11th. World Congress on Computational Mechanics (WCCM2014)
5th. European Conference on Computational Mechanics (ECCM V)
6th. European Conference on Computational Fluid Dynamics (ECFD VI)
July 20 - 25, 2014, Barcelona, Spain

STRUCTURE-PRESERVING FORMULATION OF A CONVECTED MAXWELL FLUID

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Key words: Structure-preserving schemes, mimetic methods, stress tensor, deformed mesh.

ABSTRACT

In many engineering disciplines within fluid mechanics the constitutive relations of a material depend on the local strain-rates and/or stresses. Even though a conservative formulation is used, the discretised equations may not inherit the conservative properties.

In recent years structure-preserving schemes and mimetic methods have evolved, and schemes which conserve desired quantities have been introduced. In [1] a scheme conserving the gradient of a scalar is presented. Using this as an inspiration, the steady Couette flow of a convected Maxwell fluid, described in [2], is discretised.

Through a structure-preserving spectral element method it is attempted to formulate a scheme, which conserves the operators acting on the strain-rate tensor and the stress tensor. The purpose of this is to reside the approximations of the numerical scheme where they belong, namely at the constitutive relations. Operators like the gradient and the divergence operator should be preserved, since they are metric-free. Constitutive relations however relates different quantities to each other through an empiricism, and hence a metric. A scheme which mimics this is desirable.

REFERENCES

[1] Marc Gerritsma, "An Introduction to a Compatible Spectral Discretization Method", *Mechanics of Advanced Materials and Structures*, Vol. **19**, pp. 48–67, (2012).

[2] James Oldroyd, "On the Formulation of Rheological Equations of State", *Proceedings of the Royal Society of London. Series A, Mathematical and Physical Sciences*, Vol. 200, pp. 523-541 (1950).