Welcome to

»Precise and energy efficient aeration control – reduction of carbon footprint and cost saving using load depending process control«

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Outline of the presentation

1. Introduction
2. Precise aeration controller
3. Ammonia–based DO–control
4. Sliding header pressure control
5. Case studies & results
6. Summary

Why consider cost and energy savings in wastewater treatment plants?

- Wastewater treatment plant = largest energy consumer
  - About 20% of the total energy consumption of a municipality is the wastewater treatment plant
- Electricity prices rising steadily and CO_2 limits are defined
  - Penalties are imposed
  - Governmental subsidies are only granted if the implemented measures relate to energy savings and environment
- $^2/_3$ of plant´s total power consumption is related to aeration process

→ **Greatest potential in energy and CO_2 footprint reduction is in this area!**

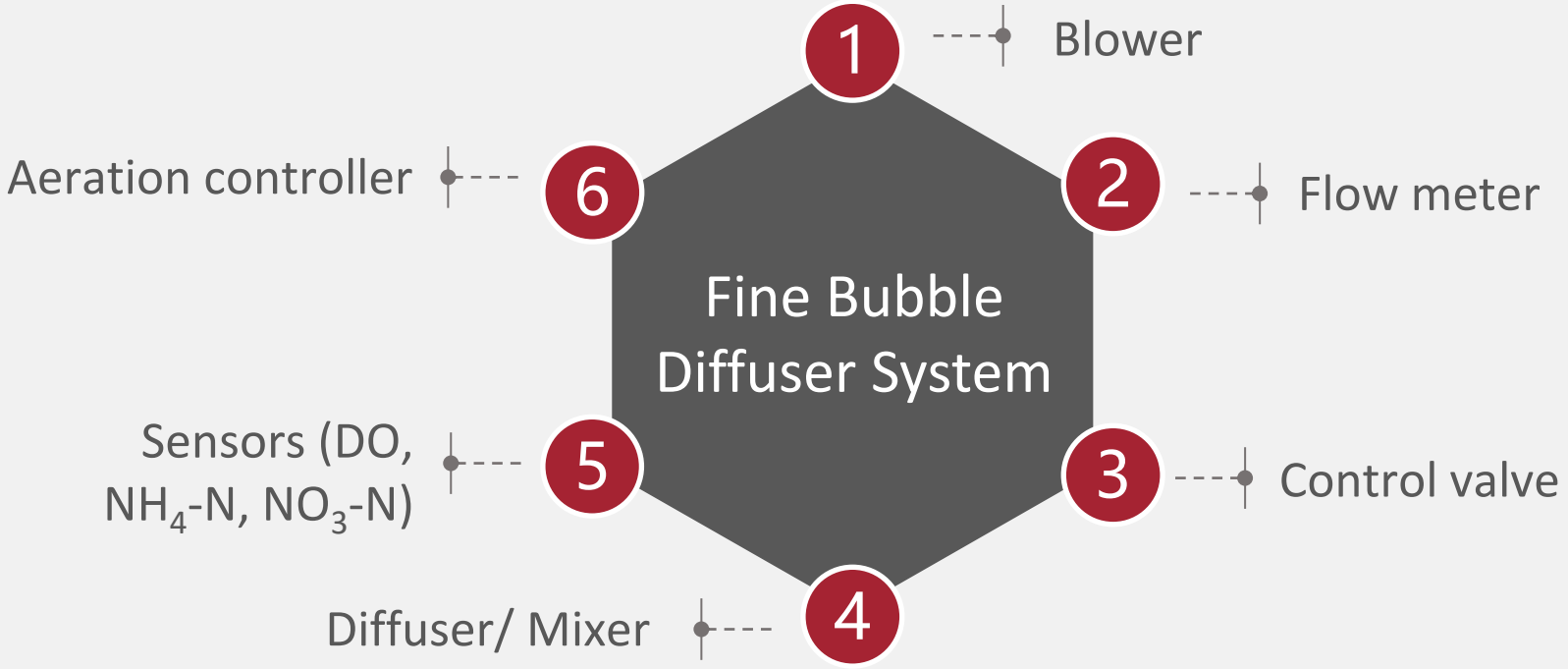
How to optimize the aeration control in wastewater treatment plants?

Energy and CO_2-footprint reduction can be achieved easily with:

- Precise and advanced aeration control
- Load depending process functions
  - Ammonia-based control of DO-concentration
  - Sliding header pressure control
  - …

Suitable equipment is essential for the aeration control system!!

