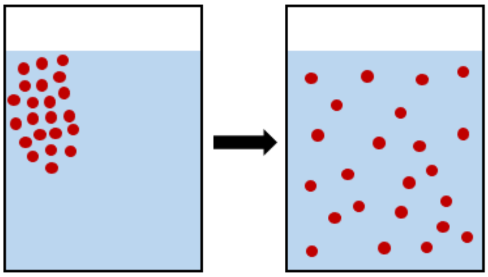
V 01: Introduction to mass transfer

Learning Goals:

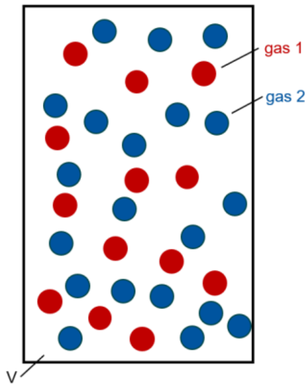
- Understand the basics of mass diffusion
- Understand diffusion in gaseous binary mixture
- Learn about Fick's law
- Learn to draw the concentration profile of one-dimensional equimolar diffusion in binary gas mixtures at rest



Comprehension Questions:

- ☐ What is the meaning of Fick's Law?
- ☐ What does equimolar diffusion mean?
- ☐ What is the relationship between molar flux and diffusive mass flux?

V 02: Fundamental quantities in mass transfer



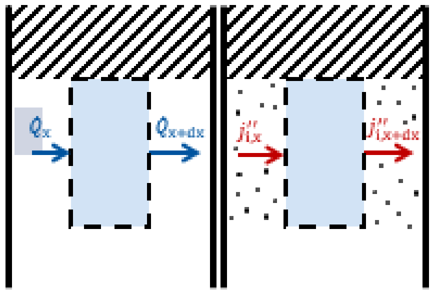
Learning Goals:

- *Enclosed volume*
- *Two different gases*
- *Constant pressure at temperature*

V 03: Derivation of the conservation equation of mass diffusion and analogy to heat transfer

Learning Goals:

- ➢ Understanding of the necessary steps to develop the conservation equation
- ➢ Knowledge of the common features of heat, mass, and momentum transfer
- ➢ Understanding of the necessary steps to develop the conservation equation



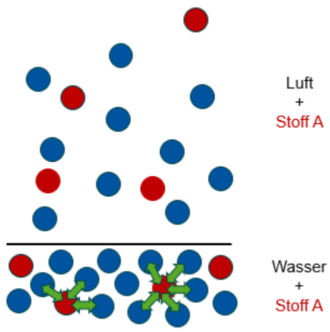
Comprehension Questions:

- ☐ What is the analogy of the diffusion coefficient in heat transfer and momentum transport?

V 04: Example for analogy: Transient 1-D

Learning Goals:

- ➢ Review of the solution of the one-dimensional heat conduction problem
- ➢ Understand the steps to solve the one-dimensional diffusion problem
- ➢ Understand to apply Heat Conduction “knowledge” to Diffusion problems



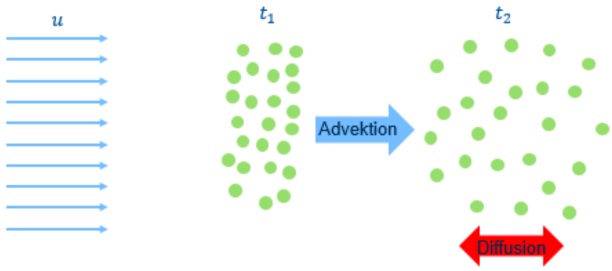
Comprehension Questions:

- ☐ Which one is the “semi-infinite” bc? What does “semi-infinite” mean? Can a piece of paper be regarded as being “semi-infinite?
- ☐ Which initial and boundary conditions are chosen when solving the one-dimensional transient diffusion problem?
- ☐ Assuming that temperature or mass fraction at the surface are identical to the free stream values: which value of α (heat transfer coefficient) or g (mass transfer coefficient) is defined by this assumption?

