



GreenShipping Niedersachsen

Catalytic Water Revolution

...Sustainability meets Efficiency at Sea

Presented at:



On November 30th, 2023

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Organized by:



Important Aspects of Maritime Water Treatment

Significance of Water Treatment in the Maritime Sector:

- *Essential for maintaining operational safety and health onboard.*
- *Direct impact on the performance and lifespan of maritime facilities.*

Current Challenges and Developments:

- *Adaptation to stricter environmental regulations and energy efficiency standards.*
- *Necessity to reduce ecological footprints and operational costs.*

Foundations and Innovations:

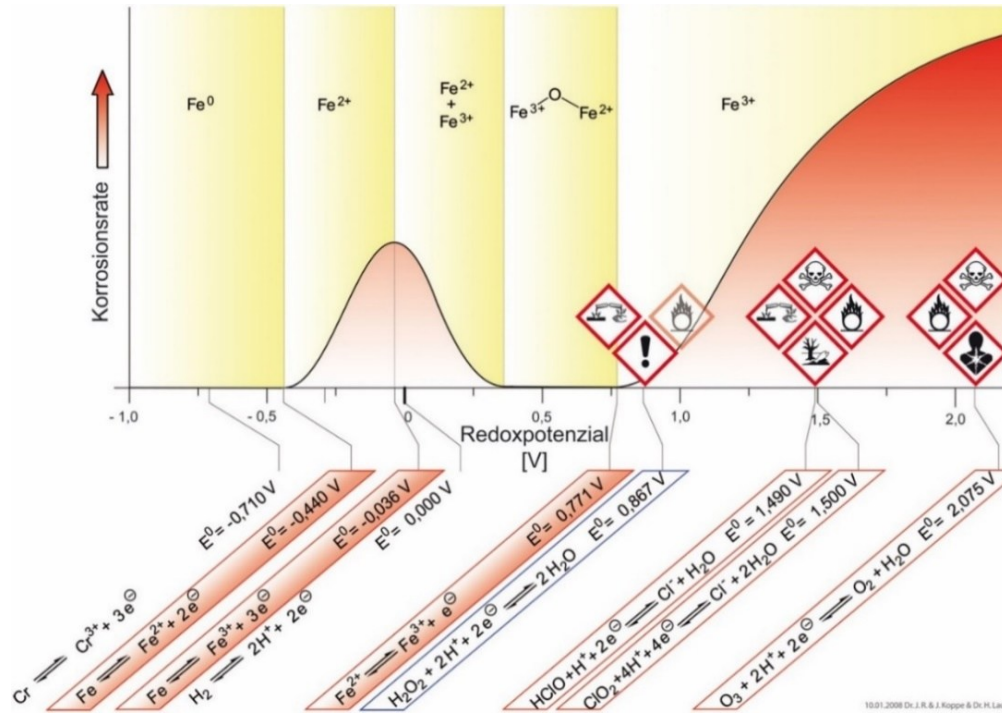
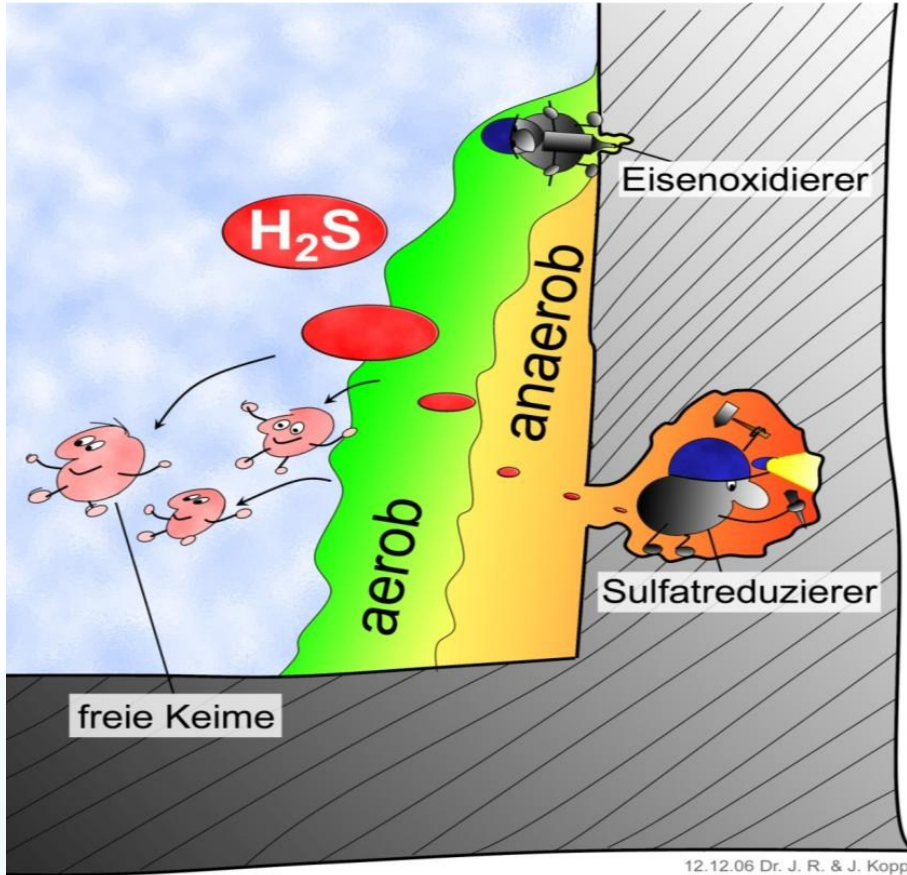
- *Advanced technologies tailored for maritime conditions.*
- *Application of optimal water treatment methods to improve ship efficiency and environmental compatibility.*

Optimizing Water Quality
... the key to efficiency and sustainability



Water – What Role Does Sustainability Play?

GreenShipping Niedersachsen



Less is More

As much chemistry as necessary
... instead of as much as possible.

Strategies and Legal Compliance

Economically Sustainable Approach:

- *Overview of current water treatment strategies.*
- *Comprehensive consideration with assurance of cost-effectiveness.*
- *Compliance with regulatory challenges and requirements.*

Customer Benefits in the Maritime Sector:

- *Economical solutions for shipping companies and port operations.*
- *Economic and ecological advantages: cost savings, improved operational efficiency, sustainability.*

*How to achieve targets at work?
How to meet the SDGs?*

Paper prepared together with BSH Germany
(The Federal Maritime and Hydrographic Agency)

Übersicht zu Biofouling- Management

Teil I: Reinigungstechnologien für Unterwasseranwendung

Dr. E. Fuchs (Fraunhofer IVV)
B. Daehne (Dr. Brill + Partner GmbH)
Dr. N. Heibeck (BSH)
Dr. M. Voigt (Dr. Voigt Consulting)
J. Koppe (MOL Katalysatortechnik GmbH)
Dr. C. von der Höh (Ankron Water Services GmbH)
Dr. B. Emde (Laserzentrum Hannover e.V.)
Dr. N. Klein (Hammann GmbH)
H.-J. Kastner (Umwelt Technik Marketing; Deutscher

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Project CWR-SEAS as a Trailblazer

Catalytic Water Revolution: Sustainability meets Efficiency at Sea

Overview of CWR-SEAS:

- *Pioneer project to promote sustainable maritime technologies.*
- *Global relevance for the maritime sector.*

Goals and Innovation:

- *Revolutionize water treatment in the maritime economy.*
- *Technology development for efficient and sustainable shipping.*

Customer Benefits:

- *Energy savings and increased efficiency onboard.*
- *Improvement of water quality & reduction in chemical usage.*
- *Contribution to sustainability & compliance with stricter environmental regulations.*



Revolutionizing Water Treatment
... Added Value for the Maritime Industry

Overcoming Maritime Challenges

...the path to efficiency and compliance

Challenges in the Shipping Industry:

- *Adapting to increasing ecological requirements and energy efficiency.*
- *Considering social aspects and ensuring economic viability.*

Ensuring High Water Quality:

- *Central importance for the crew's health and the functionality of ship operations.*
- *Necessity of continuous water quality monitoring.*

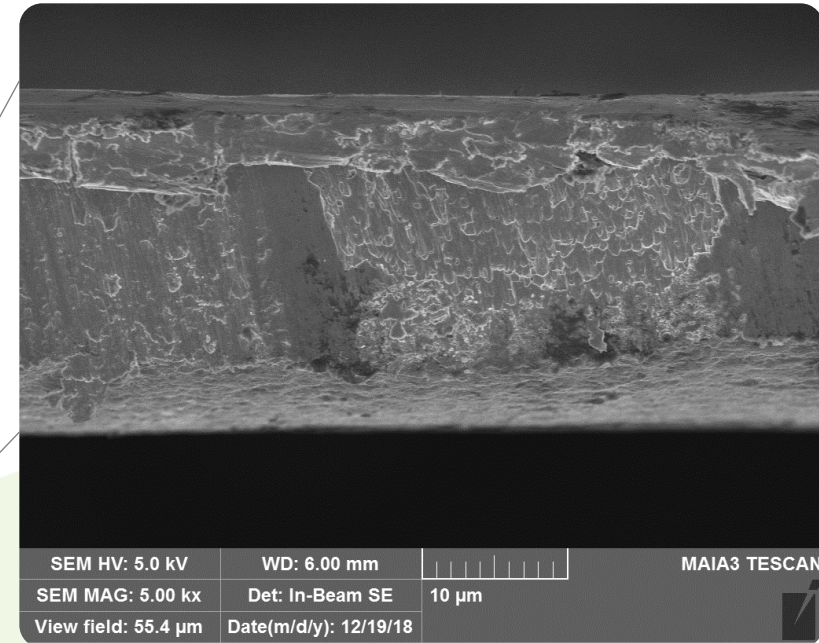
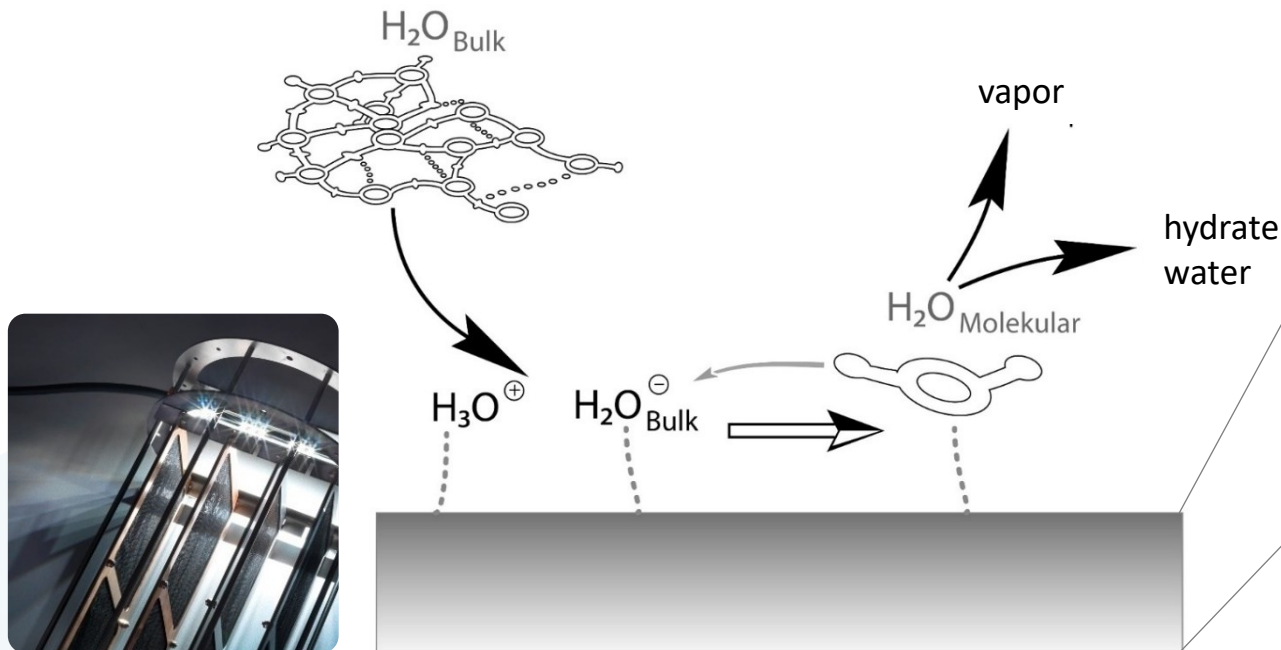
Solution Approach through CWR-SEAS:

