A Unified Approach to Mass Transfer

In this course, you will learn a method to describe *all* mass transfer processes. These include multicomponent processes (with three or more species) and processes with several driving forces. Such driving forces are gradients of concentration gradients, (or more accurately: activity), of pressure, of electrical and centrifugal potential. The method also describes transfer through solid matrices, such as in membrane processes and in porous catalysts or adsorbents. It is based on the Maxwell-Stefan equations, which are a force balance of the different species in a mixture. It links thermodynamics and transport phenomena in a way that is easily understood by engineers.

The course consists of short lectures, followed by computer tutorials. You will be working out many realistic examples on the computer (in groups of two) and discussing how to go on for at least half of the course. Most of the examples are based on realistic practical problems (many of them coming from participants of the previous courses). You will be using Mathcad to solve these problems: those of you who do not know Mathcad will receive instruction material a few weeks before the course. (You will need about half a day to prepare yourself). We do expect all participants to reasonable background in thermodynamics and transport phenomena.

Course outline

Monday : Is mass transfer theory wrong? - Driving forces and friction in mass transfer - Examples of binary mass transfer (stripping, polarisation, vaporisation, distillation and catalysis) - Examples of ternary mass transfer (condensation, distillation), Simultaneous heat and mass transfer (condensation, drying, heat effects in chemical reactions).

Tuesday : Effect of non-idealities (distillation and liquid-liquid extraction) - Estimation of multicomponent diffusivities and mass transfer coefficients - Electrical fields and electrolytes - Centrifugal and pressure gradients as driving forces (ultracentrifuge and gas separations) Comparing the different formulations of multicomponent mass transfer theory.

Wednesday: Solid matrices - Polymers - Diffusion in polymers - Dialysis and gas membrane separation –
Preparation for and start of the final assignments.

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Thursday : Pervaporation and reverse osmosis - Electrolysis and Electrodialysis - Ion exchange - Gases in porous media (with viscous flow) - Heterogeneous catalysis (mass transfer with chemical reactions) - Adsorption in porous media (surface diffusion).

Friday : Ultrafiltration of proteins (with viscous selectivity).
Review of the course.

Course information

- This is a one-week course in May or June
- The location is one of the universities involved in the OSPT; sometimes at the university of one of the guest-lecturers.
- Course materials: Mathcad instruction, the book “Mass Transfer in Multicomponent Mixtures” by J.A. Wesselingh and R. Krishna, Cambridge University Press, Mathcad assignments and solutions.

Lecturers

Prof.dr.ir. L.A.M. van der Wielen is with the Department of Biotechnology of the University of Delft. He is professor in bioseparations. His research interests are crystallisation/precipitation proceses as well as in multifunctional bioreactors and especially in the separation of biomolecules by modern chromatography.

Prof.dr.ir. J.T.F. Keurentjes studied process engineering at Wageningen Agricultural University, where he obtained his Ph.D. on application of membrane processes in food technology. He then joined Akzo Nobel, where he worked on several membrane processes and chiral separations. He is now professor and setting up a group on process development at the Technological University of Eindhoven.

Prof.dr.ir. R.M. Boom did his studies at Twente University, where he obtained a Ph.D. on the preparation process of porous polymeric membranes for separations purposes. He then worked for Unilever on membrane separations and cleaning technology, and is currently professor of Food Process Engineering at Wageningen University.

Registration and Fees

See the “Conditions for participations in the OSPT-courses” .