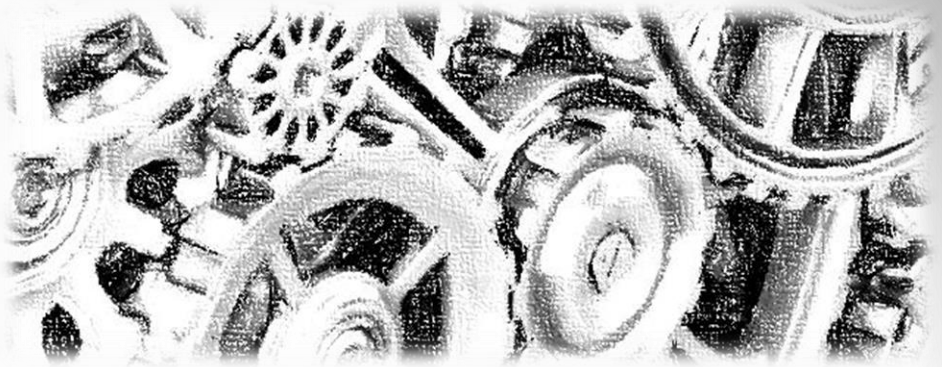
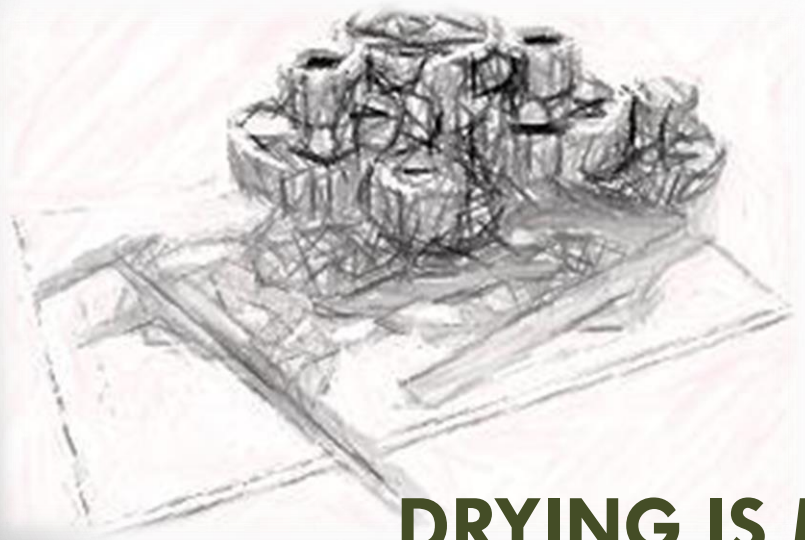




