Overpressure in a double porosity medium: continuous failure and acoustic properties

Izvekov O.Y., Cheprasov I.A.

Moscow Institut of Physics and Technology, Dolgoprudniy, Russia

e-mail: izvekov_o@inbox.ru

Overpressure is a common phenomenon in ultra-low permeability reservoirs, such as gas and oil shale. The main reasons for the overpressure formation are the decomposition of kerogen in the source rock and non-equilibrium compaction. Overpressure can lead to the development of secondary cracks in a low permeability rocks. This phenomenon (natural hydraulic fracturing) is well known and discussed in the literature.

For the continual description of the behavior of fractured-porous media, as a rule, the dual porosity model is used. Fractured porous media are characterized by the presence of a low-permeable matrix containing the main part of the fluid and a system of conductive fractures of both natural and technogenic origin (for example, multi-stage hydraulic fracturing technology in shale deposits involves the artificial creation of a permeable channel network). The dual porosity model is based on the description of the superposition of three continua: two fluids with exchange of mass, and a solid skeleton. One fluid is formed by the liquid in the matrix, and the other fluid is formed by the liquid in the cracks.

A thermodynamically consistent model of the medium with double porosity is proposed. The brittle matrix of the medium is capable of accumulating micro cracks under the influence of the overpressure. It is assumed that the medium is poroelastic and isotropic, the matrix and the system of cracks are saturated with the same liquid. The destruction of the matrix is described using Kondaurov's theory of damage and leads to enhancing mass transfer between the matrix and the system of main cracks and to reducing of the elastic moduli of the rock. For simplicity, it is assumed that damage is only caused by overpressure hence shear failure is not considered. The problem of the propagation of weak discontinuities in such media is considered, the types of possible weak discontinuities and characteristic velocities are determined.