3D MICROMODELS OF POROUS STRUCTURES

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Speaking about modeling in technical sciences, we have in mind an analysis of mathematical (computational) or physical analogies of objects to be studied. *Physical modeling* means a systematic building of physical objects heaving some analogy with the studied physical reality. For the models of porous structures, the notion *micromodels* has been introduced. The *micro*- means that the model represents only a small fraction of real porous structure and that some essential schematization of reality is included. The difference between a micromodel and a simple probe of a natural porous material (a small volume of soil, sand, etc.) consist in the fact that some exact geometrical information is ahead. Very often, the real porous space is schematized into a regular graph network. The Lenormand´s micromodels are 2D objects where a random square network has been cut in a sophisticated way into a layer of resin between two layers of plexiglass.

The 2D micromodels have been used since the eighties of the last century). The authentic purpose of developing them in the Schlumberger Corporation was to collect the residual rock-oil after the natural reservoir have been "emptied"- as much as 50 % of the primary volume (Lenormand). The residual oil should have been displaced by water. Another application of 2D micromodels has been that for studying the flow of water under influence of gravity in coarse soils (Pražák, 1992).

The 2D mickomodels provide us with much interesting information due the fact that the visualization of processes going on is very easy. On the other hand, the difference between processes going on in 2D and 3D structures is rather deep. As an illustration, the comparison of percolation thresholds for square (2D) and cubic (3D) network can be displayed (Tab. 1)

	p_{nc}	p_{bc}
square network	.590	.500
cubic network	.307	.247

(Tab 1., p_{nc} is the percolation threshold of nodes, p_{bc} is the percolation threshold of bones; after Stauffer, 1985).

The substantial qualitative difference is that in the 3D structure the infinite clusters of active and inactive bones – full and empty capillaries - (nodes as well) can coexist, in the 2D structure not. It means e.g. that in the real 3D structure, the roots of a plant can be connected with an infinite cluster of water and in the same moment it can be connected with the free air above the soil. In 2D model is it not possible.

It can be concluded that the creating of the 3D micromodels is for the physical modeling of soil of the basic importance.

3D micromodels with a completely random structure

Making of 3D micromodels with a complete random structure is easy: For a defined space (defined by means of a plexiglass box, e.g.) the physical conditions of its experimental application are to be created (inflow – outflow openings etc.) and the space is filled up by plenty of small objects of defined geometrical shape (spheres, cubes, …) with given distributions of sizes. The choice is given by problem to be solved and by the craft of the mathematical apparatus to be applied. The simplicity and the economical accessibility are dmain goals of this type of micromodels. The main disadvantage is generally the unknown distribution in the porous space having been created.

3D micromodels with a deterministically random structure

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 *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 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.

Literature

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