11th World Congress on Computational Mechanics (WCCM XI)
5th European Conference on Computational Mechanics (ECCM V)
6th European Conference on Computational Fluid Dynamics (ECFD VI)
July 20–25, 2014, Barcelona, Spain

ENERGY-ENTROPY-CONSISTENT TIME INTEGRATION FOR NONLINEAR THERMO-VISCOELASTIC CONTINUA

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Key words: *Structure preserving time integration, Finite thermo-viscoelasticity.*

This paper deals with an energy-entropy-consistent time integration of a thermo-viscoelastic continuum in Poissonian variables. The four differential evolution equations of first order are transformed by a new G*eneral* E*quation for* N*on*-E*quilibrium* R*eversible*-I*rreversible* C*oupling* (GENERIC) format into a matrix-vector notation. Since the entropy is a primary variable we include thermal constraints to affect the temperatures at the boundaries. This enhanced GENERIC format with thermal constraints yields with the related degeneracy conditions structure preservation properties for a system with thermal constraints. The properties of an isolated system are in addition to a constant linear and angular momentum, the constant total energy, an increasing total entropy and a decreasing Lyapunov function. The last one is a stability criterion for thermo-viscoelastic systems and also for unisolated systems without loads valid. The discretization in time is done with a new TC (*Thermodynamically Consistent*) integrator. This enhanced TC integrator is constructed such, that the algorithmic structural properties after the discretization in time reflect the underlying enhanced GENERIC format with thermal constraints. As discretization in space the Finite-Element-Method is used. A projection of the test function of the thermal evolution equation is necessary for an energy-consistent discretization. The enhanced GENERIC format with thermal constraints, which is here given in the strong evolution equations, contains the external loads. This yields the necessary weak evolution equations for the solution of the system. The consistency properties are shown for representative numerical examples with different boundary conditions. The coupled mechanical system is solved with a multi-level Newton-Raphson method, based on a consistent linearization.