- *Use of catalytic water treatment technology to meet these challenges.*
- *Benefits: Reduced energy consumption, improved water quality, cost reduction.*



Water & Catalysis ...the formular for small vapor bubbles

The most suitable catalyst is a mineral metal compound

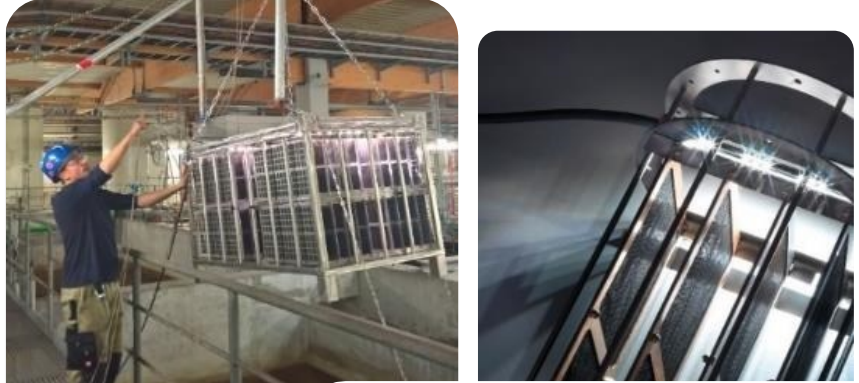


With thanks to Professor Dr. Su Benshueng
Engineering Research Institute
Beijing University of Chemical Technology

Water & catalysis – how does it work?

Water & Catalysis

...the Formula for Success with a Wide Range of Applications



1. Sustainable Efficiency:

Achieving success by adhering to the principle of minimization.

2. Durable & Low-Maintenance:

High resistance and minimal service requirement.

3. Environmentally Friendly & Cost-Efficient:

Completely recyclable materials



Water - the substance that looks ordinary but has extraordinary properties.

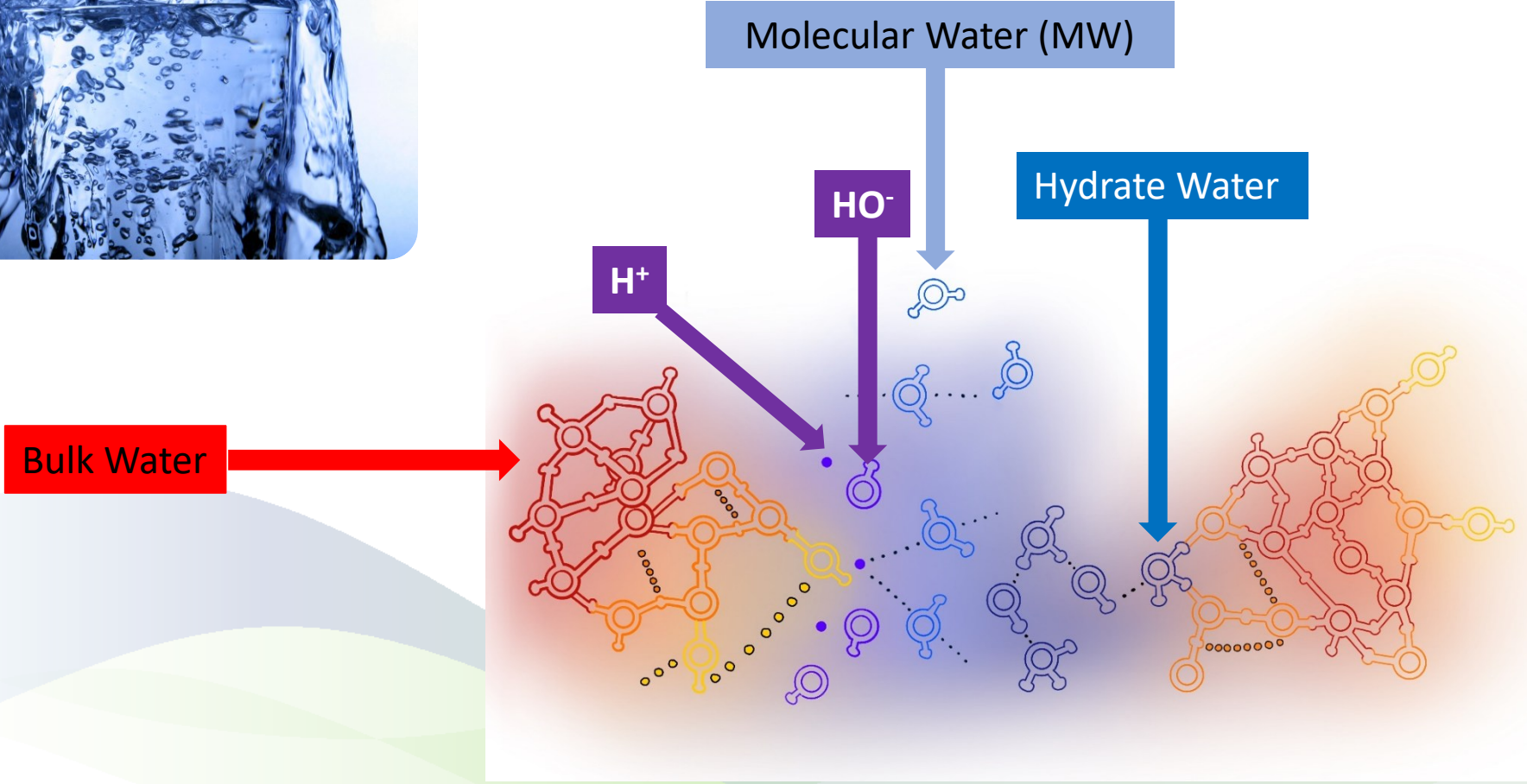
*125 years ago:
Mr. C. W. Röntgen postulates
the water model of resonance structures*

H₂O consists of two resonance structures:
Ice + Vapour

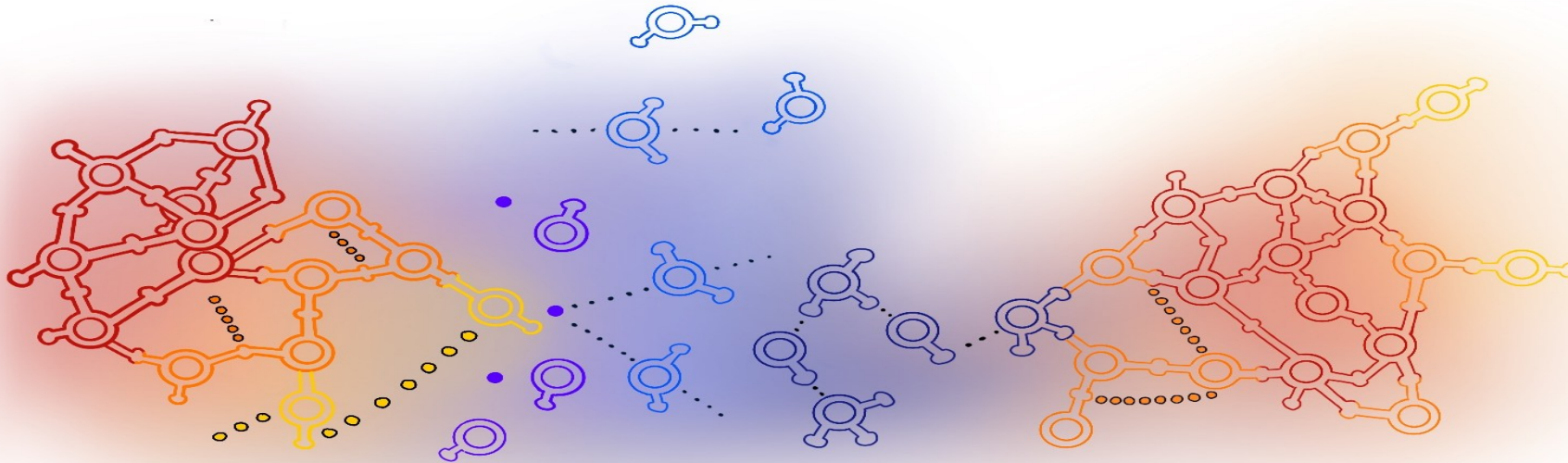
The equilibrium is strongly influenced by:
Temperature + Pressure

Is there a value added on business and economics?

