TO A QUESTION ON STATEMENT OF A PROBLEM ON MODELLING PROCESSES OF STRUCTURIZATION OF FOAM CONCRETES

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Economic conditions in our country define the new approach to a choice of effective building materials for housing construction. One of perspective directions is work on perfection of manufacturing of such materials as porous concretes (and foam concretes, in particular), which differ by durability, rather simple technology of manufacturing, etc. The modelling of porous systems allows to consider influence of technology factors on synthesis of their structure and building-technical characteristics. Also this direction of researches is one of the most urgent questions of modern building materiology. Processes of structurization are important by way of creation of strong and easy compositions. However it is necessary to note, that opportunities of mathematical modelling and engineering calculation are rather limited, that is connected with thermodynamic instability of investigated systems.

The analysis of scientific papers on structurization of foam concretes shows, that the majority of the developed methods have experimental character and are connected with stabilization of foam due to introduction of polymeric stabilizers, thickeners, the additives promoting formation of insoluble deposits on border between liquid and gaseous phases, etc.

It is meanwhile obvious, that formation of porous system is defined not only the superficial phenomena, but also hydrodynamical factors on different technological repartitions. According to existing technologies it is possible to allocate following hydrodynamical conditions which essentially differ both structure of cooperating phases, and processes of formation of a gas phase, such as:

- a mode of preparation of foam in the high-speed hashing amalgamator;
- a mode of preparation of a foam-concrete mix, which is realized by various methods (i.e. injection, cavitas process, etc.);
- a mode of transportation of a mix;
- a mode of casting of a mix in the form.

For example, in conditions of high-speed hashing we consider a biphase environment (i.e. gas and liquid), and in conditions of mixture of a cement-sandy composition with foam - the three-phase environment in which under action of inertial forces there are complex phenomena. Wrong selection of technological parameters in practice leads to loss of stability of a multicomponent mix in the form of stratifications of phases.

On stability of foams it is necessary to carry to fundamental scientific works first of all V.V. Krotov, K.B. Kann, V.K. Tikhomirov's researches.

The lead analysis of works has shown, that available methods of modelling can be applied only to special cases of biphase systems.

The processes occuring in three-phase systems, essentially differ such parameters, as:

- interaction of firm and gas phases results both in crushing a gas phase, and its mineralization and hardening;
- constraint of phases;
- influence of superficial factors;
- essential influence of hydrodynamical fields on formation of structure of a porous composite.

There are no precise approaches and principles of formation of mathematical models for different technological repartitions. It speaks difficulty of the description of processes of cooperating phases as it is necessary to consider structure of streams of mixing up phases and an interphase exchange of impulses. Proceeding from the above-stated, we undertake attempt to plan approaches to modelling of porous mixes on the basis of mechanics of interpenetrating environments.

In a basis of the description of investigated system there are equations of indissolubility, an impulse, energy, and the conditions which have been written down for elementary volume, for each of phases.

The equations of indissolubility of phases have a following appearance:

$$\frac{\partial \varphi_i}{\partial \tau} + div(\varphi_i \cdot \mathbf{V_i}) = \sum_{i,j=1}^{3} J_{ij}\,, \quad i = 1 \ldots 3 \qquad (1)$$

So, φ_i is the volumetric maintenance of phases. As a continuous phase it is considered liquid phase (i=1), and as disperse - firm (i=2) and gaseous phases (i=3).

The right part of the equation (1) characterizes transitions of one phase in to another.

The equations of preservation of an impulse for each of phases have a following appearance:

$$\rho_i \cdot \varphi_i \frac{d\mathbf{V_i}}{d\tau} = \rho_i \cdot \varphi_i \cdot (\pm g_i) + \varphi_i \cdot (\mathbf{V}_i - \mathbf{V}_j) \cdot f_{ij} + \varphi_i \cdot \nabla P + \nabla \sigma_i \qquad (2)$$

In the left part of $\frac{dV_i}{d\tau} = \frac{\partial V_i}{\partial \tau} + V_i \cdot \frac{\partial V_i}{\partial x_k}$ - is a full derivative of phase’s speed.

In the right part of the equation (2) there are following data:

- the first composed is an impulse of mass forces;
- the second composed characterizes an interphase exchange of impulses;
- the third composed is an impulse from a gradient of pressure in the continuous environment;
- the fourth composed is an internal pressure in the disperse phases, caused by superficial pressure.

