

# A DUAL-MIXED APPROXIMATION FOR A HUBER REGULARIZATION OF VISCOPLASTIC FLOW PROBLEMS.

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ABSTRACT. In the present study, we introduce a dual-mixed formulation tailored to address stationary viscoplastic flows exhibiting yield behavior, exemplified by the Bingham or Herschel-Bulkley flow models. Our approach is rooted in the Huber regularization of the viscosity term, culminating in a two-fold saddle-point nonlinear operator equation governing the resultant weak formulation. We establish the existence and uniqueness of solutions within the continuous framework and advance a discrete computational strategy based in Arnold-Falk-Winther finite elements. This discretization strategy yields a system of nonlinear equations characterized by slant differentiability. To address these nonlinearities, we propose and implement a semismooth Newton algorithm. Furthermore, we present an *a priori* error analysis for the Bingham case. To demonstrate the efficacy and robustness of our methodology, we present a series of numerical experiments, providing insights into the method's performance and behavior.

**Keywords:** Viscoplastic fluids, Dual-mixed methods, Twofold saddle point, Semismooth Newton methods.

**Mathematics Subject Classifications (2010):** 76A05, 49M29, 47A52, 76M10.

## REFERENCES

- [1] S. González-Andrade and P. E. Méndez, *A dual-mixed approximation for a Huber regularization of generalized -Stokes viscoplastic flow problems*. Comput. Math. Appl. 112 (2022), 7696.
- [2] Gatica, Gabriel. *Solvability and Galerkin Approximations of a Class of Nonlinear Operator Equations*. Zeitschrift Fr Analysis Und Ihre Anwendungen 21, no. 3 (2002): 76181.
- [3] Ervin, Vincent J., Jason S. Howell, and Iuliana Stanculescu. *A Dual-Mixed Approximation Method for a Three-Field Model of a Nonlinear Generalized Stokes Problem*. Computer Methods in Applied Mechanics and Engineering 197, no. 3340 (June 2008): 28862900.

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