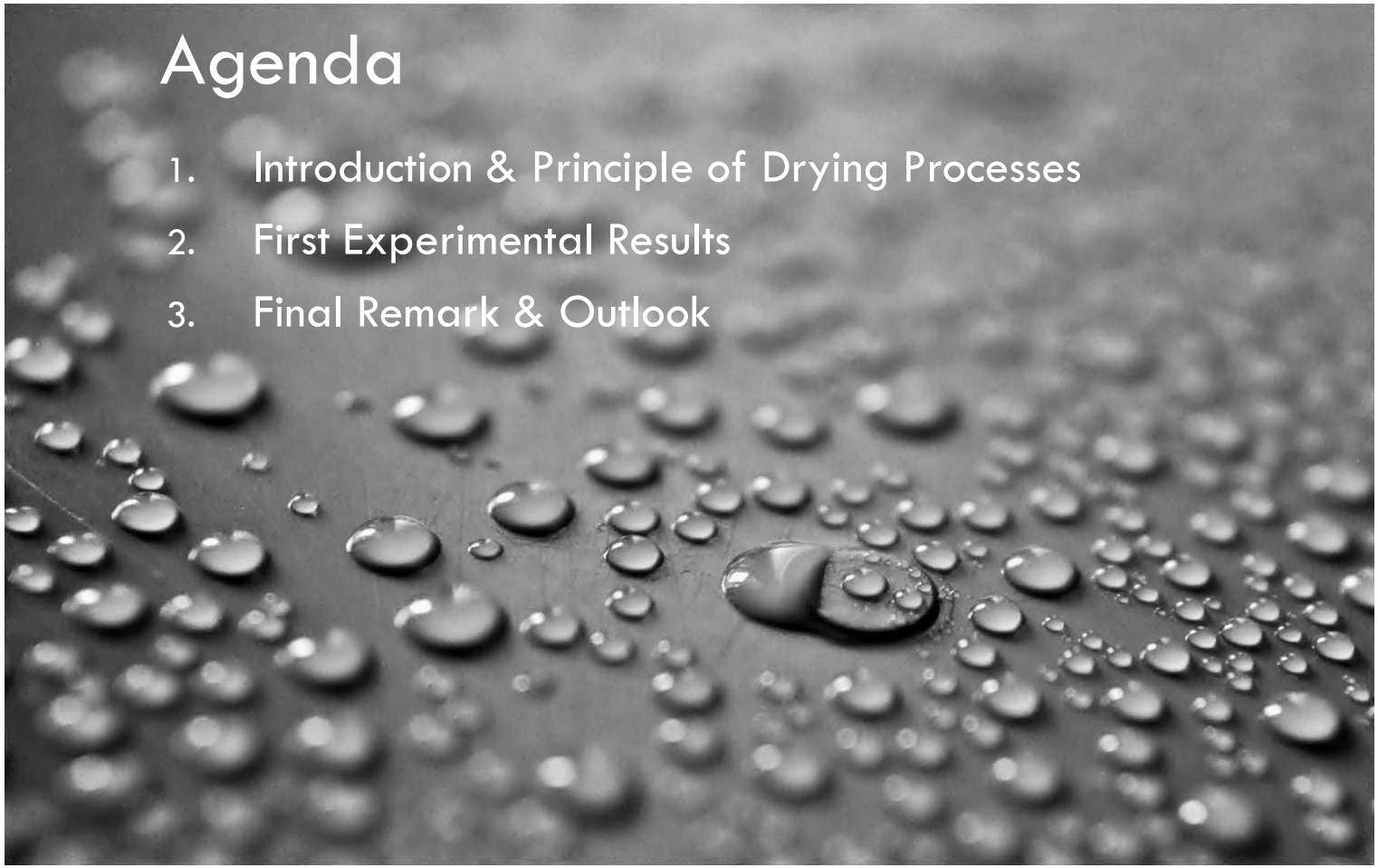
DRYING IS MORE THAN HOT AIR

MKVS 2018, 22.10.2018, 12.00 - 12.30

Prof. Dr.-Ing. D. Eggerath

Agenda

1. Introduction & Principle of Drying Processes
2. First Experimental Results
3. Final Remark & Outlook



Introduction

Basic Data Atlantic Ocean:

- *Volume: 355M km³*
- *Area: 80M km²*

Introduction

???How long does it take to evaporate the whole water in the Atlantic Ocean???

?

Assumption:

- *No gas side resistance*
- *No condensation back into the Ocean*

Introduction

???How long does it take to evaporate the whole water in the Atlantic Ocean???

?

Hertz-Knudsen Molecular Movement:

$$\dot{m} = \sqrt{\frac{1}{2\pi R}}\frac{p}{\sqrt{T}} \approx 1{,}99\ kg/m^2 s$$

p= Vapour Pressure
T= Evaporation Temperature
R= Specific Gas Constant

$R = 461{,}4\ J/kgK$
$T \approx 16°C$
$p \approx 18mbar$

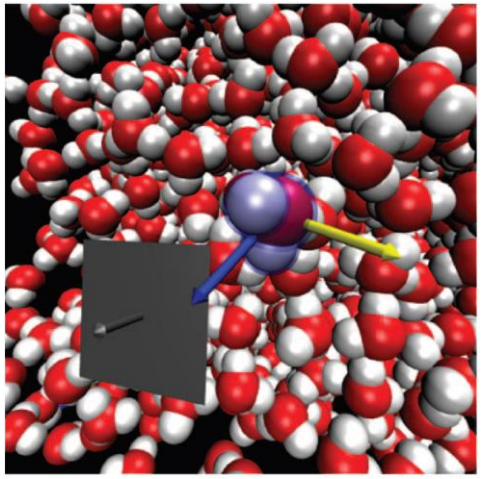
Introduction

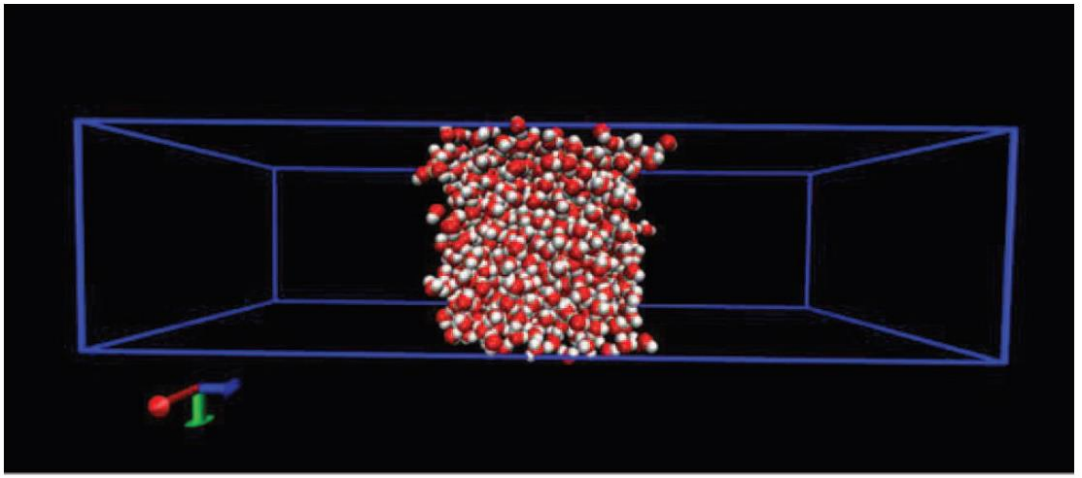
???How long does it take to evaporate the whole water in the Atlantic Ocean???

