An IMEX scheme combined with Richardson Extrapolation for reaction-diffusion equations

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The numerical solution of advection-reaction-diffusion problems is a central problem in the numerical analysis. The numerical treatment of the boundary layer effect and the possibly stiff terms lead to challenging problems. The importance of this topic lies in the applicability of the corresponding models in the natural sciences, in our case for modelling of proton exchange membrane (PEM) fuel cells.

A previously [1] presented implicit-explicit (IMEX) method of second order in space is supplemented with Richardson Extrapolation methods (passive and active) in time. The new method is developed for the numerical solution of reaction-diffusion equations with pure Neumann boundary conditions in order to have a method of second order both in space and in time. Richardson Extrapolation is a very efficient method to increase the accuracy of many numerical methods. It consists of applying a given numerical scheme with different discretization parameters (in our case different time steps) and combining the obtained results with a properly chosen weights [2].

As an interesting model problem we consider a one-dimensional model for the overpotential distribution of a PEM fuel cell. We will have first to convert the conservation equations into a form of reaction-diffusion equations and verify that the conditions in the corresponding analysis are satisfied. The thorough computational experiments confirm the applicability of the method and the theoretical results. Moreover, the results obtained with passive and active Richardson Extrapolation methods are compared in the work.

[1] I. Faragó, F. Izsák, T. Szabó, Á. Kriston, *Central European Journal of Mathematics* **(submitted in 2012)**

[2] Z. Zlatev, I. Faragó, Á. Havasi, *Central European Journal of Mathematics* **(2011)**, 10(1), 159-172