Master's thesis 19.2.2025

Designing and testing of liquid distributors using integral experiments and magnetic resonance imaging measurements

Motivation

Separation processes like distillation and absorption are responsible for 40 to 60 % of energy and capital costs in chemical plants [1]. To address this, extensive research has focused on optimizing column internals, such as structured packings [2], to enhance mass transfer and reduce energy demands. The underlying project aims to improve structured packings' performance via optimization algorithms using CFD simulations. The numerical simulations are validated and refined by MRI measurements and integral experiments. A key challenge identified is designing a non-metallic distributor for MRI-compatible columns that ensures even liquid distribution. An initial maldistribution at the column head impairs the overall performance of the process, a challenge that structured packings alone cannot compensate for. Therefore, within this master's thesis different liquid distributors are designed, tested and compared by using collector experiments to determine the liquid distribution under varying flow conditions at the bottom of the column. Additionally, the liquid hold-up for selected configurations over the column height is measured using magnetic resonance imaging (MRI) experiments. The integral experiments and the MRI measurements will be compared to each other.

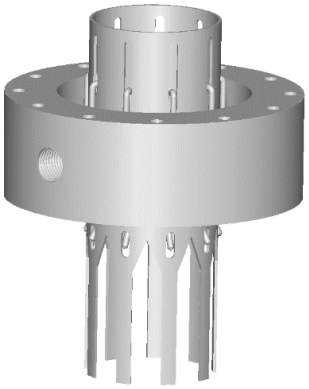

Figure 1: CAD design of a liquid distributor that uses capillary forces for distributing the liquid at the top of the column.

Contents of the work

Theory: Familiarisation with the theory of trickle beds, absorption and distillation processes, literature research on liquid distributor and collectors, literature research on MRI
Design: Preparation of CAD drawings of liquid distributors and collector
Experiments: Collector experiments to determine the maldistribution factor for different distributor designs under varying flow conditions, MRI measurements to determine the liquid distribution over the column height

Learning objectives of the work

- In-depth understanding of trickle bed
- Design skills using a CAD program
- Development of an experimental plan
- Practical experience in measuring with an MRI-scanner
- Writing a project report including literature research

Contact

Supervisor: Alina Dobschall, alina.dobschall@tuhh.de, Hannah Rennebaum, hannah.rennebaum@tuhh.de
Examiner: Alexander Penn, IPI TUHH

Literature

[1] J. A. Chavez Velasco et al., Joule, **2021**, 5 (2), 330–343, DOI: 10.1016/j.joule.2020.12.002.
[2] W. Yang et al., Chin. J. Chem. Eng., **2015**, 1, 42-49, DOI: 10.1016/j.cjche.2014.10.003.