$$t \approx 26\ days$$

Princ. of Drying Processes

Simulation of evaporation process on molecular scale at MIT





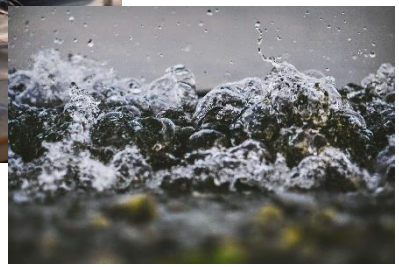
Key Information:

- *Energy for evaporation comes from the kinetic energy of the molecules*
- *Time scale is in the order of* $1\ \mu s$
- *Nature produces enough vapour / time*

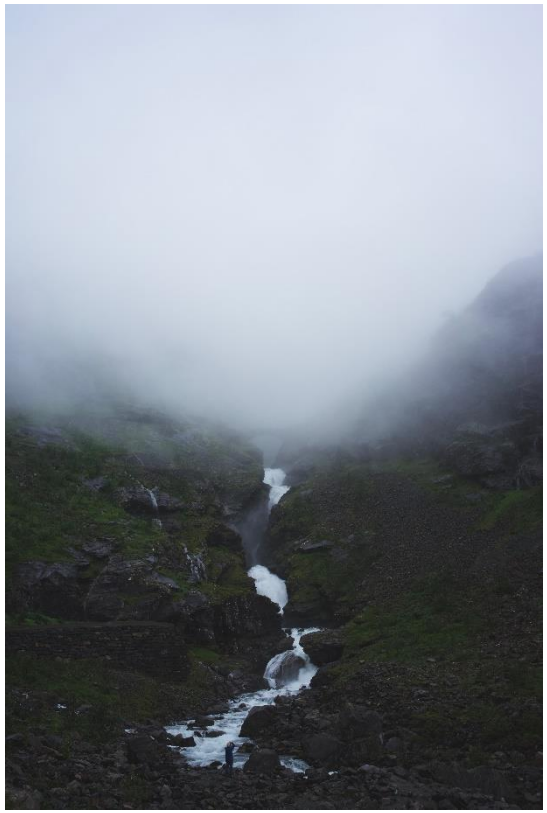
J. Chem. Phys. 138, 134707 (2013)

Princ. of Drying Processes

Difference between vaporation and evaporation



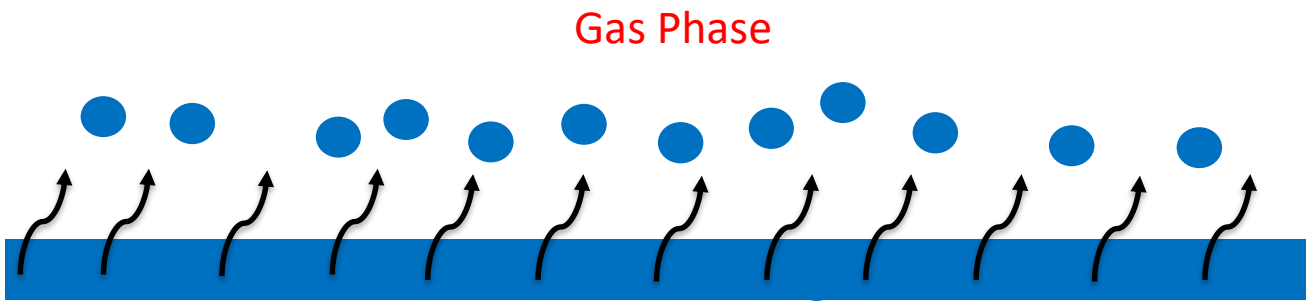
Vaporation



Evaporation

Princ. of Drying Processes

Conditioning the gas phase:

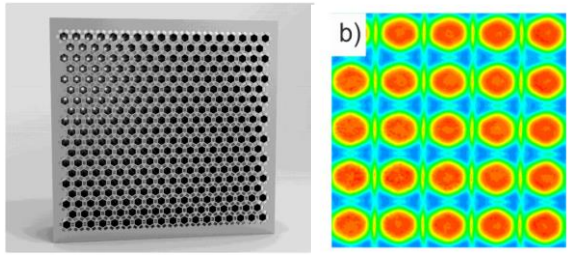


$$\dot{m} = -\rho D \left(\frac{1}{P} \frac{\partial P}{\partial x} - \frac{1}{2T} \frac{\partial T}{\partial x} \right)$$

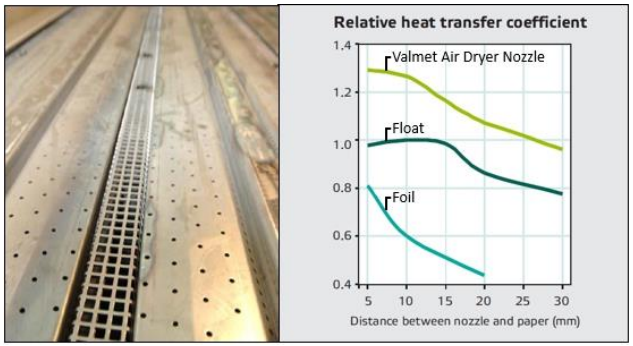
Learning:

- *Evaporation is a diffusion process*
- *<u>Aim:</u>*
  - *Decrease boundary layer*
  - *Increase temperature and maximum partial pressure*

