

## Nomenklatur

Subskript:

adv	Advection
diff	Diffusion
conv	Convektion
i	Component-specific partial share
v	Vapor
$\infty$	Environment
tot	Total
w	Water
O	Free Surface (Interface)
l	Liquid
v	Vaporisation

Superskript:

"	Area-related
'''	Volume-related
•	Time derivative (heat flow, mass flow, enthalpy flow, etc.)

Symbole

m	Mass	[kg]
M	Molar mass	[kg/kmol]
n	Molar quantity	[kmol]
$\rho_i$	Partial density	[kg/m <sup>3</sup> ]
$\rho$	Total density	[kg/m <sup>3</sup> ]
C	Molar concentration	[kmol/m <sup>3</sup> ]
$\psi$	Mole fraction	[–]
$\xi$	Mass fraction	[–]
$p_i$	Partial pressure	[N/m <sup>2</sup> ]
V	Volume	[kg/m <sup>3</sup> ]
$\dot{n}$	Mass flux	[kmol/s m <sup>2</sup> ]
$\dot{j}$	Diffusion mass flux	[kg/s]
$\dot{m}$	Mass flow	[kg/s]
D	Diffusion coefficient	[m <sup>2</sup> /s]
$\nu$	Kinematic viscosity	[m <sup>2</sup> /s]
$\lambda$	Heat conductivity	[W/m K]
$c_p$	Specific heat capacity	[J/kg K]
$H_i$	Henry-coefficient	[–]
u	Velocity	[m/s]
$\alpha$	Convective heat transfer coefficient	[W/m <sup>2</sup> K]
$\Delta h_v$	Evaporation enthalpy	[kJ/mol]
g	Mass transfer coefficient	[kg/m <sup>2</sup> s]

## Wärme- und Stoffübertragung: Lernpfad Stoffübertragung

### Dimensionslose Kennzahl

Re	Reynolds number	[–]
Pr	Prandtl number	[–]
Nu	Nusselt number	[–]
Sh	Sherwood number	[–]
Sc	Schmidt number	[–]

## V 01: Introduction to mass transfer

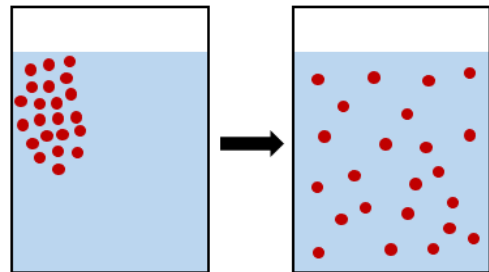
### Learning goals:

- 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:

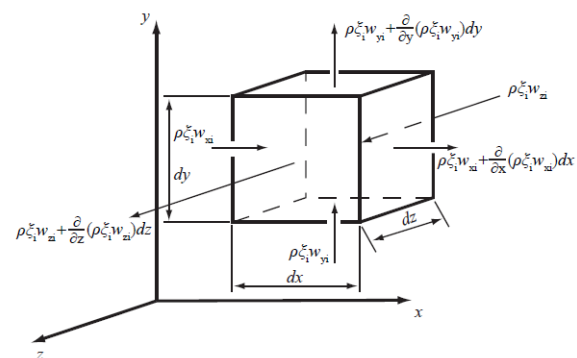
- ☐ What is the meaning of Dalton's Law?
- ☐ What is the meaning of Fick's Law?
- ☐ What does equimolar diffusion mean?
- ☐ What is the relationship between molar flux and diffusive mass flux?



## V 02: Derivation of the conservation equation of material 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



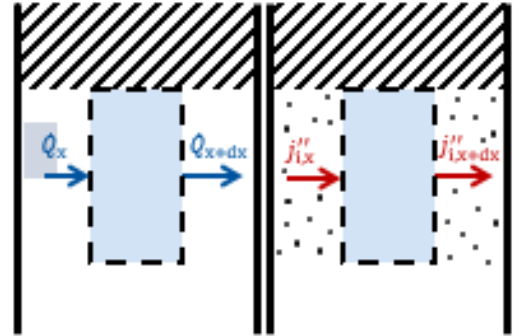
### Comprehension questions:

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

## V 03: 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:

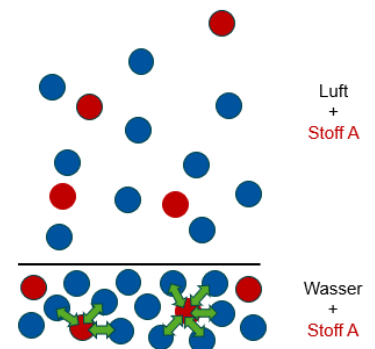
- ☐ Which initial and boundary conditions are chosen when solving the one-dimensional transient diffusion problem?
- ☐ For what kind of problems can the Heisler diagrams be used? Which boundary conditions must be fulfilled?

