多组分混合物中的质量传递 Mass Transfer in Multicomponent Mixtures

- 教师介绍 Faculty

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Education

August, 1992 – May, 1996:
Tianjin University, Tianjin, China
PhD in Chemical Engineering
September, 1986 – March, 1989:
Tianjin University, Tianjin, China
MS in Chemical Engineering
September, 1980 – June, 1984:
Tianjin University, Tianjin, China
BS in Chemical Engineering

Work Experience

October, 2001 - present: Professor
College of Chemical Engineering, Beijing University of Chemical Technology
June, 1998 – September, 2001: Associate Professor
College of Chemical Engineering, Beijing University of Chemical Technology
May, 1996 – May, 1998: Post Doc
College of Chemical Engineering, Beijing University of Chemical Technology
July, 1989 – April, 1996: Assistant Editor and Associate Editor

Representative Publications

[1] Hongxia Wang, **Hui Liu**. Distribution‐free estimation of f(E) in the distributed activation energy model based on matrix singular value decomposition method, Chemical Papers, 2019, 73(8): 1893-1902

[2] Qingyuan Xia, **Hui Liu**. A theoretical method for obtaining Padé type approximation to temperature integrals via the Stieltjes integral, J Math Chem, 2018, 56:1262 – 1279

[3] Xin Zhang, **Hui Liu**, Amar Samb, Guofeng Wang. CFD simulation of homogeneous reaction characteristics of dehydration of fructose to HMF in micro-channel reactors, Chinese Journal of Chemical Engineering, 2018, 26: 1340–1349

[4] Yuan Zhou, Milorad P. Dudukovic, Muthanna H. Al-Dahhan, **Hui Liu**, Multiphase Hydrodynamics and Distribution Characteristics in a Monolith Bed Measured by Optical Fiber Probe, AIChE Journal, 2014, 60(2): 740-748

[5] Peng He, **Hui Liu**, Jiqin Zhu et al.,, Tests of excess entropy scaling laws for diffusion of methane in silica nanopores, Chemical Physics Letters, 2012, 535: 84–90

[6] Peng He, **Hui Liu**, Yanfeng Li, Jiqin Zhu et al., Adsorption of benzene and propene in zeolite MCM-22: a grand canonical Monte Carlo study, Adsorption, 2012, 18:31–42

[7] Zhou Yuan, Zhang Qingyong, **Liu Hui**, Lei Zhigang, Measurements and characterization of bubble dynamics in capillary two-phase flows by a micro double-tip conductivity probe, Flow Measurement and Instrumentation, 2012, 24: 36 – 42

[8] He Peng, **Liu Hui**, Li Yanfeng, Lei Zhigang, Huang Shiping, Wang Peng, Tian Huiping. Enhanced selectivity and capacity of adsorption of CO_2 and CH_4 in zeolite-like metal-organic frameworks with different extra-framework cations: a Molecular Simulation study. Molecular Simulation, 2012, 38(1): 72-83

[9] XU Min, **LIU Hui**, JI Shengfu, LI Chengyue, Intensification of Deep Hydrodesulfurization Through a Two-Stage Combination of Monolith and Trickle Bed Reactors, Chinese Journal of Chemical Engineering, 2014, 22(4): 888-897

[10] ZHOU Yuan, AL-DAHHAN Muthanna, DUDUKOVIC Milorad, **LIU Hui**, Effect of Distributor Design on Gas-Liquid Distribution in Monolithic Bed at High Gas/Liquid Ratios, Chinese Journal of Chemical Engineering, 2012, 20(4): 693-700

- 课程介绍 About Course

This course is designed primarily for foreign MS students and will be taught in English. It will provide the students with important topics in advanced mass transfer

phenomena on the basis of the Maxwell-Stefan formulation (rather than the Fick equation normally used). Topics include the fundamentals of mass transfer theory and various processes such as distillation, absorption, heterogeneous catalysis, chromatography, ultrafiltration and many others. Focus will be to develop physical understanding of principles, with particular emphasis on chemical engineering applications. Two exams (final and midterm) and homework assignments are required.

Outlines:

Chapter 1. Beginning…（3 hours）
Chapter 2. Is Something Wrong?（2 hours）
Chapter 3. Driving Forces（3 hours）
Chapter 4. Friction（3 hours）
Chapter 5. Binary Examples（2 hours）
Chapter 6. Ternary Examples（3 hours）
Chapter 7. Non-idealities（3 hours）
Chapter 8. Diffusion Coefficients（2 hours）
Chapter 9. Centrifugal and Pressure Forces（2 hours）
Chapter 10. Why we use the MS-equations（2 hours）
Chapter 11. Solid Matrices（3 hours）
Chapter 12. Dialysis and Gas Separation（2 hours）
Chapter 13. Pervaporation and Reverse Osmosis（2 hours）
Chapter 14. Ion Exchange（2 hours）
Chapter 15. Gas Permeation（2 hours）
Chapter 16. In Porous Catalysts（2 hours）
Chapter 17. In Adsorbents（2 hours）
Chapter 18. Ultrafiltration（2 hours）

- 课程大纲 Syllabus

Instructor: Hui Liu, Dr./Prof.

Course Code:

Hours: 48

Credits: 3.0

Prerequisites: Transport Phenomena; Chemical Engineering Thermodynamics.