First Exp. Results

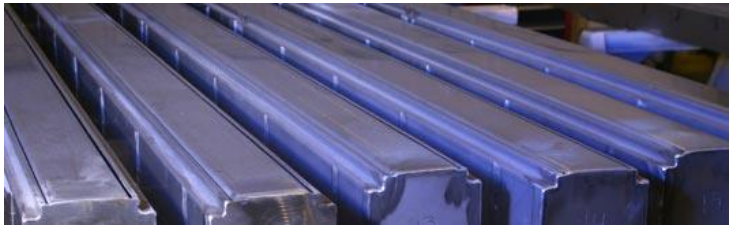


https://www.kit-technology.de/fileadmin/user_upload/601_Flyer01.pdf

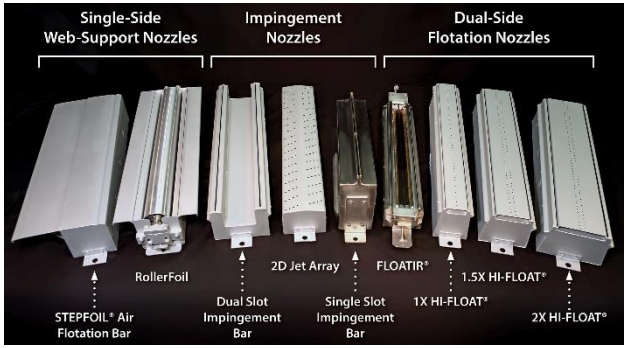


https://www.valmet.com/media/articles/up-and-running/new-technology/FPPfPIshino/

Low speed / High outlet area



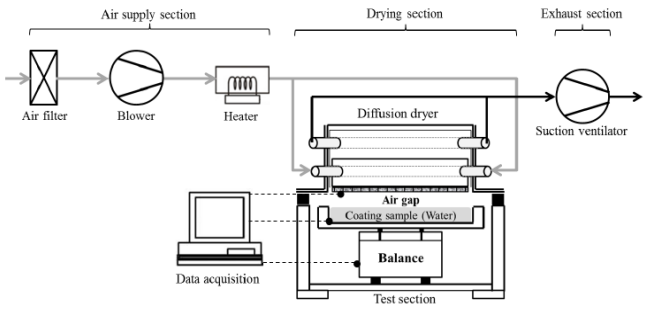
http://www.globaltechllc.com/



http://www.megtec.com/en/products/drying-curing

High speed / Low outlet area

First Exp. Results



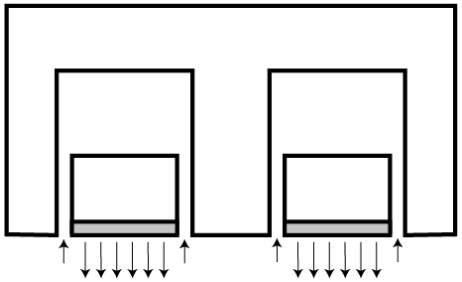
Hr. Frommelt

Hr. Nienke