---

## V 04: Diffusion Phase Equilibrium

### Learning goals:

- Describing the equilibrium between two phases, liquid/gas or liquid/liquid
- Consequences for the concentration course



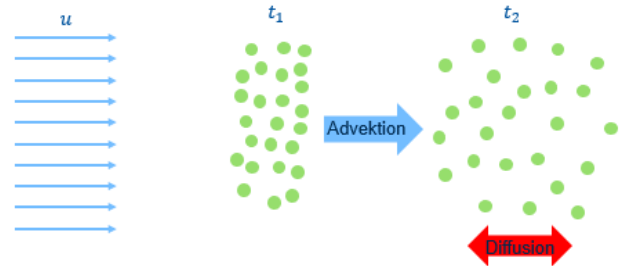
### Comprehension questions:

- ☐ 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 05: Advective Mass Transport

### 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



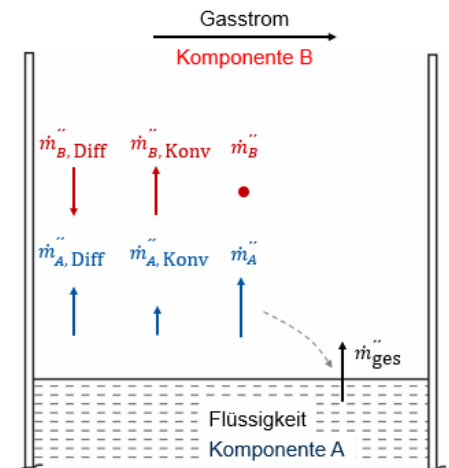
### Comprehension questions:

- ☐ 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 06: Evaporation at a liquid surface (Stefan-Strom)

### Learning goals:

- Understanding the particularities of mass transfer on a liquid semi-permeable surface
- Understand and be able to explain the occurrence and important boundary conditions of the Stefan flow



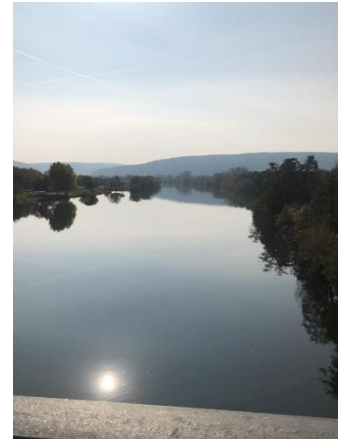
### Comprehension questions:

- ☐ 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 07: Example Evaporation Lake

### Considerations:

- Does mass transfer limit the problem?  
Mass flow = Transport coefficient \* Driving potential
- Does heat transport limit the problem?  
Heat flow = heat transfer coefficient \* driving potential  
Mass flow = heat flow / evaporation enthalpy



### Comprehension questions:

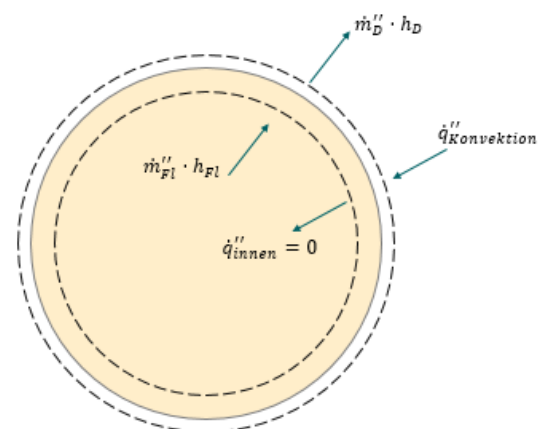
- ☐ How are mass fractions calculated?
- ☐ Under what conditions does the Lewis' law apply?
- ☐ How is the mass transfer coefficient calculated using Lewis' law?
- ☐ How is the mass of evaporating water determined?

$$\xi_{H_2O,i} = \frac{1}{\frac{1 - p_{H_2O}}{p_{H_2O}} \cdot \frac{M_{Luft}}{M_{H_2O}} + 1}$$

## V 08: 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?