The model should be added by the equations of indissolubility in space of the sizes on available disperse phases. So, for a gas phase (according to V.V. Kafarov), the equation has a following appearance:

$$\frac{\partial}{\partial \tau} f_3(r) + div(f_3(r) \cdot V_3) + \frac{\partial}{\partial r} f_3(r) \cdot \eta_3 = \sum K(r,\mu_i) \cdot f_3(r) \cdot f(\mu_i) d\mu_i \qquad (3)$$

In above resulted equation (3) there are following data:

- $f_3\,(r)$ is a density of distribution of gas bubbles in the sizes, that is dispersiveness of a gas phase, and $f\,(\mu)$ is for a μ-phase;
- η_3 is a growth rate of gas inclusions, for example, due to chemical processes or diffusion;
- $K\,(r,\mu)$ is a probability of a meeting of gas inclusions, particles with the r and μ. sizes.

The first member of the left part characterizes change of number of particles due to the non-stationary processes, the second member - due to convection processes, and the third - due to phase carry. The right part characterizes speeds of formation and disappearance of particles of a gas phase.

Let's note, that complexity of the given work consists that the process of aggregation occuring between the same and heteronymic phases is studied.

The result of interaction of a firm particle with a gas bubble depends both on kinetic energy of interaction, and from a condition of a surface of a bubble. Questions of probability of collision of particles were considered in N.B. Urev, V.V. Kafarov, J.B. Rubinshtejn's scientific works, etc.

A number of difficulties at realization of the above-stated model (namely: multiphasal nature and complexity of dynamics of interaction of phases, complex of hydrodynamical conditions in volume with presence of a turbulent mode, nonlinearity of process, etc.) lead to necessity of simplification of model and consideration of special cases. In researches often replace a three-phase continuum on biphase, that allows to exclude, for example, interaction of firm and gas phases.

Thus, we accept a number of the assumptions simplifying formation of mathematical model, in particular: we exclude a pulsation of phases, i.e. average characteristics of phases are considered; we consider an isothermal mode; we exclude inertial forces as they are insignificant in comparison with mass forces in processes of formation of a product (but in a case of intensive hashing of phases this factor cannot be neglected); we accept a stationary mode, believing, that time of the induction period is much more than time of interaction between phases; we assume, that the grain of a firm phase is inert during the induction period, i.e. we neglect interphase effects of the physical and chemical nature (such as adsorption, wettability, electrokinetic phenomena, etc.); we consider an one-dimensional problem, etc.

After the entered simplifications of the equation of impulses for each of phases will accept such kind as:

$$\varphi_1 \cdot \rho_1 \cdot g - \sum_{i=2}^{3} \gamma_i \cdot (V_1 - V_i) - \varphi_1 \cdot \frac{\partial P}{\partial z} = 0\,, \qquad (4)$$

$$\varphi_2 \cdot \rho_2 \cdot g + \gamma_2 \cdot (V_1 - V_2) - \varphi_2 \cdot \frac{\partial P}{\partial z} - \frac{\partial \sigma_2}{\partial z} = 0\,, \qquad (5)$$

$$-\varphi \cdot \rho_3 \cdot g + \gamma_3 \cdot (V_1 - V_3) - \varphi_3 \cdot \frac{\partial P}{\partial z} - \frac{\partial \sigma_3}{\partial z} = 0\,, \qquad (6)$$

In formulas (4 - 6) there are following parameters: the first composed are the mass forces acting on phases, the second composed are the forces arising from interaction of interphase borders, the third composed are the forces acting on a phase due to a gradient of pressure in the bearing phase, the fourth composed are pressure in firm and gas phases.

From the resulted equations of indissolubility and impulses a number of special cases after carrying out of the further simplifications can be received. In particular, it is possible to receive model of infiltration of a liquid phase on capillary-porous system. On the mechanism offered by us, process of water-branch of a liquid can be explained within the limits of the theory of self-organizing. In this case under action of gravitational forces there is a formation of infinite claster on a liquid component.

Thus, some approaches to statement of a problem of mathematical modelling process of structurization of foam concretes are considered.

The received results of work will allow to predict behaviour of foam concretes on technological repartitions and will serve for adjustment of a parametrical mode of preparation mixes in industrial conditions.