Finite element methods of an operator splitting applied to population balance equations

Naveed Ahmed[1] Gunar Matthies[2] Hehu Xie[3] Lutz Tobiska[4]

In population balance equations, the distribution of the entities depends not only on space and time but also on their own properties referred as internal coordinates.

The operator splitting method is used to transform the whole problem into two unsteady subproblems of smaller complexity. The first subproblem is a time dependent convection-diffusion problem while the second one is a transport problem with pure advection.

We use the backward Euler method to discretise the subproblems in time. Since the first problem is convection-dominated, the local projection method is applied as stabilisation in space.

The transport problem in the one-dimensional internal coordinate is solved by a discontinuous Galerkin method.

The unconditional stability of the method will be presented. In the L^2 norm, error estimates are given which are of optimal order. The theoretical results are confirmed by numerical tests.

[1] Otto-von-Guericke University Magdeburg, Institute for Analysis and Numerics, PF 4120, 39016 Magdeburg, Germany,
naveed.ahmed@ovgu.de

[2] Universität Kassel, Fachbereich 10 Mathematik und Naturwissenschaften, Institut für Mathematik, Heinrich-Plett-Straße 40, 34132 Kassel,
matthies@mathematik.uni-kassel.de

[3] LSEC, ICMSEC, Academy of Mathematics and Systems Science, Chinese, Academy of Sciences, Beijing 100190, China,
hhxie@lsec.cc.ac.cn

[4] Otto-von-Guericke University Magdeburg, Institute for Analysis and Numerics , PF 4120, 39016 Magdeburg,
lutz.tobiska@ovgu.de