Water ...the Lifeblood



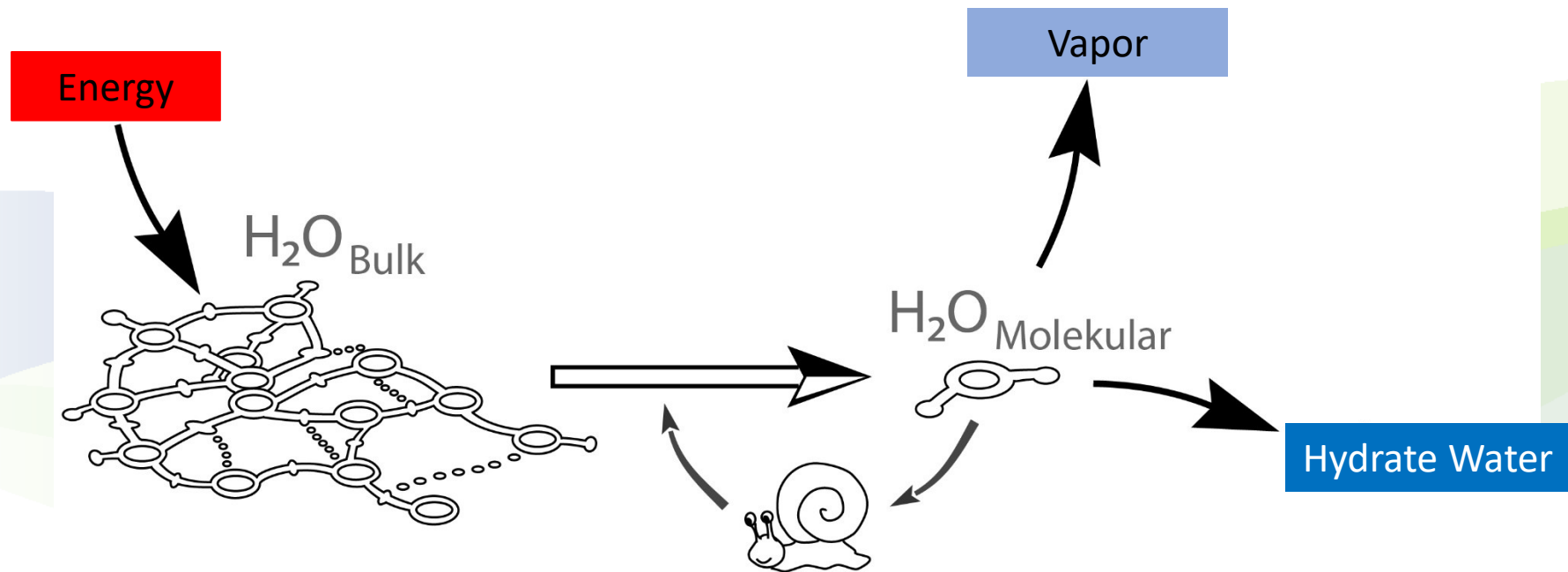
Switching between water structures is irreversible



„There is no possibility for jumping twice in the same river“ [HERAKLIT, 540 – 475 v. Chr.]

The concentration of the components within water is temporally constant:

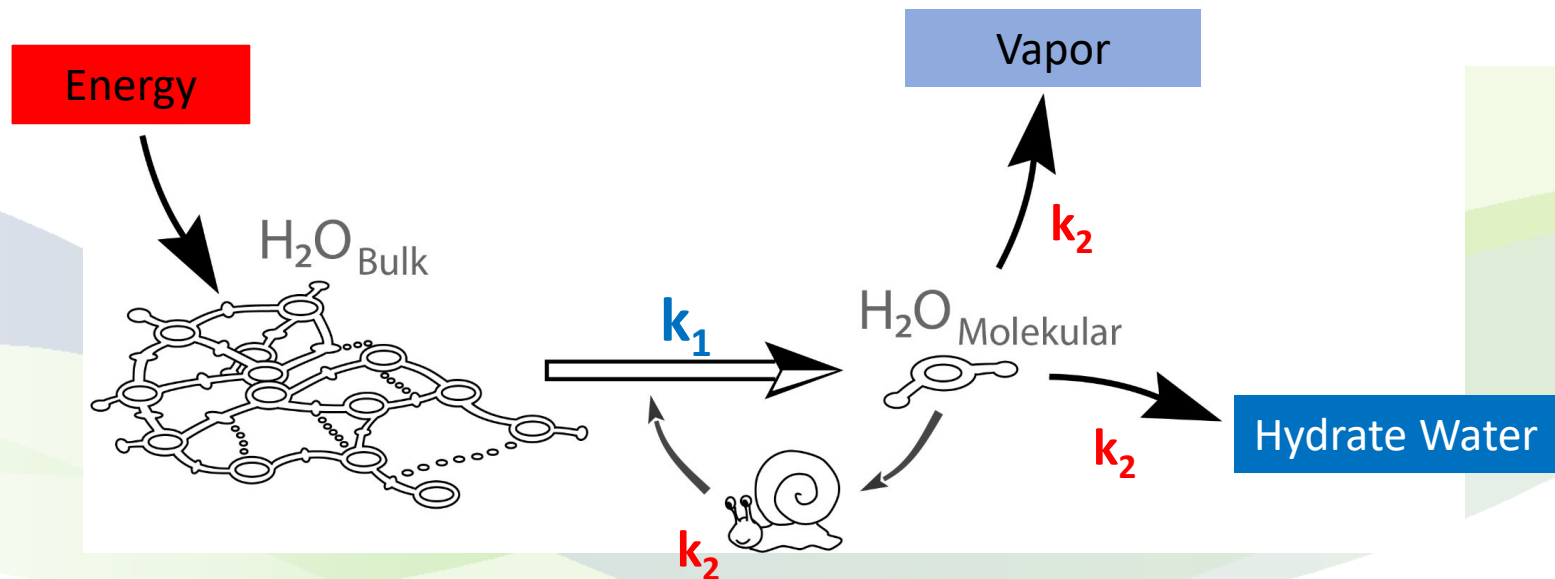
$$\frac{d[H_2O_{molecular}]}{dt} = 0 = k_1 \cdot [H_3O^+] \cdot [HO^-] - k_2 \cdot [H_2O_{molecular}]$$



By substitution of $[H_3O^+]$ by $[H^+] \times [H_2O_{\text{molecular}}]$ it results to:

$$K_D = [H^+] \cdot [HO^-] = \frac{k_2}{k_1}$$

$K_D @ 20^\circ\text{C} \sim 0.000\ 000\ 000\ 000\ 01\ \text{mol}^2/\text{l}^2 = k_2/k_1 \rightarrow k_1 = 100\ 000\ 000\ 000\ 000 \times k_2$



Water ...the maritime importance of water structures



Every water use

→ temporary structural disturbance

*The more energy supplied to the water,
the more pronounced the temporary structural disturbances.*



maritime water use – critical point:

Energy input
by pump systems



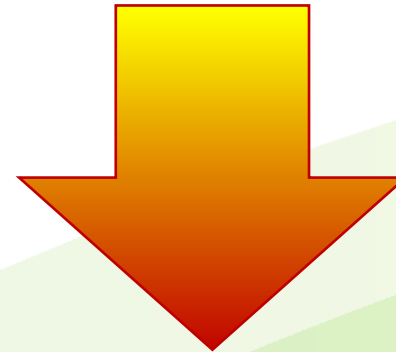
Osmotic
pressure

Water ...the maritime importance of water structures



Mr. Vaughan DERITEND, UK

Energy input
by pump systems $>$ Osmotic
pressure
 \rightarrow **huger vapor bubbles formed**



scaling / fouling / cavitation / corrosion

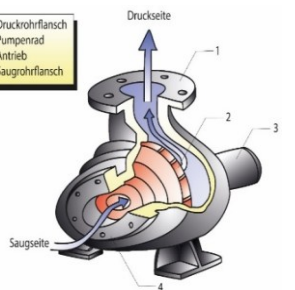
How can industrial vapor bubble growth influenced?



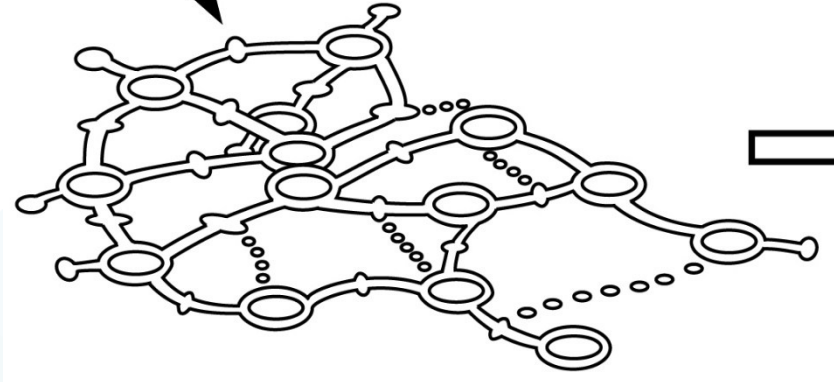
Water ...the maritime importance of water structures

Effect of pumps on water

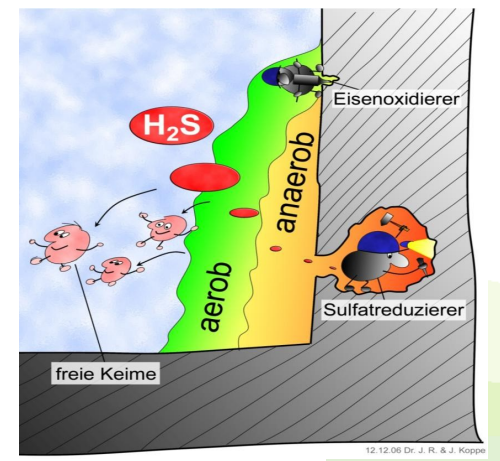
Evaporation = Cooling



H_2O Bulk



H_2O Molekular



Missing hydrate water = Scaling & Fouling



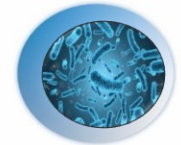



Water ...the maritime importance of water structures

- ✓ **Healthy water**
- ✓ **Cleaning effect**
- ✓ **Optimal heat transfer**
→ **Economic benefits**

- ✓ **Legionella**
- ✓ **Cavitation**
- **Materials damage**
+ troubles with QHSE



Bläschengröße	Schaubild	Erläuterung
sehr kleine Bläschen Ø ~ 0,15nm		kleiner als Bakterien Ø ~ 1µm
kleine Bläschen (nicht sichtbar) Ø < 500 nm		
mittlere Bläschen (stabil) Ø ca. 500nm - 100µm		Ø Lungenbläschen 50µm - 250µm Ø Amöbe 100µm - 800µm
große Bläschen (unstabil) Ø > 100µm - 150µm		Kavitation

