sieving and other sizing methods*, Subcommittee SC 4, *Sizing by methods other than sieving*.

ISO 15901 consists of the following parts, under the general title *Pore size distribution and porosity of solid materials by mercury porosimetry and gas adsorption*:

— *Part 1: Mercury porosimetry*

— *Part 2: Analysis of mesopores and macropores by gas adsorption*

— *Part 3: Analysis of micropores by gas adsorption*

Introduction

Generally speaking, different types of pores can be pictured as apertures, channels or cavities within a solid body, or as the space (i.e. an interstice or a void) between solid particles in a bed, compact or aggregate. Porosity is a term which is often used to indicate the porous nature of solid material and is more precisely defined as the ratio of the volume of accessible pores and voids to the total volume occupied by a given amount of the solid. In addition to the accessible pores, a solid can contain closed pores which are isolated from the external surface and into which fluids are not able to penetrate. The characterization of closed pores (i.e. cavities with no access to an external surface) is not covered in this part of ISO 15901.

Porous materials can take the form of fine or coarse powders, compacts, extrudates, sheets or monoliths. Their characterization usually involves the determination of the pore size distribution, as well as the total pore volume or porosity. For some purposes, it is also necessary to study the pore shape and interconnectivity, and to determine the internal and external surface areas.

Porous materials have great technological importance, for example in the context of the following:

a) controlled drug release;

b) catalysis;

c) gas separation;

d) filtration including sterilization;

e) materials technology;

f) environmental protection and pollution control;

g) natural reservoir rocks;

h) building material properties;

i) polymer and ceramic industries.

It is well established that the performance of a porous solid (e.g. its strength, reactivity, permeability or adsorbent power) is dependent on its pore structure. Many different methods have been developed for the characterization of pore structure. In view of the complexity of most porous solids, it is not surprising to find that the results obtained do not always concur, and that no single technique can be relied upon to provide a complete picture of the pore structure. The choice of the most appropriate method depends on the application of the porous solid, its chemical and physical nature and the range of pore size.

Commonly used methods are as follows.

— **Mercury porosimetry**, where the pores are filled with mercury under pressure. This method is suitable for many materials with pores in the approximate diameter rang of 0,003 µm to 400 µm, and especially in the range of 0,1 µm to 100 µm.

— **Mesopore and macropore analysis by gas adsorption**, where the pores are characterized by adsorbing a gas, such as nitrogen, at liquid nitrogen temperature. This method is used for pores in the approximate diameter range 0,002 µm to 0,1 µm (2 nm to 100 nm), and is an extension of the surface area estimation technique (see ISO 9277). (Discussion of other pore size distribution analysis techniques can be found in Recommendations for the Characterization of Porous Solids [1].)

— **Micropore analysis by gas adsorption**, where the pores are characterized by adsorbing a gas, such as nitrogen, at liquid nitrogen temperature. This method is used for pores in the approximate diameter range 0,000 4 µm to 0,002 µm (0,4 nm to 2 nm).