Description: This course is designed for chemical and biochemical engineering postgraduates. It allows the students to calculate how rapidly components in a mixture move with respect to each other. This is important in the designing of equipment such as reactors and separation units. The method covers both traditional and modern equipment, including catalytic and membrane processes. The method is based on a force balance of each species in the mixture. (This in contrast to the Fick equation normally used). It can handle any number of components and considers forces due to gradients of concentration; and of pressure, centrifugal and other fields. It leads to a unified description of all mass transfer processes: distillation, absorption, heterogeneous catalysis, chromatography, ultrafiltration and many others. In accordance with class teaching, about one hundred worked examples are provided, many of which are live

computer models and some of which will be implemented as exercises by the program Mathcad.

Textbook: Wesselingh, J.A. and Krishna, R., Mass Transfer in Multicomponent Mixtures. Delft: Delft University Press, 2000

References: Taylor R. and Krishna R. Multicomponent Mass Transfer. New York: Wiley, 1993

General Syllabus:

Chapter 1. Beginning…（3 hours）

1.1 What this course covers

1.2 Structure of the course

1.3 Symbols

1.4 Conventions

Chapter 2. Is Something Wrong?（2 hours）

2.1 The Starting Point

2.2 Three Gases

2.3 Two Gases and a Porous Plug

Chapter 3. Driving Forces（3 hours）

3.1 Potentials, Forces and Momentum

3.2 Momentum (Force) Balance of a Species

3.3 The Driving Force: a Potential Gradient

3.4 The Maxwell-Stefan Equation

3.5 Simplifying the Mathematics

3.6 The Film Model

3.7 Difference Form of the Driving Force

Chapter 4. Friction（3 hours）

4.1 Friction Coefficients and Diffusivities

4.2 Velocities and the Bootstrap

4.3 Velocities and Fluxes

4.4 The Difference Equation

4.5 Mass Transfer Coefficients

Chapter 5. Binary Examples（2 hours）

5.1 Stripping

5.2 Polarisation

5.3 Vaporisation

5.4 Gasification of a Carbon Particle

5.5 Binary Distillation

Chapter 6. Ternary Examples（3 hours）

6.1 From Binary to Ternary

6.2 A Condenser

6.3 A Ternary Distillation

6.4 A Ternary Reaction

6.5 Binary Approximation of a Ternary

Chapter 7. Non-idealities（3 hours）

7.1 Chemical Potential and Activity

7.2 Non-ideal Binary Distillation

7.3 A Simple Model of Non-idealities

7.4 Large Non-Idealities: Demixing
7.5 Maxwell-Stefan versus Fick
7.6 When can we neglect Non-ideality?
7.7 Mass Transfer in Liquid-Liquid Extraction
Chapter 8. Diffusion Coefficients（2 hours）
8.1 Diffusivities in Gases
8.2 Diffusivities in Liquids
8.3 How do you measure diffusivities?
Chapter 9. Centrifugal and Pressure Forces（2 hours）
9.1 Volumetric Properties
9.2 The Pressure Gradient
9.3 Gravitational Force
9.4 Centrifuges
9.5 Gas and Protein Centrifugation
9.6 Difference Equation for the Pressure Force
9.7 The Maxwell-Stefan Equations (again)
Chapter 10. Why we use the MS-equations（2 hours）
10.1 Three Ways
10.2 A Mixture of Three Gases
10.3 The Fick Description
10.4 Thermodynamics of Irreversible Processes
10.5 The Maxwell-Stefan Description
Chapter 11. Solid Matrices（3 hours）
11.1 The Applications
11.2 Membrane Processes
11.3 Adsorption and Chromatography
11.4 Heterogeneous Catalysis
11.5 Structured and Non-structured Matrices
11.6 Effects of a Matrix on Mass Transfer
11.7 Compositions with a Matrix
Chapter 12. Dialysis and Gas Separation（2 hours）
12.1 Dialysis
12.2 Gas Separation
Chapter 13. Pervaporation and Reverse Osmosis（2 hours）
13.1 Pervaporation
13.2 Reverse Osmosis
Chapter 14. Ion Exchange（2 hours）
14.1 Fixed-Bed Processes
14.2 Ion Exchange Equilibria
14.3 Linear Driving Force Model
14.4 Ion Exchange (Film Limited)
14.5 Ion Exchange (Particle Limited)
Chapter 15. Gas Permeation（2 hours）
15.1 Transport in Cylindrical Pores

15.2 The Diffusion Coefficients
15.3 Looking Back
15.4 Transport in a Bed of Spheres
15.5 The Dusty Gas Model
Chapter 16. In Porous Catalysts（2 hours）
16.1 Introduction
16.2 Pressure gradients inside a particle
16.3 Separate Transport Equations
16.4 Single-variable Pressure and Rate Expressions
16.5 Solution for a Slab
Chapter 17. In Adsorbents（2 hours）
17.1 Adsorption 1
17.2 Equilibria – Langmuir Isotherm 2
17.3 Maxwell-Stefan and Fick Diffusivities 4
17.4 Macropore Diffusion7
17.5 Transport Equations 8
17.6 Transient Adsorption of a Binary 8
17.7 Membrane Applications 9
Chapter 18. Ultrafiltration（2 hours）
18.1 The Module
18.2 Membrane and Permeants
18.3 Osmotic Pressure (No Ions, no Charge)
18.4 Size Exclusion
18.5 Polarisation
18.6 Transport Equations
18.7 Inside the Membrane
Class Discussions（2 hours）; Examination（4 hours）
Grading: Final Exam 60 %. Homework, Midterm test and Attendance 40 %.

- 教案 Teaching Plan
- 视频 Video