AN INVERSE COEFFICIENT PROBLEM FOR A NONLINEAR PARABOLIC EQUATION

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We consider a one-dimensional equation describing the filtration of homogeneous liquid in porous media at non-linear elastic regime [1]

$$\frac{\partial \varphi}{\partial t} = \chi \frac{\partial}{\partial x}\left(\varphi^{\gamma-1}\frac{\partial \varphi}{\partial x}\right), \qquad (1)$$

where $\chi = k_0/(\mu_0 m_0 \beta)$, $\varphi = \exp[-\beta(p_0 - p)]$, $\alpha = a_k + \beta_f - a_\mu$, $\gamma = \alpha/\beta$, $\beta = \beta_m + \beta_f$, and k_0, m_0, μ_0 – initial (at pressure $p = p_0 = \text{const}$) values of permeability, porosity and viscosity, respectively; t – time; x – linear coordinate; p – current pressure; β_f – compressibility coefficient of the liquid; a_k, β_m, a_μ – rate coefficients in change of permeability, porosity and viscosity, respectively.

To solve inverse coefficient problem we are to give an additional condition

$$p(x_1, t) = z(t), \quad x_1 \in (0, \infty) \qquad (2)$$

at the characteristic point of the bed $x = x_1$, $z(t)$ can be treated as a ”megeared” pressure.

The pressure conductivity coefficient χ and γ we search by minimization of square functional J

$$J(\chi, \gamma) = \int_0^T [p(x_1, \xi) - z(\xi)]^2 d\xi. \qquad (3)$$

Minimization of the functional (3) is performed by using the simplex Nelder-Mead’s method. It is established, that for non-perturbated data this method yields good results, though iteration number is great. Perturbation of initial data leads to the increasing of the error in solution. The use of the gradient methods gives rather comprehensible results only for non-perturbated initial data.

References

[1] Nikolayevskiy V.N. (1996) Geomechanics and fluidodynamics with applications to reservoir engineering. Dordecht/Boston/London. Kluwer Academic Publishers.