V 05: Phase equilibrium

Learning Goals:

- How is the equilibrium between two phases, liquid/gas or liquid/liquid described?
- Consequences for the concentration course

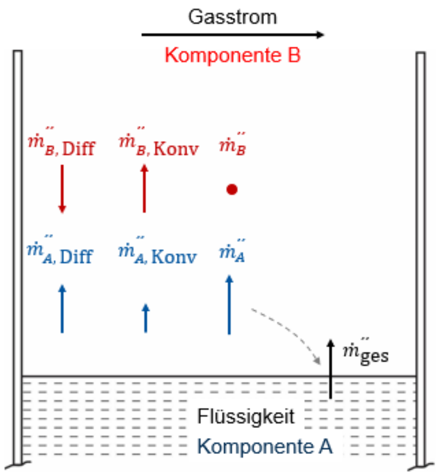


Comprehension Questions*:*

- ☐ Which quantities determine the ratio of the mass concentration at a phase interface between liquid and gas phase?
- ☐ Why do the mass concentrations at the interface correspond to the equilibrium state even in the transient case?

V 06: Advective mass transport and derivation of conservation equations

Learning Goals:



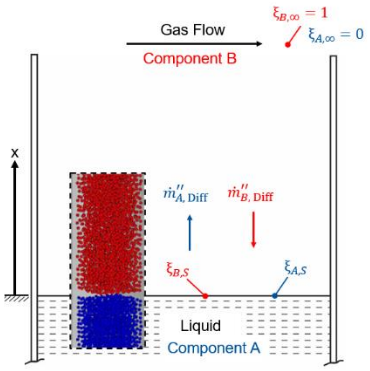
- Differentiation between diffusive and advective mass transport
- Understand the concept of mass average velocity and component velocity
- Learn the relevant dimensionless numbers and the analogy to heat transfer

Comprehension Questions:

- ☐ What is the name of the driving potential of diffusion and advective mass transfer?
- ☐ Which mass transfer dimensionless number can be considered as an analogue to the Prandtl number in heat transfer?
- ☐ Why is the sum of all diffusion flows equal to zero?

V 07: Evaporation at a liquid surface - Stefan Flow -

Learning Goals:



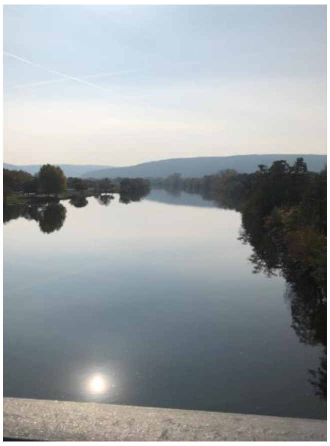
- ➢ Understanding of the particularities of mass transfer on a liquid semi-permeable surface
- ➢ Knowledge about the Stefan flow

Comprehension Question:

- ☐ What causes the additional convection? What does it compensate for?
- ☐ Which parameter influences the amplification of the evaporation mass flow by convection in a significant way?

V 08: Short calculation example: Evaporation on a liquid surface - Stefan Flow

Learning Goals:



- ➢ How can the problem be described?
- ➢ Does mass transport limit the problem?
- ➢ Does heat transport limit the problem?

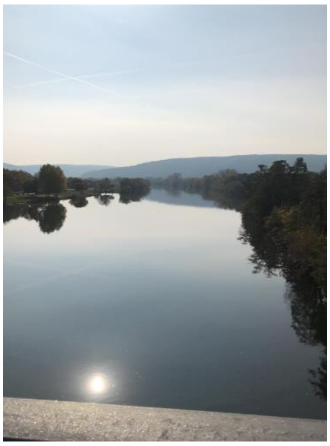
Comprehension Questions:

- ☐ How are mass fractions calculated?
- ☐ Under what conditions does the Lewis‘law apply?
- ☐ How is the mass transfer coefficient calculated using Lewis‘law?
- ☐ How is the mass of evaporating water determined?

Institute of Heat and Mass Transfer, RWTH Aachen University
Prof. Dr.-Ing. Reinhold Kneer

V 09: Example: Evaporation of a droplet - Stefan flow

Learning Goals:



- Balance at the droplet
- Equilibrium temperature during evaporation of a droplet
- Mass flow of the evaporated fuel $\dot{m}''$
- Duration of complete evaporation of a droplet

Comprehension Questions:

- ☐ Why is the determination of the surface temperature only possible iteratively?
- ☐ What are the considerations behind the estimation of the evaporation time of a droplet?
- ☐ Why is the evaporation time of an exhaled droplet relatively large?
