Hydrodynamic chromatography (HDC) is a method that separates molecules based on their size, due to local variations in flow rate (e.g. a parabolic or Poiseuille profile) [1]. These variations cause smaller particles to have a lower average velocity than larger particles, since smaller particles are able to access the slower stream lines near the wall. The overall aim of this project is to gain insight on the flow profile that occurs between the packing particles in hydrodynamic chromatography. Specifically, on the influence of the size of column-packing particles on the flow profile. Recent studies have suggested that existing theoretical models for HDC cannot accurately describe the influence of the particle size and ionic strength of the solvent on the elution volumes of analytes.

The elution time of analytes can be expressed in the dimensionless parameter $\tau$, which equals the elution time of the analyte ($t_i$) divided by the elution time of the mobile phase ($t_0$) [1,2]. This parameter can also be written as a function of the variable $\lambda = R_i/R_h$, where $R_i$ is the radius of the analyte and $R_h$ is the hydrodynamic radius of a column) and a constant C. When the constant C is equal to 1, the model is only based on the separation of the particles due to the flow patterns. For higher C values, other effects that could influence the elution of the analytes are also considered. According to the works of Striegel et al. [1] and Tijssen et al. [2,3], the C term takes the analyte permeability and the rotation of the particles in laminar flow profiles into account [1,2]. Different values and models for the C term are found in the literature. However, none of these models take the particle size of the packaging material into account.

Experimental results on six different HDC columns with different particle sizes and using eluents of varying ionic strength were compared with CFD simulations. The experimental results showed an increase in the C term from 5.4 to 18.3 with an average packing particle size of 1.9 and 8.7 µm, respectively, which does not correspond with the values found in literature. A possible change in flow profile with changing particle size was investigated. Simulations were used to gain insight in the flow profile.

References