small



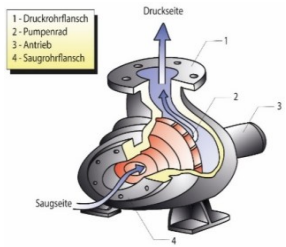
gas bubbles



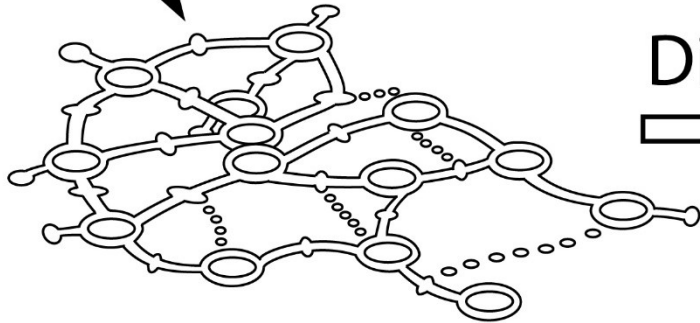
big

20.11.2018_MOL Katalysatortechnik GmbH

Water & Catalysis ...the formular for small vapor bubbles



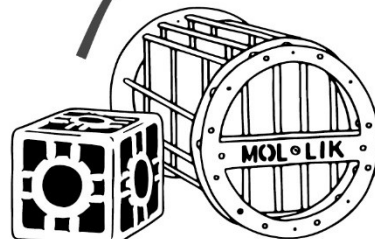
H_2O Bulk



Dissoziation



H_2O Molekular



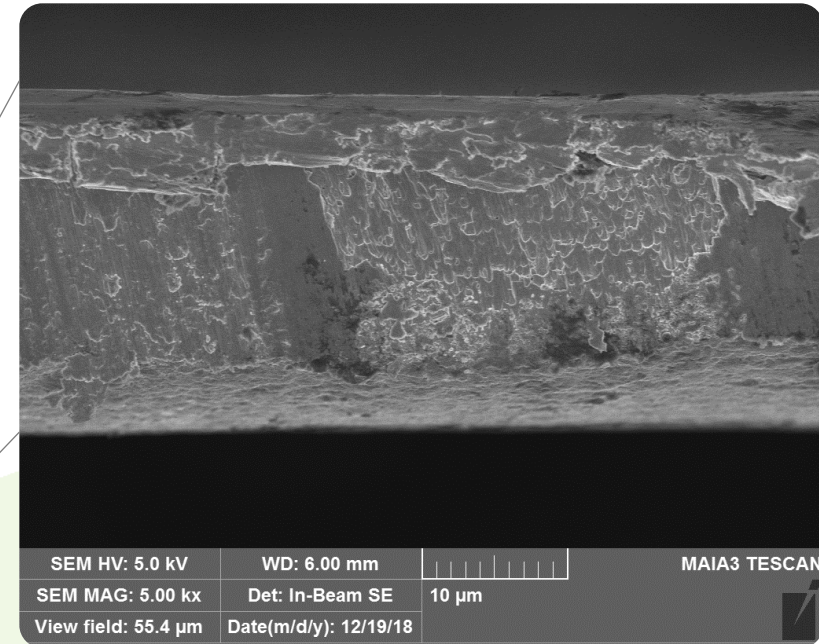
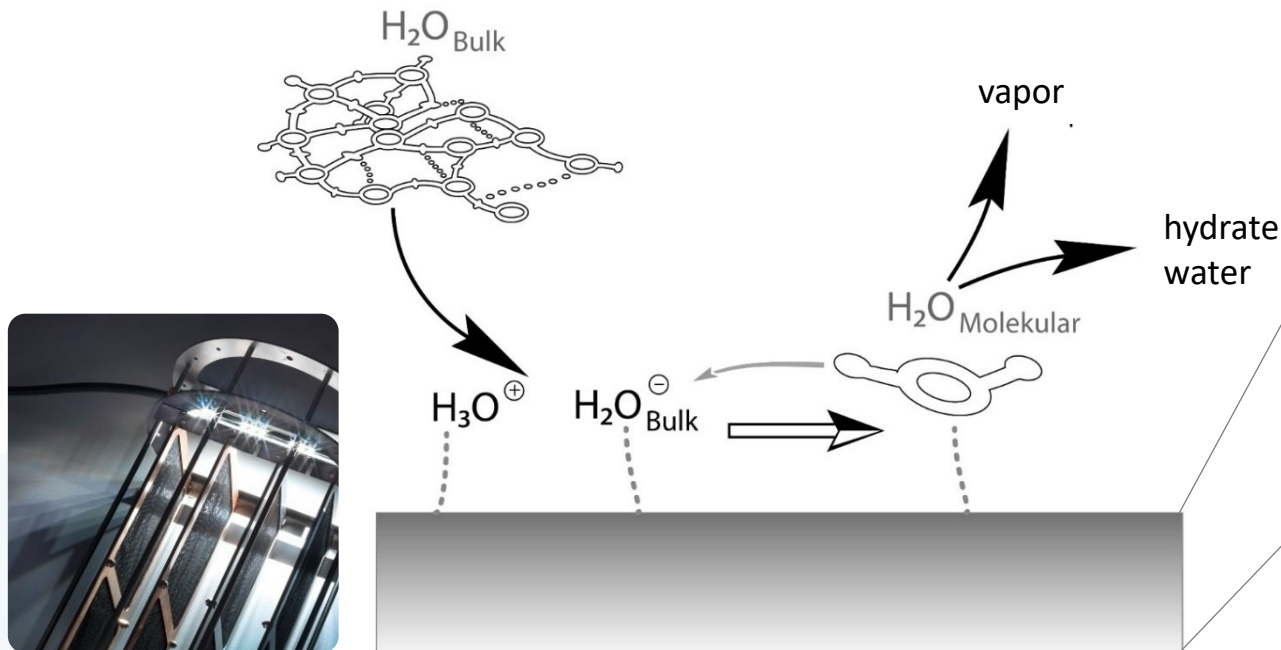
Activation of molecular water
(through adsorption on catalysts surface)

Foming of small gas bubbles

Reducing scaling

Water & Catalysis ...the formular for small vapor bubbles

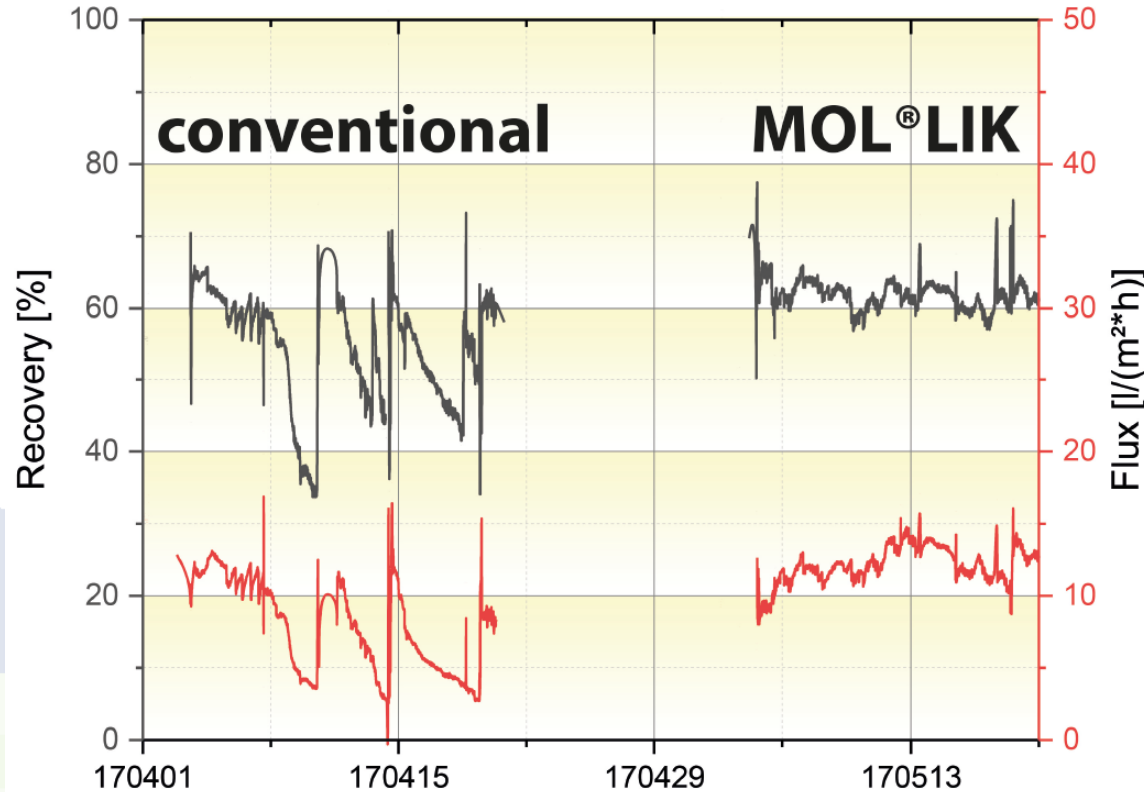
The most suitable catalyst is a mineral metal compound



With thanks to Professor Dr. Su Benshueng
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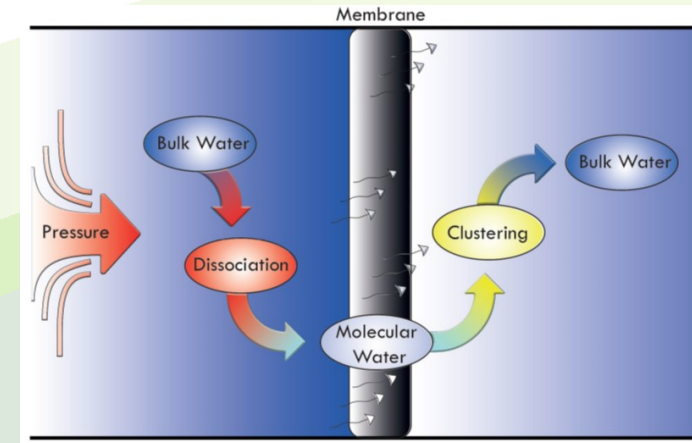
Water & catalysis – how does it work?

Water & Catalysis ...value added on membranes systems (RO)

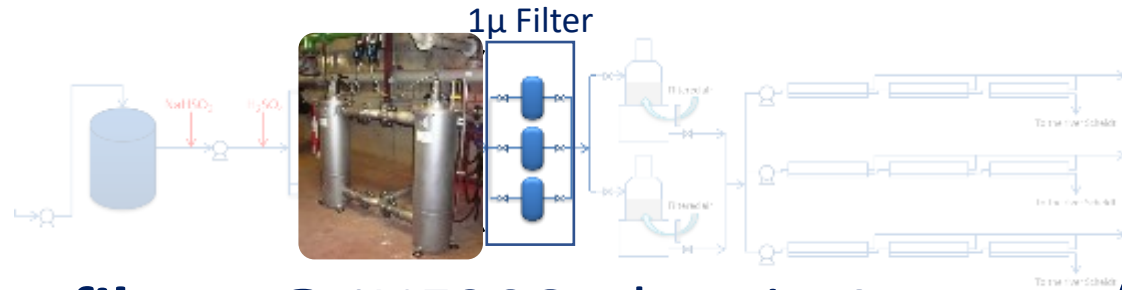


Based on: Reyniers, S.; Depuydt, V.: Chemicalienvrije Afvalwater Recuperatie in de VoEdingsindustrie – CARVE Projekt Meeting - Tussentijdse meeting; 23.06.2017; https://www.vlakwa.be/fileadmin/media/pdf/presentatie_Pantarein_hergebruik_bij_voedingsbedrijven_.pdf

