Time discretization in visco-elastodynamics at large displacements and strains in the Eulerian frame

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The fully-implicit time discretization (i.e. the backward Euler formula) is applied to compressible nonlinear dynamical models of viscoelastic media in the Eulerian description, i.e. in the actual deforming configuration. The Kelvin-Voigt rheology or also, in the deviatoric part, the Jeffreys (also called anti-Zener) rheology describing a (possibly nonlinear) creep or a rate-dependent plasticity are considered. Both a linearized convective model at large displacements with a convex stored energy and the fully nonlinear large strain variant with a (possibly generalized) polyconvex stored energy are considered. The time-discrete suitably regularized schemes (suggesting an implementable numerical strategy) are devised for both these heavily nonlinear cases. The numerical stability and, considering the multipolar 2nd-grade viscosity, also convergence towards weak solutions are proved, exploiting the convexity of the kinetic energy when written in terms of linear momentum instead of velocity. In the fully nonlinear case, the examples of neo-Hookean and Mooney-Rivlin materials are presented. A comparison with models of viscoelastic barotropic fluids is also made and thermodynamical extension is outlined, too.

A reference:
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