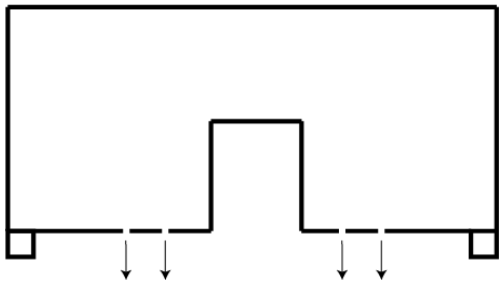
Test Facility

University: Employees

Aim: Evaluation of different convective drying principles

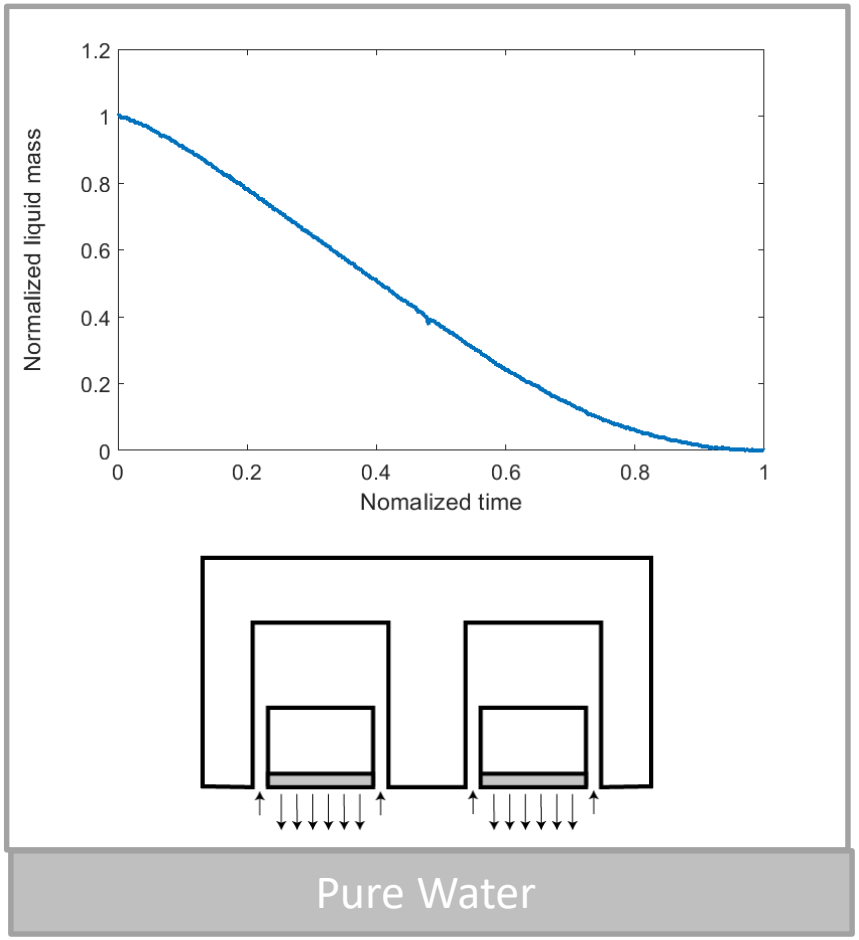


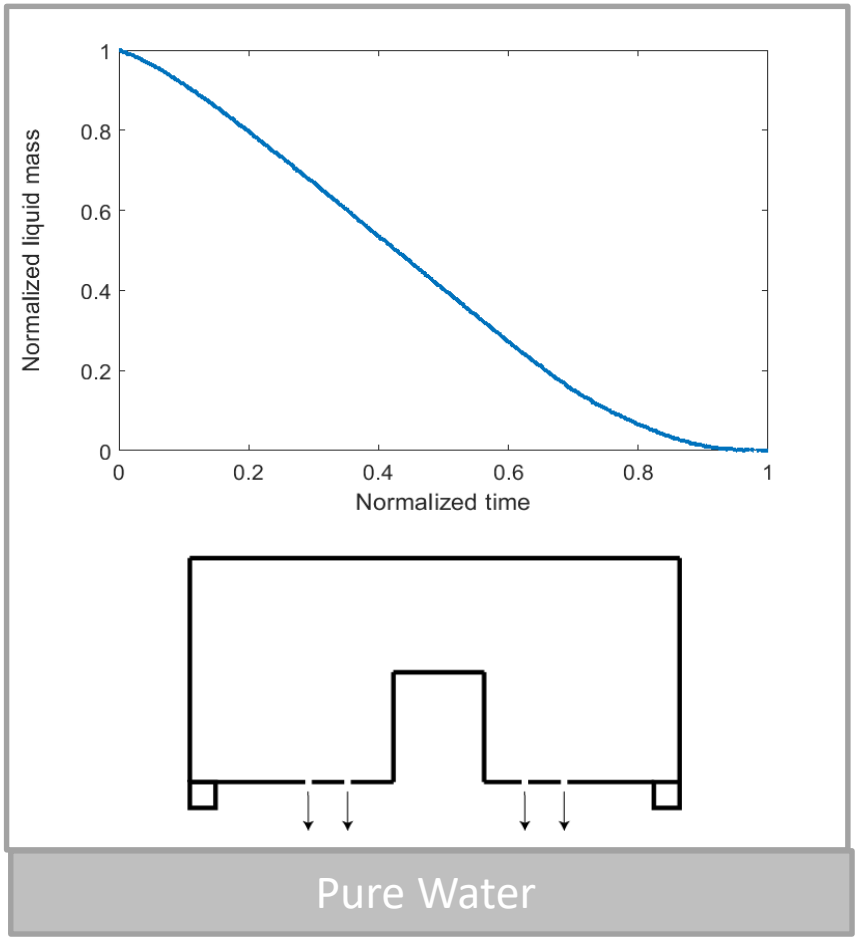
Low speed / High Outlet area



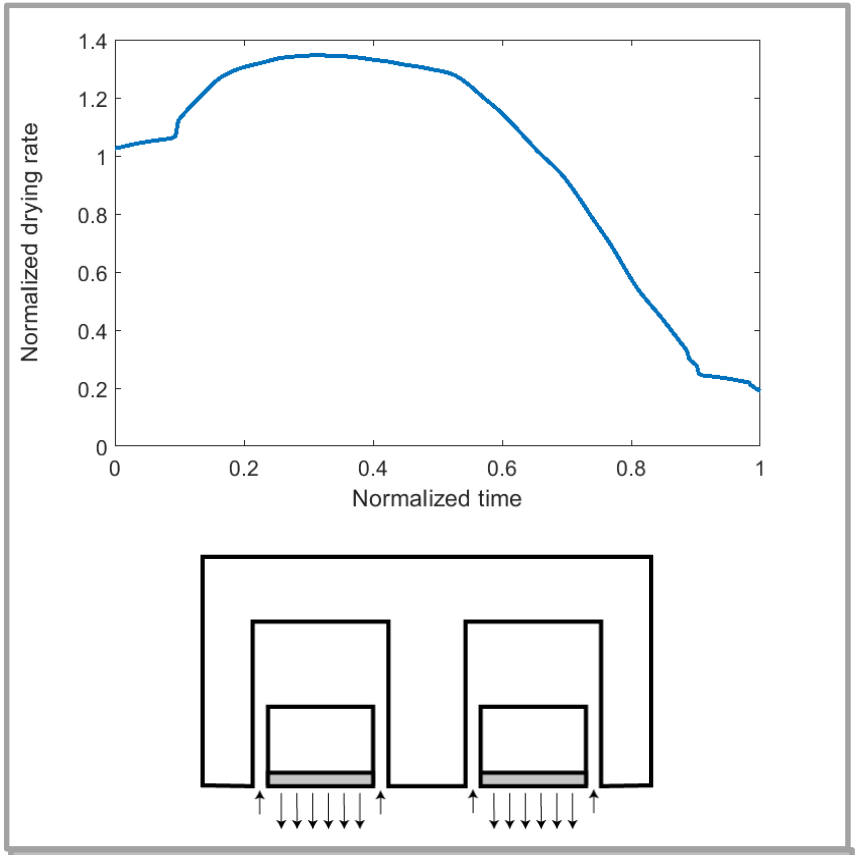
High speed / low outlet area

First Exp. Results

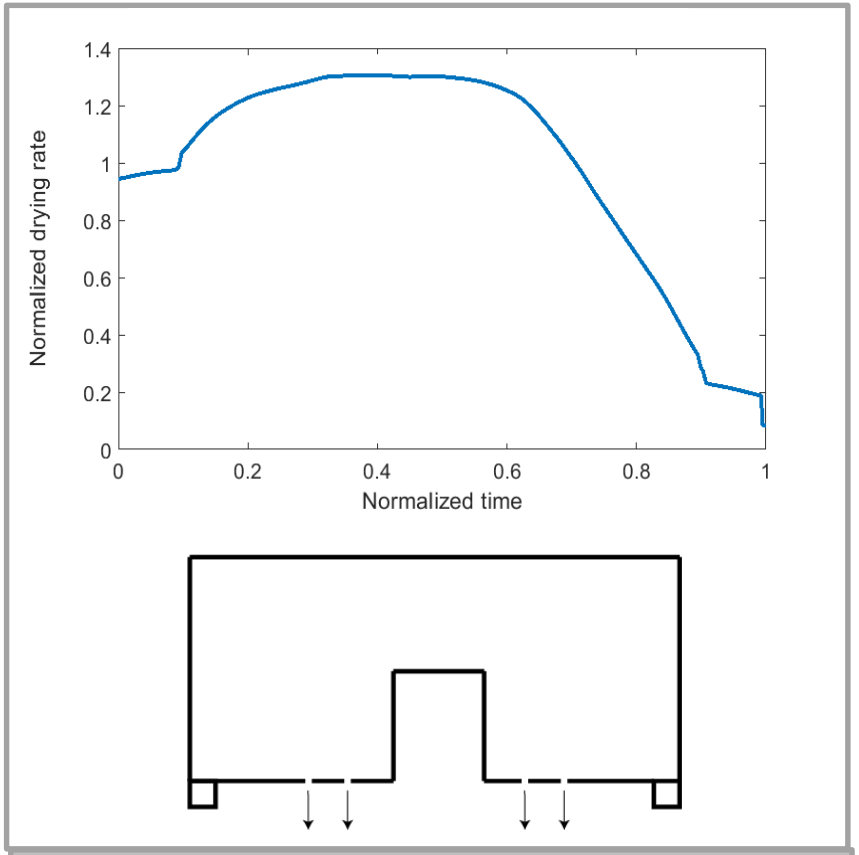




First Exp. Results

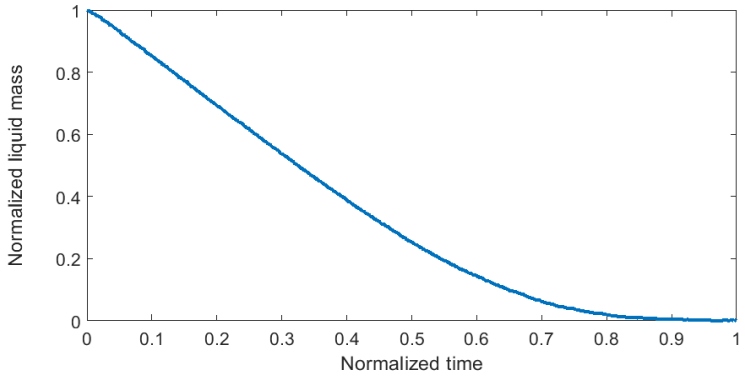


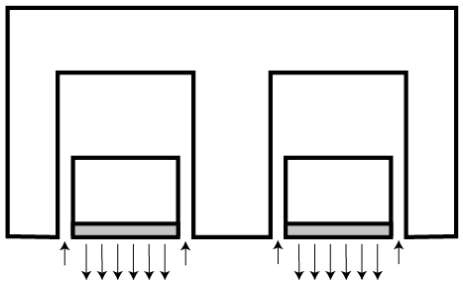
Pure Water