- ✓ Improved recovery
- ✓ Stable flux
- ✓ Reduced CIP



Water & Catalysis ...value added on filter systems



RO-Prefilters @ INESCO plant in Antwerp/Belgium

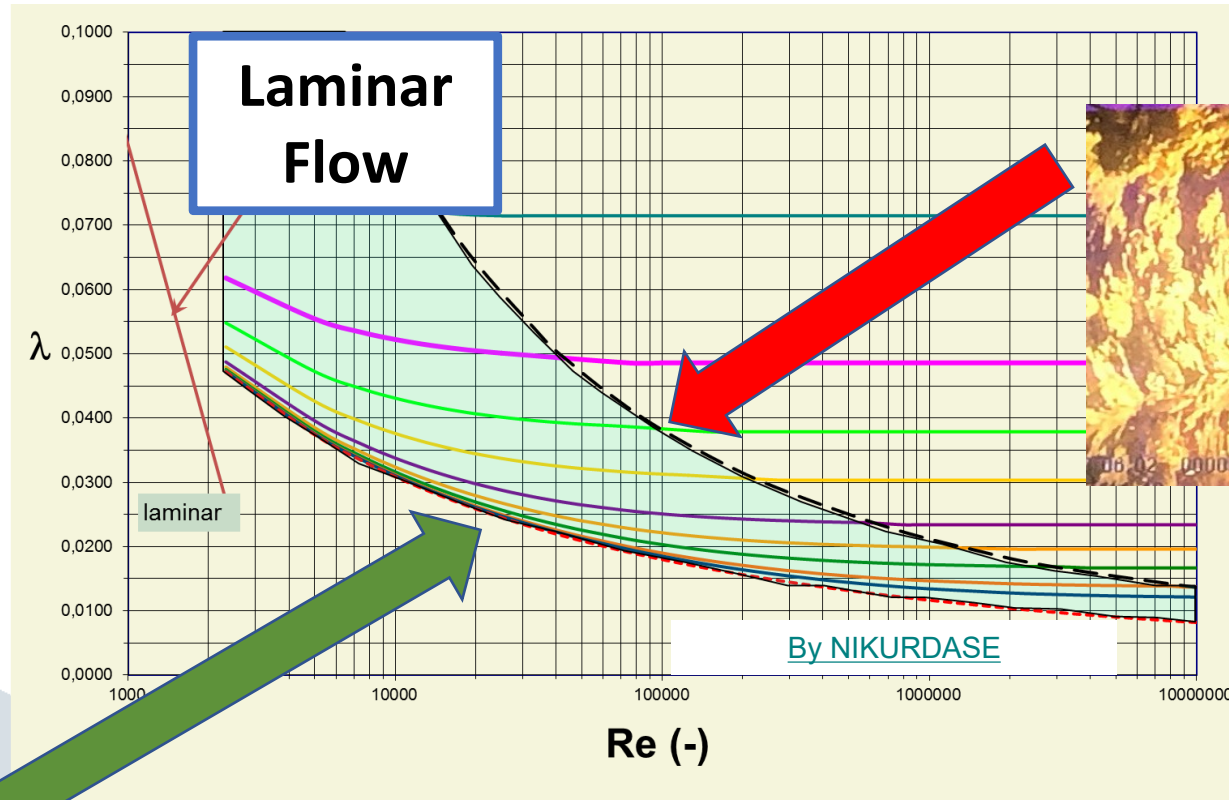
WTU Inesco

	Conventional	MOL [®] LIK
Average Flow Rate	40 m ³ /h till 90 m ³ /h	65 m ³ /h till 100 m ³ /h
Average difference pressure	0.1 till 0.3 bar	0.05 till 0.1 bar
CIP-Intervall	2 till 3 days	30 days

- ✓ **Enhanced Resource Utilization**
- ✓ **Consistent & Reliable Performance**
- ✓ **Simplified Maintenance & Prolonged System Life**

Koppe, J1: Limitations in Water Supply -
 Strategies for Solving a Global Issue
 3rd International MerWaterDays
 III/2018 -, Merseburg/Germany

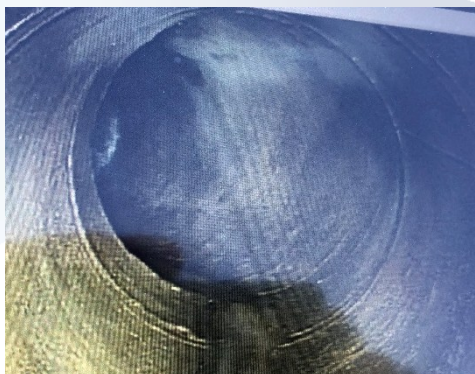
Water in maritime Sector ...the importance of pipe friction



rough surface

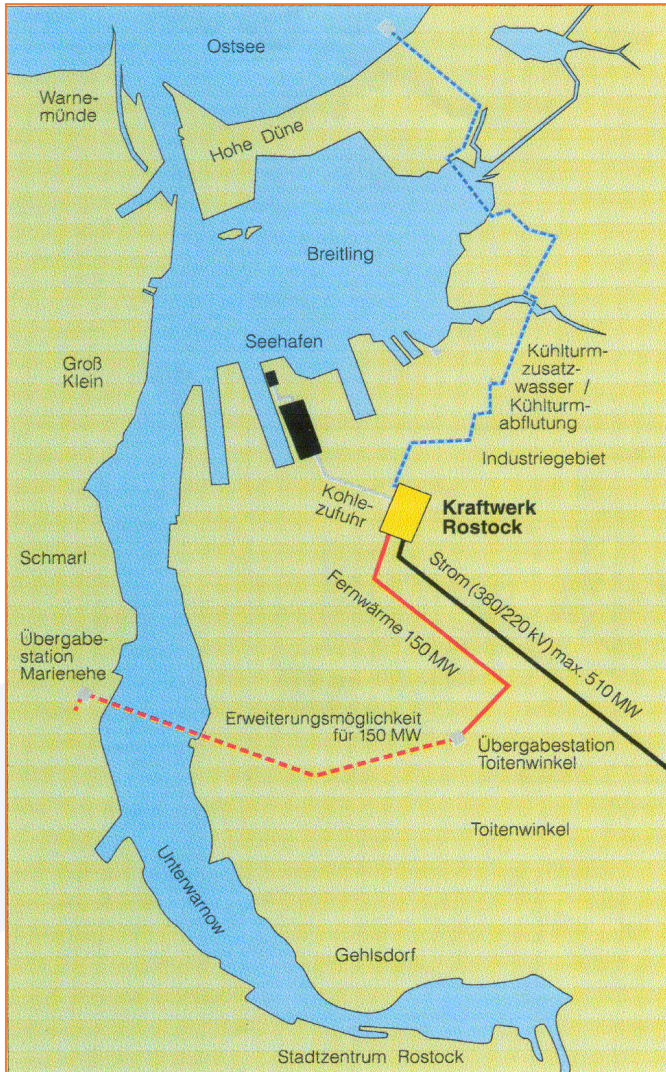
$$1/\sqrt{\lambda} = 2 \cdot \lg_{10} (D/k_B) + 1,14$$

k_B ... thickness of deposit



hydraulic smooth: $\lambda = 0,3164/Re^{0,25}$

Water in maritime Sector ...the importance of pipe friction



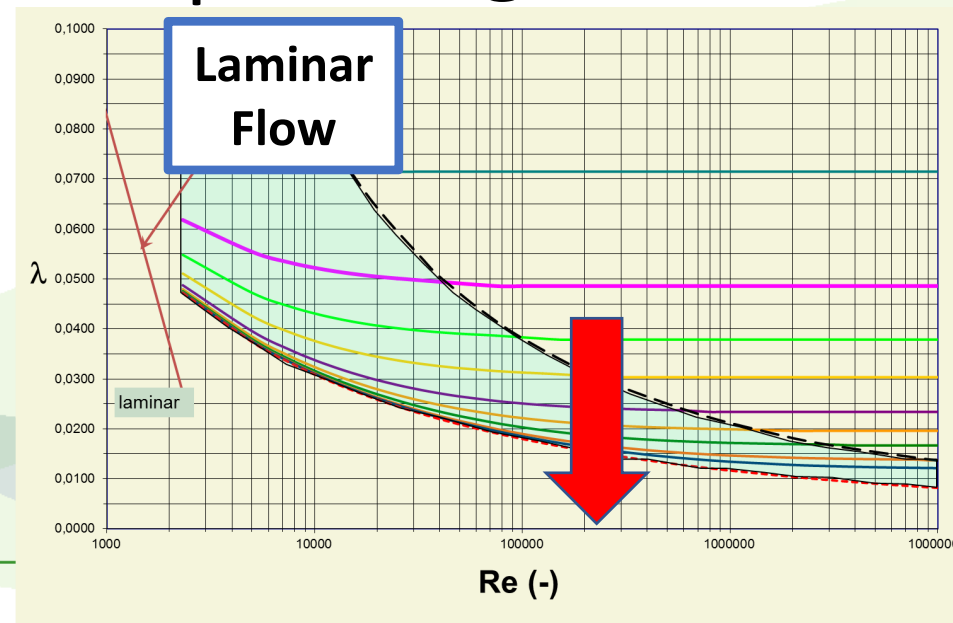
Make-up water quality:
Flow rate:

Baltic sea
1,000 – 1,500 m³/h

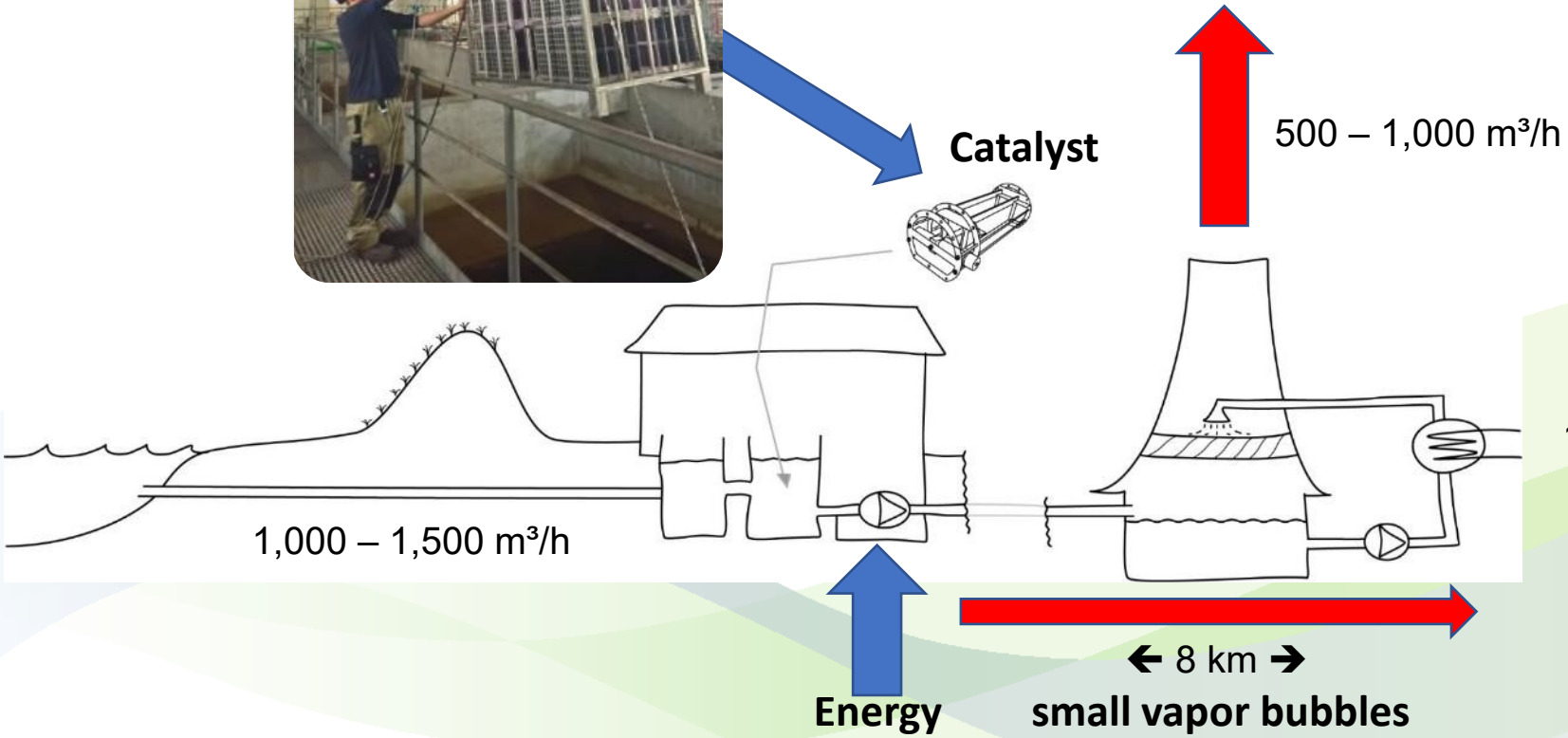
Diameter of piping system:
Linear flow rate:
Re number:

1.5 m
0.16 m/s
235,000

Pipe friction @ KNG Rostock



Water & Catalysis ...value added on heat exchange (HX)



~ 50,000 m³/h
V: 25,000 m³

Water & Catalysis ...value added on heat exchange (HX)



(1) Reliable Compliance & Safety:

None Authority stress

Maximum Technical security

(2) Economic & Eco-friendly Efficiency:

Cost cutting

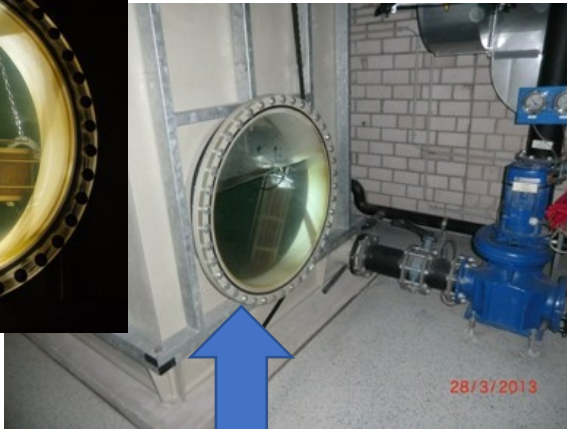
Biocide-free solutions

(3) Innovative Utilization:

Harnessing cooling water as a valuable heat source

Water & Catalysis ...value added on filter units

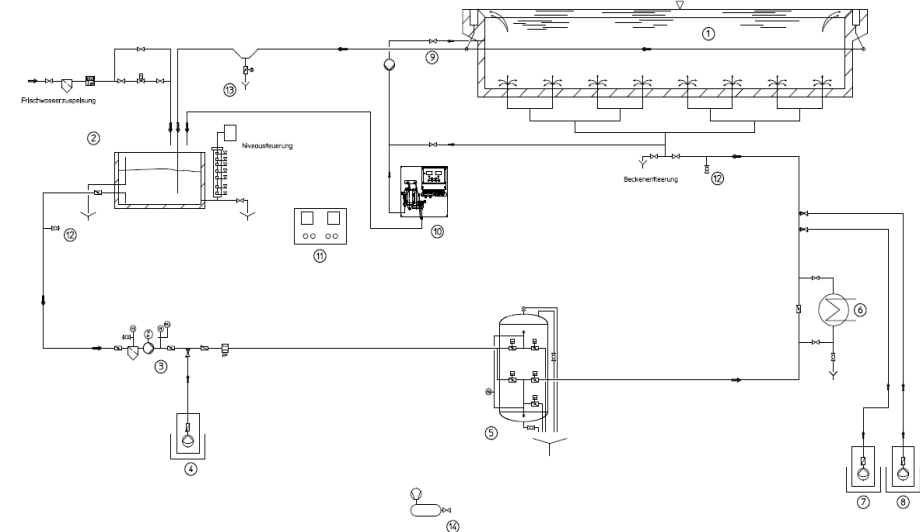
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$V = 4 \text{ m}^3$
 $Q = 79 \text{ m}^3/\text{h}$
 $T = 37 \text{ }^\circ\text{C}$



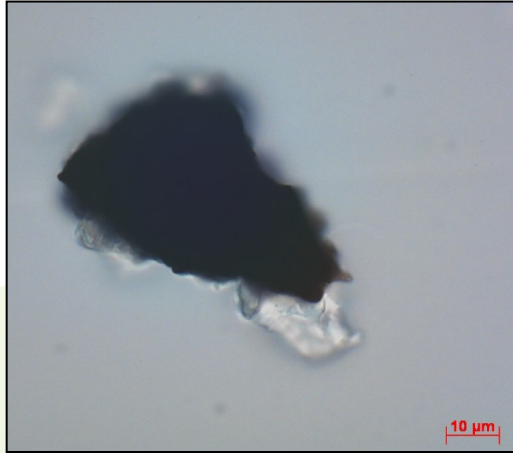
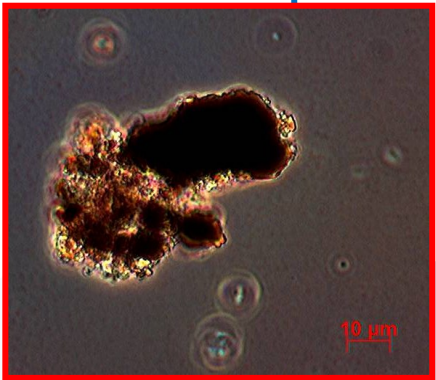
4 W / 12 V / 5 kg



Water & Catalysis ...value added on filter units

- Urea 0.6 mg/l → less than 0.1 mg/l
- Chloramines (combined chlorine 0.15 mg/l → 0.1 mg/l)
- Free chlorine 1.0 mg/l → 0.9 mg/l
- Redoxpotential 800 mV → 830 mV

Life time of filter unit: 2 month → more than 3 years
Water quality continuously within the guidelines



Water & Catalysis ...value added on filter units



Catalytic improved fun splash:

- Pure water
- Free of unpleasant odor
- None skin irritation
- Water quality continuously within the guideline



Water & Catalysis

...the formular of success on common projects

Application		MOLKAT Effect
	Cooling (HX)	<ul style="list-style-type: none">✓ Optimized Thermal Performance✓ Streamlined Maintenance✓ Regulatory Peace of Mind
	Membranes (RO)	<ul style="list-style-type: none">✓ Enhanced System Efficiency✓ Extended Maintenance Intervals✓ Eco-friendly & Safer Operations

Water & Catalysis ...the formular of success on common projects

(1) Precision & Expertise:

Proper installation
(with reaction vessel & treatment basin)

(2) Measurable & Targeted Performance:

Suitable KPI
(Key Performance Indicator)

(3) Sustained Operational Excellence:

Optimal cleaning of the catalyst



Health & Well-being ...the importance of optimal humidification


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“Take action and join me in the fight against respiratory infections! Relative humidity of 40-60% in buildings will reduce respiratory infections and save lives.”

Stella H. Zyl, MD



Health & Well-being ...the importance of optimal humidification

Reto U. Schneider: Neue Zürcher Zeitung, 10th April 2020

70 Years Ago: How are viruses transmitted?

Andrewes had already conducted several experiments to answer the question. In the summer of 1950, he sent twelve volunteers into isolation on Eilean nan Ron, an uninhabited island off the north coast of Scotland. Ten weeks later, he brought six students with colds to the island. They sneezed on objects that the healthy volunteers had to touch, stayed in the same room as them, or lived with some of them for three days.

➔ **Nothing happened.** [optimal humidity]

It was only when a farmer with a cold visited the island and spent a few hours at a campfire with four volunteers that three of them became infected.

➔ **The solution follows! – "The Campfire Effect"**



Health & Well-being ...the importance of optimal humidification



Reflecting on 54 Years Ago [G. RITZEL: Kindergarten Study, Basel 1966]:

Reduction in respiratory infections with air humidification was:

For adults: 25%

For children: 50%



Expanding humidification to:

Living spaces,

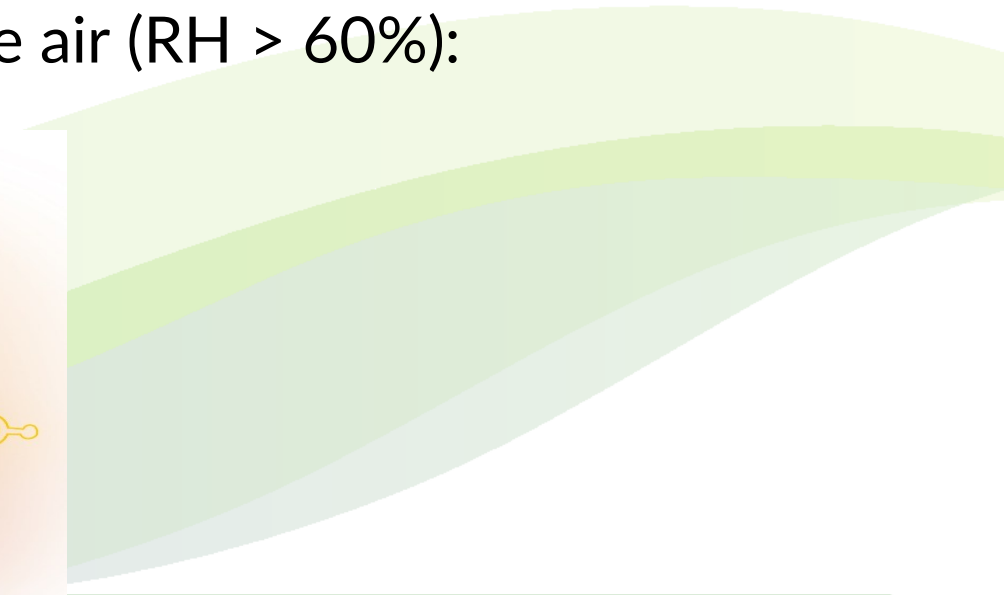
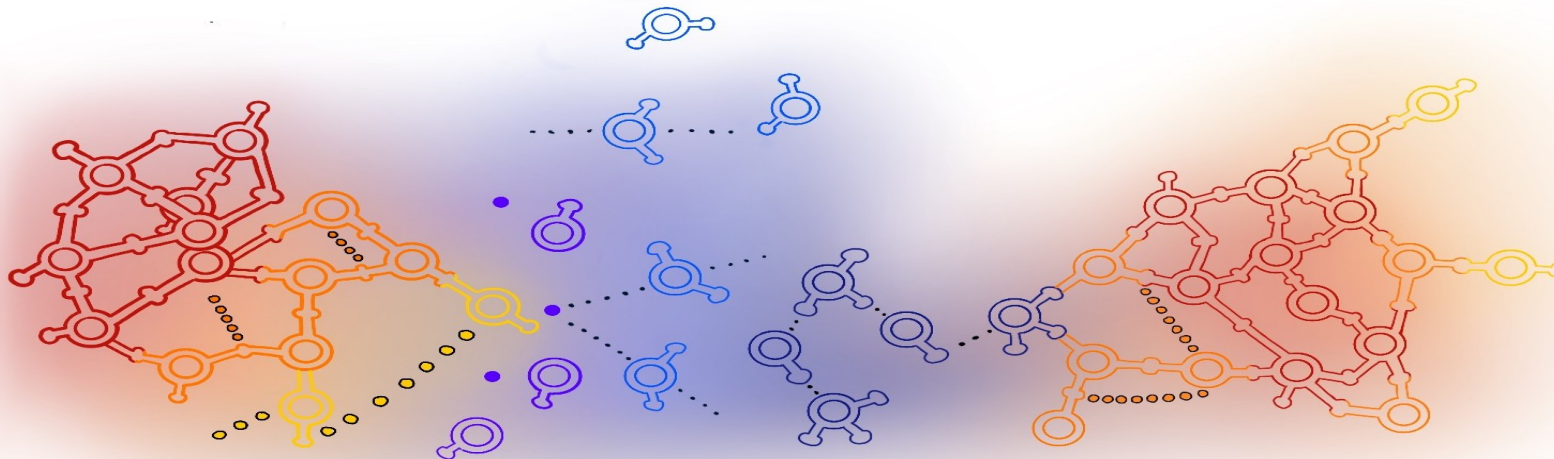
Public buildings,

