Weak solvability of some fractional viscoelasticity models

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Abstract: The mathematical models of dynamics of viscoelastic fluids with constitutive relations of the form

$$\sum_{k=0}^{n}\sum_{i=0}^{s} b_{ki} D_{0t}^{k+\beta_{ki}}\sigma = \sum_{k=0}^{m}\sum_{i=0}^{r} a_{ki} D_{0t}^{k+\beta_{ki}}\varepsilon, \quad 0 \le \beta_k < 1, \tag{1.2}$$

where D_{0t}^{α} is the Riemann–Liouville fractional derivative of order $\alpha > 0$, σ is the deviator of the stress tensor, and ε is the deformation tensor are under consideration. Fractional analogous of Voigt and anti-Zener models are under investigation. We establish the existence of weak solutions of the corresponding initial-boundary value problems. In the planar case the uniqueness of weak solutions is proved. For the proofs of the main results we approximate the problems under consideration by a sequence of regularized systems of Navier-Stokes type. The solvability of regularized systems and apriori estimates of their solutions allow to pass to the limit in the regularized systems and obtain the solvability of original problems. The theory of fractional powers of positive operators, fractional calculus and classical results on Navier-Stokes equations are used.

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