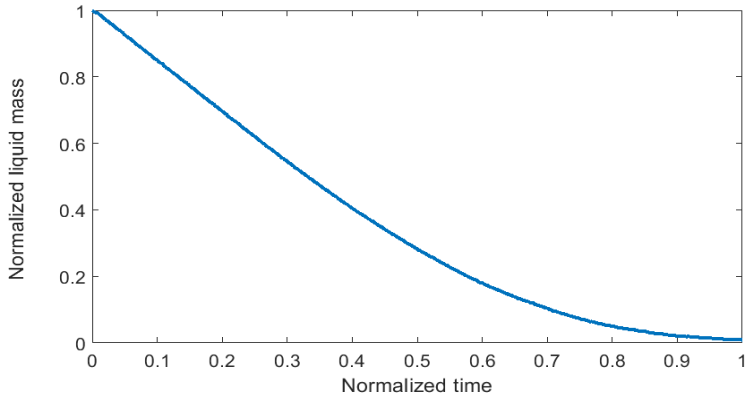
Pure Water

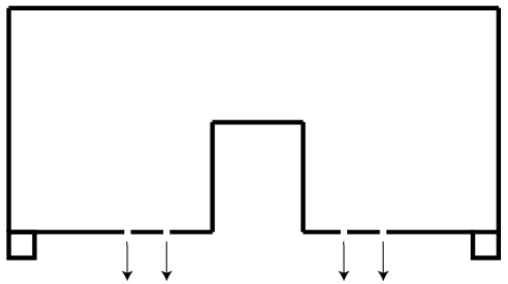
First Exp. Results





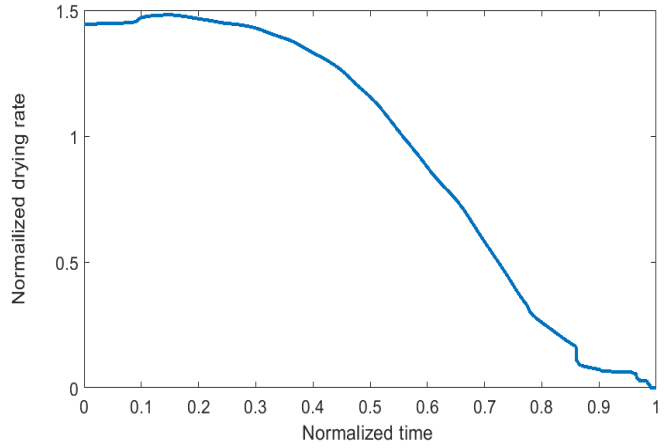
Absorbent Solid Particles

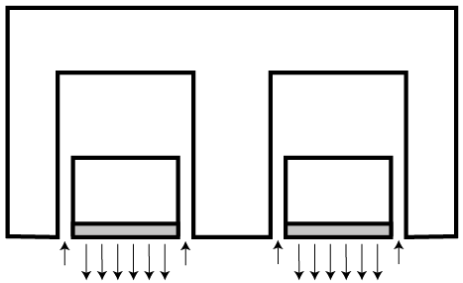




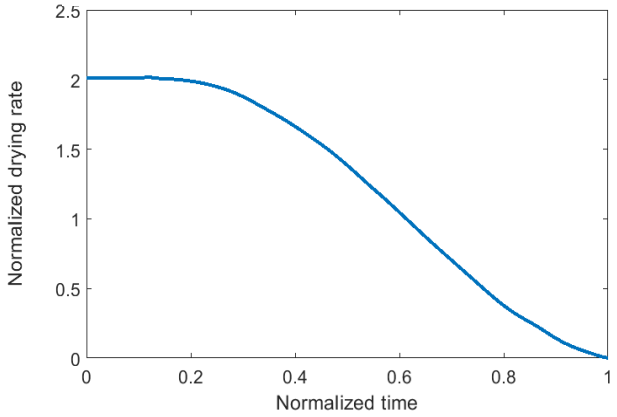
Absorbent Solid Particles

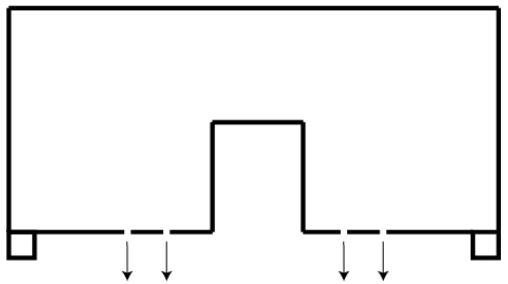
First Exp. Results





Absorbent Solid Particles



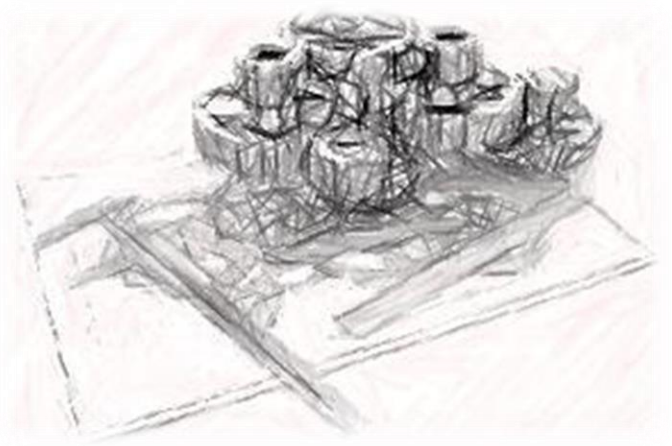


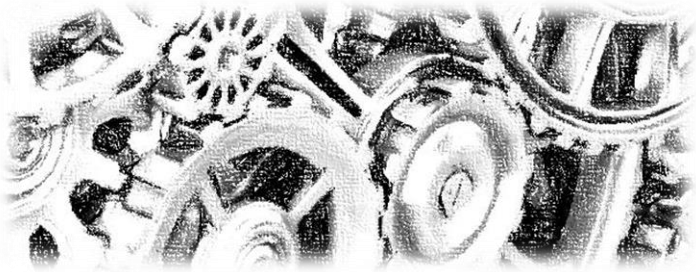
Absorbent Solid Particles

Final Remarks & Outlook

- „Low Speed / High outlet Area“ nozzles seem to show advantages compared to classical impingement nozzles
- First experimental results show an improvement in the order of **50%** in the falling rate period
- **Outlook:**
  - Further investigations indicate a possible improvement with respect to a maximum drying rate in the order of **60%** compared to classical impingement nozzles in the constant rate period
  - Further investigations are neccessary

Thank you for your attention





Any questions / remarks ? daniel.eggerath@hm.edu