Transport vehicles,

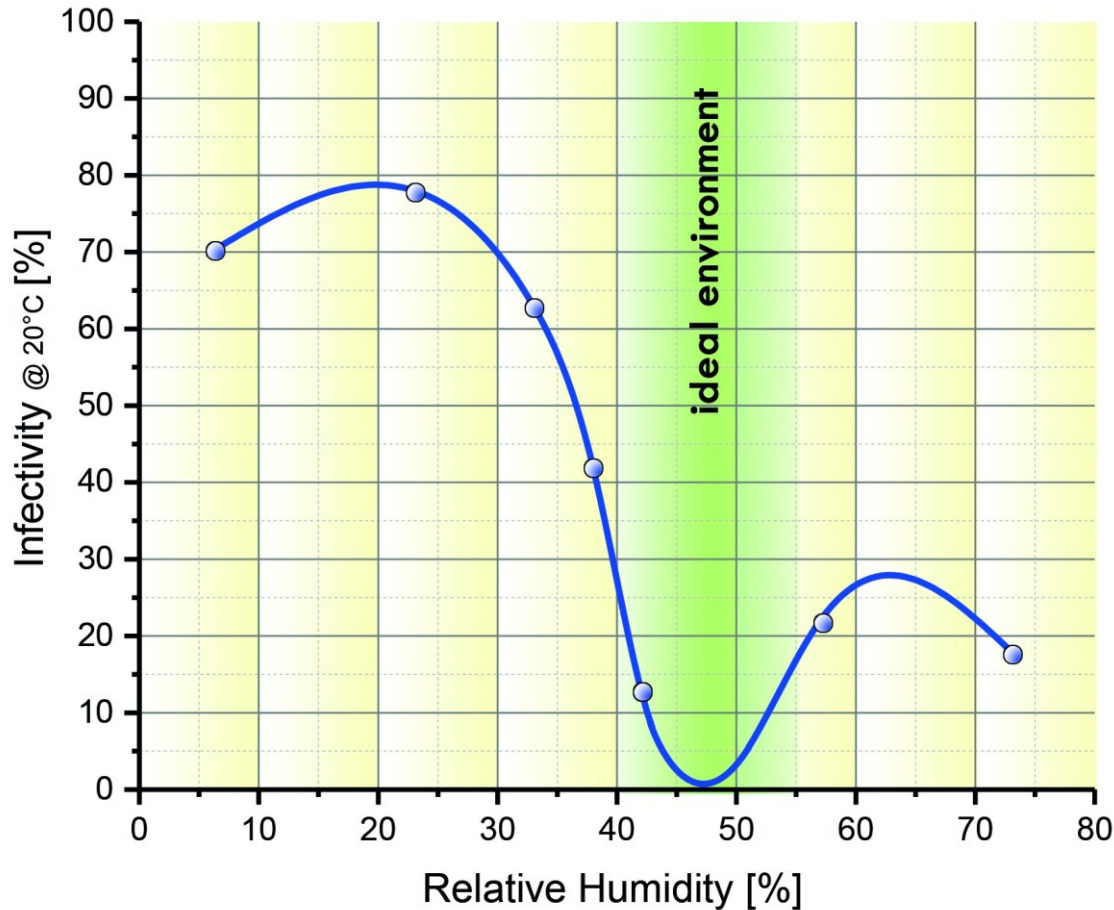
could further amplify the benefits.

What Do We Know Today?

- **Low evaporation water in the air (RH < 40%):**
→ high virus activity – dry skin – wood cracking.
- **Sufficient evaporation water in the air (RH 40 to 60%):**
→ comfort – virus degradation – skin protection.
- **Too much evaporation water in the air (RH > 60%):**
→ bacteria – mold – corrosion.



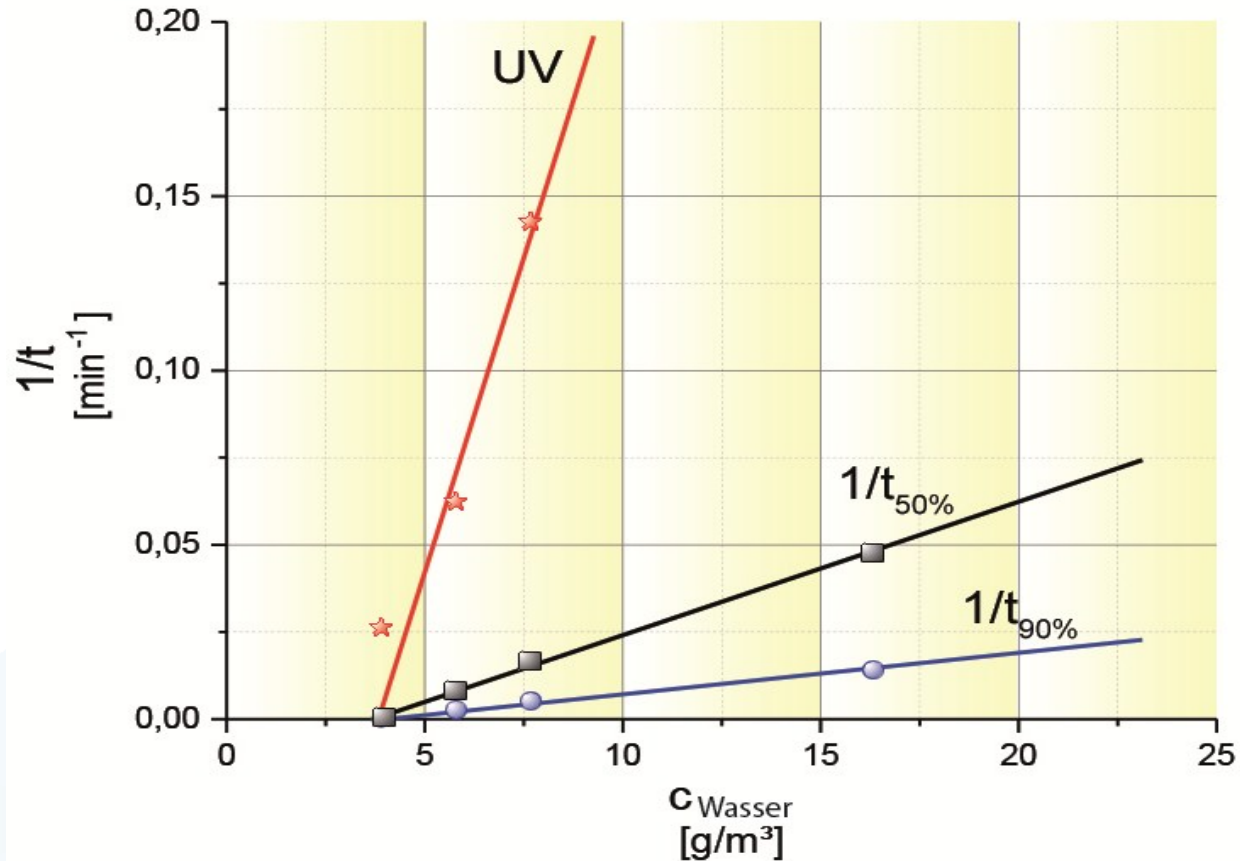
Health & Well-being ...the importance of optimal humidification



Infectivity of viruses depending relative humidity
(based on Noti et. al 2013)

- **Elevated Risk at Lower Humidity:**
Research by Noti et al. indicates that areas with 20% relative humidity (RH) see significantly higher virus infectivity rates.
- **Optimal Humidity for Safety:**
The recommended RH level by BGI/GUV-I 7003 is approximately 45%, where the risk of virus transmission is notably lower.
- **Scientific Rationale:**
The heightened risk at lower humidity is due to the rapid and extensive spread of microdroplets, coupled with viruses surviving longer in drier conditions.

