Micromodels of porous structures

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Speaking about modeling in the scope of technical sciences, we are usually in mind the mathematical/computational or the physical models. Let us limit ourselves on the physical ones. *Physical modeling* means a systematic building of object heving an analogy with physical reality. For the models of porous structures, the notion micromodels has been introduced. (Lenormand, 1983). The *micro*- means that the model represents only a small fraction of real porous structure, usually magnified small fraction and that some essential schematization of reality is included. Very often, the real porous space is schematized into a regular graph network. Another possibility is, to model the real porous space by means of randomly composed small objects of a simple, geometrically defined shape (cubes, spheres, …). The difference between a micromodel and a simple probe of a natural porous material (a small volume of soil, sand, clay …) consist in the fact that at least a bit of exact geometrical information is ahead.

Deterministically random structure is a concrete graph having some characteristic dimension (various numbers connected with its nodes or bondes) spread randomly with a prescribed distribution. It is random by its creation but deterministic by using it. This is the feature characteristic for the 2D micromodels in general.

The may be first idea of how to make a 3D analog of the 2D micromodels is to borrow into a compact piece of a (preferably transparent) material a system of mutually intersecting openings with a given distribution of diameters. Main disadvantage of this acces is, besides the costs and dimensional limitation, the strong correlation of capillaries dimensions and practical possibility to use the cube-like graphs only.

Another theoretical possibility how to make a 3D micromodel is to compose it of many small of a given distribution of dimensions. It is not unimaginable by using of computer-controlled micro-robotics but the costs would be unimaginable. The artifact, we have the cubic shape in mind, could bee applied from its 6 sides. The statistics of results would be rather poor. In addition, the creation of 3D micromodels after both mentioned schemes contains due the in-dissolubility of them the danger that an object for only one use, a “disposable micromodel” would be created. A thorough selection of liquids to be applied would be necessary.

On the bases of introduced possibilities and some other ones as well, the conclusion have been made that the most simple and also from other points of view the optimal solution are the 3D micromodels with stratified structure.

The *3D micromodels with stratified structure (multi-sandwiches)* are sets of superposed slides every of which is a 2D micromodel connected with its neighbors by vertical openings. If not for special purposes, all the slides have the same distribution of pores and the distribution of dimensions of vertical openings is the same as that horizontal one (fig 3, 4).

The multi-sandwich conception of 3 D micromodels enables a simple construction of new micromodels with a given distribution of pores by means of simple rearrangement of the slides and by rotating them horizontally. A micromodel made up of *n* horizontal square slides gives $n!.4^{n-1}$ new individual micromodels by its rearrangement. For instance, if $n = 20$, the rearrangement gives as much as10^{30} possibilities. Each de-composition an following random re-composition gives us (practically) an absolutely new never before existing micromodel.

Discussion and conclusions

The micromodels of multi-sandwich construction offer to apply a wide collection of various graph networks to be applied. The number of bonds connected in one node is arbitrary. Due the decomposability of them, various possibilities for the preparation of surfaces (hydrophile, hydrophobe). Numerically controlled cutting tools are optimal instruments for creating the slides of multi-sandwich 3D micromodels.

A prototype of the multi-sandwich 3D micromodel has been already made. It has been made in a simplified form with a homogenous two-value of pole diameters. The nodes are 6-fold (six bonds for a node), the slides have form of a rectangle. Micromodels with square slides and 9-value homogenous and gauss distributions are prepared.

Aknowledgments

This work was supported by Grant Agency of Czech Republic by grant No. *526/08/1016*

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