ON FOUNDATIONS OF THE BIOT'S THEORY. NEW INTERPRETATION ON THE BASIS OF THE GENERALIZED VARIATIONAL PRINCIPLE.

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Conception of two interpenetrating continuums, corresponding to the mean mass displacements of solid and liquid phases consisting porous penetrating media, lays in the basis of the Biot's theory [1,2]. Original Biot's equations are derived with use of Hamilton's variational principle for dissipationless medium and further dissipative terms are introduced by hands into the right parts of these equations. Important element of the Biot's theory is general quadratic forms for kinetic and potential energies, containing the crossing terms. Coefficients of quadratic forms satisfy to some general conditions and finally they are determined by characteristics of waves which are solutions of the Biot's equations. The Biot's theory predicts existence of a single shear wave and a couple of longitudinal waves one of them has a diffusive behavior at low frequencies. In the mentioned form the Biot's theory with its latest modifications was successfully applied for description of porous permeable materials during past five decades.

However, there are questions directly to the basis of the Biot's theory. In particular, why the kinetic and potential energies, which should be additive functions for phases separated in space, contain crossing terms? Formally these terms do not satisfy to this condition. Attempt to answer on this question leads to new interpretation of the Biot's theory.

Consistent approach for description of multiple phase media can be formulated on the basis of generalized variational principle for dissipative continuum mechanics [3,4]. Important element of this approach is a physical mean of variables in which terms the theory is formulated. The consistent statement has to be formulated in terms of variables dealt with integrals of motion of material points, representing a continuum. The various definitions of mean velocities of phases are available for multiple phase media in dependence on interpretation of temperature. The correct account of this circumstance allows to overcome the mentioned contradiction of the Biot's theory and to evaluate simultaneously some coefficients which should be determined experimentally in the framework of the original Biot's theory. As illustration of the new approach the simplest double phase media such as suspension and rod structures filled by fluid are considered by uniform way in the report.

REFERENCES

1. Biot M.A. Theory of propagation of elastic waves in fluid-saturated porous solid. I. Low-frequency range. // J. Acoust. Soc. Am., 1956, V.28, N2, p.168-178.
2. Biot M.A. Theory of propagation of elastic waves in fluid-saturated porous solid. II. Higher frequency range. // J. Acoust. Soc. Am., 1956, V.28, N2, p. 179–191.
3. Maximov G.A. Generalized variational principle for dissipative hydrodynamics and its application to the Biot's equations for multicomponent, multiphase media with temperature gradient. // In: New Research in Acoustics, B.N. Weis, (Ed.), 2008, pp.21-61, Nova Science Publishers Inc., ISBN 978-1-60456-403-7.
4. Maximov G.A. Generalized variational principle for dissipative hydrodynamics and its application to the Biot's theory for the description of a fluid shear relaxation. // Acta Acustica united with Acustica 2010, V.96, pp. 199-207.