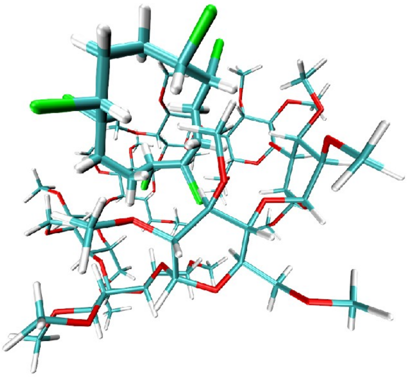
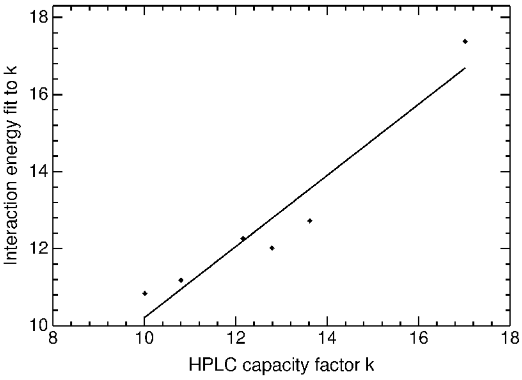
Multi-Mode Molecular Dynamics Simulation of the Chromatographic Elution Order of Hexabromocyclododecane Stereoisomers

Vedat Durmaz*, Marcus Weber*, Roland Becker**

**ZIB Zuse Institute Berlin, Department of Numerical Analysis and Modelling, Computational Molecular Design*

***BAM Federal Institute for Materials Research and Testing, Department of Analytical Chemistry, Reference Materials*





Liquid chromatographic separation of the six major diastereomers – three enantiomeric pairs – of the additive flame retardant hexabromocyclododecane (HBCD) has been studied by means of classical molecular mechanics with both explicit solvents water and acetonitrile. For this pupose, classical force field interaction energies with the entire surrounding were fit to experimental capacity factors derived from retention times of HPLC analysis. Since molecular dynamics simulations rarely provide considerable spatial rotations and conformational changes, high-temperature hybrid Monte-Carlo runs were performed with subsequent conjugate gradient minimizations in order to gain global minimum conformations serving as starting structures for multiple runs with differing initial binding modes in accordance with the icosahedron's symmetry. Besides, three strategies have been developed in order to determine the optimal binding mode. Using the small data set of HBCD, high squared coefficients have been computed of the correlation between optimal interaction energies coping with thermodynamic principles and experimental capacity factors with $R^2=0.92$ where enantiomeric separation was estimated exactly.