

ADAPTIVE SOLUTIONS OF SP_N -APPROXIMATIONS TO RADIATIVE HEAT TRANSFER IN GLASS

Axel Klar, Jens Lang* and Mohammed Seaïd

Department of Mathematics

Darmstadt University of Technology, 64289 Darmstadt, Germany

*Correspondence author: Fax: +49-6151-16-3954 Email: lang@mathematik.tu-darmstadt.de

ABSTRACT This paper presents numerical models of radiative heat transfer in glass manufacturing that can be performed on normal workstations, yet are sufficiently accurate. Since many of the glass production processes are so complex that a complete simulation is still unthinkable at present, there is a great interest for such models in order to optimise final glass products. We use simplified approximations of spherical harmonics to obtain approximate solutions of high accuracy in optically thick regimes. The arising systems of partial differential-algebraic equations of mixed parabolic-elliptic type are numerically solved by a self-adaptive discretization method based on an error-controlled finite element method in space and a one-step method of Rosenbrock-type with variable step sizes in time. The method itself judges the quality of the numerical solutions and determines adaptive strategies to keep the discretization error below a user-prescribed tolerance. Multilevel techniques based on reliable and efficient a posteriori error estimators and time embedding are used to improve the spatial discretization by local refinement and to steer the step size selection routine. We present numerical results for a typical step in glass manufacturing, the cooling of a glass cube. Our approximate solutions are validated with solutions to the full radiative transport equation and compared to Rosseland approximations widely used in the engineering practice. The results show that simplified approximations of spherical harmonics are efficient and sufficiently accurate. They are a significant improvement of the classical diffusion models.