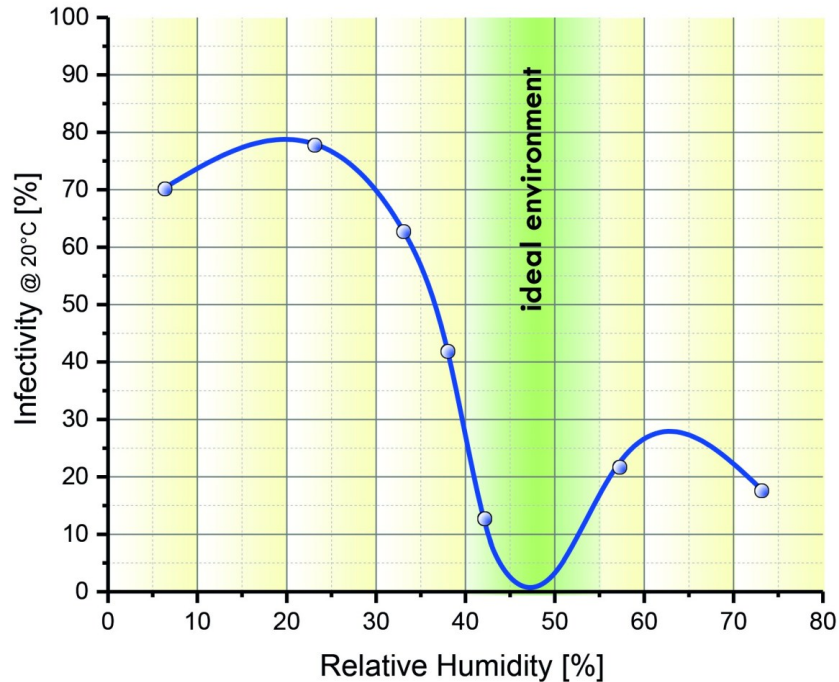
Health & Well-being ...the importance of optimal humidification



Viren-Abbau (50 % - 90 % und in Gegenwart von UV-Strahlung)
[Ausgangspunkt für diese Betrachtungen waren die vom US Department of Homeland Security zum Thema „Infektiosität von SARS-CoV-2 Viren“ publizierten Ergebnisse in der von W. HUGENTOBLE in cci-Zeitung 10/2020 auf S. 10 gewählten Tabellenform]

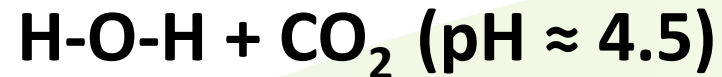
	Temperature [°C]	H2O [g/m ³ Luft]
(Winter) @ 45 % RH	0	4.8
(Summer) @ 45 % RH	20	17.3

Health & Well-being ...the importance of optimal humidification



What Happens at 40...60% Relative Humidity?

The air is adequately "supplied" with molecular water.
Surfaces, including viruses, are covered with molecular water



leads to hydrolysis of viruses (lipid envelope)
through a first-order chemical reaction.

**Note: Dust particles and water droplets
can impair the effectiveness of molecular water.**

Health & Well-being ...the importance of optimal humidification

Plants



Adiabatic Humidification

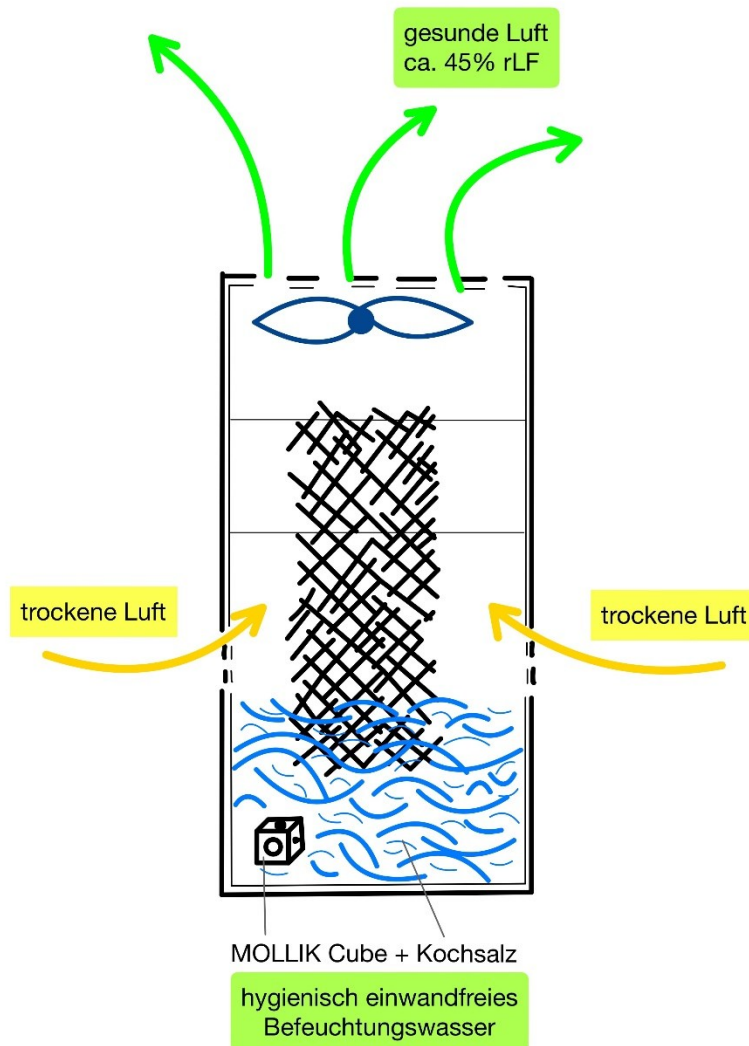


→ ~ 45 % RH

Health & Well-being ...the importance of optimal humidification



40TO60RH.COM
THE HEALTHY HUMIDITY



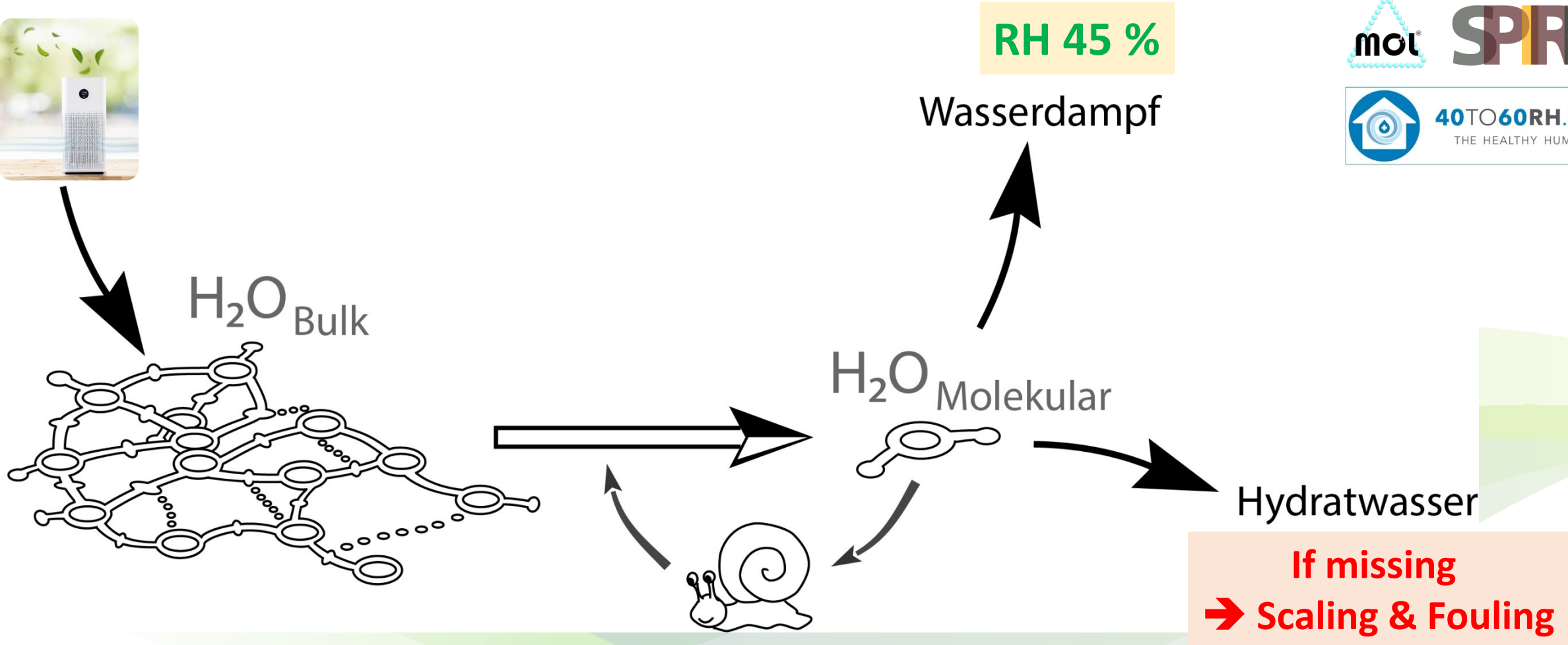
Maintaining Optimal Humidity

- Energy is required during the winter months, similar to a cooling tower's function.
- Humidifiers create an active connection between air and water.

Health & Well-being ...the importance of optimal humidification



40TO60RH.COM
THE HEALTHY HUMIDITY



Health & Well-being ...the importance of optimal humidification

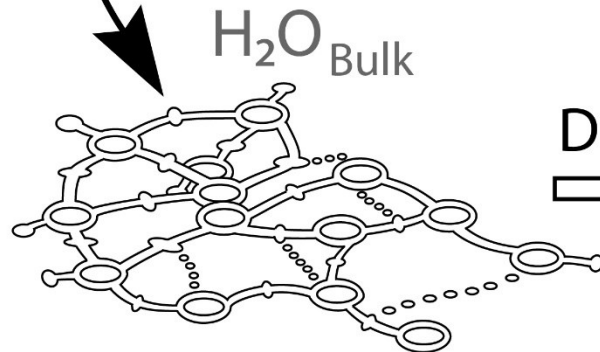


40TO60RH.COM
THE HEALTHY HUMIDITY

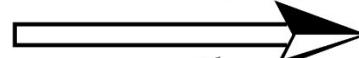
Effects of Catalyst & Salt Addition

Formation of very small water vapor bubbles

Saline Effect



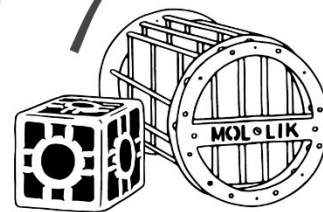
Dissoziation



$H_2O_{Molekular}$



Hydratwasser



Katalysator



Low maintenance operation.

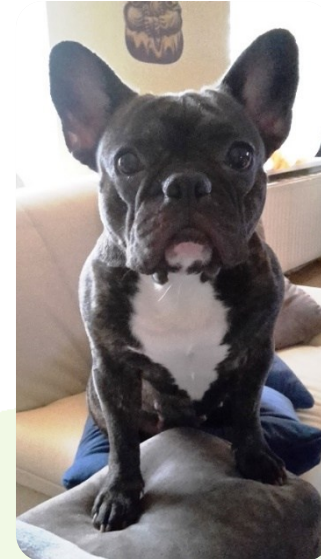
Health & Well-being ...the importance of optimal humidification

The Principle of Air Humidification:

- A causal (predictable) principle in dealing with viruses → Health.
- Important: Avoid "Campfire Effects"! (dry air)

Additional Benefits:

- Reduction of skin and eye irritation → Comfort (also applies to dogs).
- Protection of vocal cords → Occupational safety for teachers and sales staff.
- DGUV 215 – 410 / Section 8.4.4 Indoor Climate.
- Protection of expensive wooden furniture and parquet from drying cracks.



“Take action and join me in the fight against respiratory infections! Relative humidity of 40-60% in buildings will reduce respiratory infections and save lives.”



Stella H. Zyl, M.D.



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THE HEALTHY HUMIDITY

Overcoming Maritime Challenges



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