Components of the aeration system



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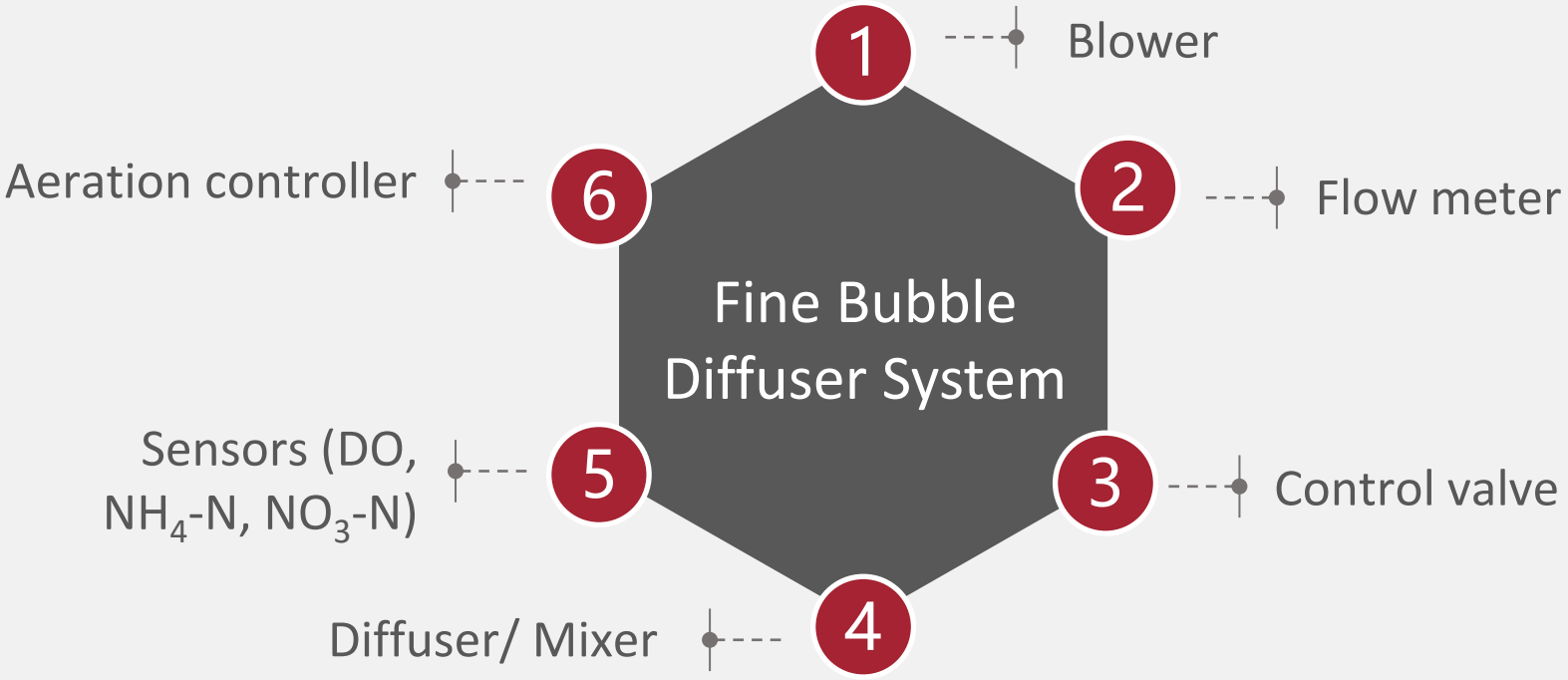


„A chain is only as strong as the weakest link“

Basis for an energy efficient aeration control system:

Precise aeration controller:

- Ensure of process stability and safety
- Compliance with limit parameters to protect the plant equipment
- Failsafe strategies
- Consider all external disturbance variables

Energy efficiency

DO-ACT = DO-SET +/- 0.3 mg/l

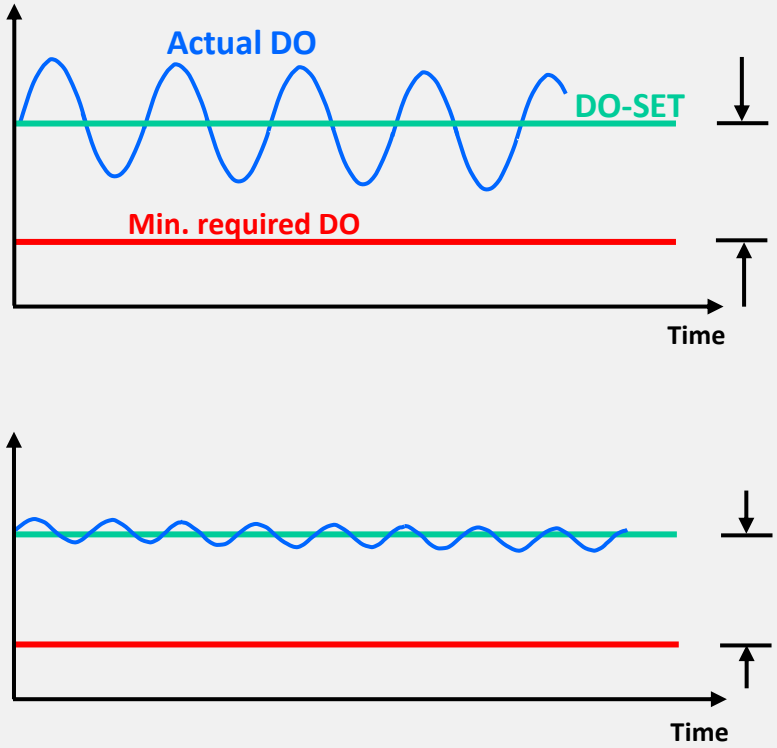
Load-depending control of DO-SET and header pressure

Why is a standard PID controller overwhelmed by the aeration control?

- A standard PID-controller with fixed terms for P, I and D can give static results only
- A wastewater treatment plant is a dynamic system due to permanent load changes and exceptional disturbances (heavy rain fall, blower stop, …)
- Advanced aeration control requires a **dynamic control algorithm with AI** to eliminate variable process disturbances

→ **PIID – controller with AI and damping factors for the disturbing values**

Savings by an intelligent and accurate aeration controller



Improved control accuracy –
standard deviation gets improved
from 30% to 50% **without** process risk

Load depending method: Ammonia–based DO–control

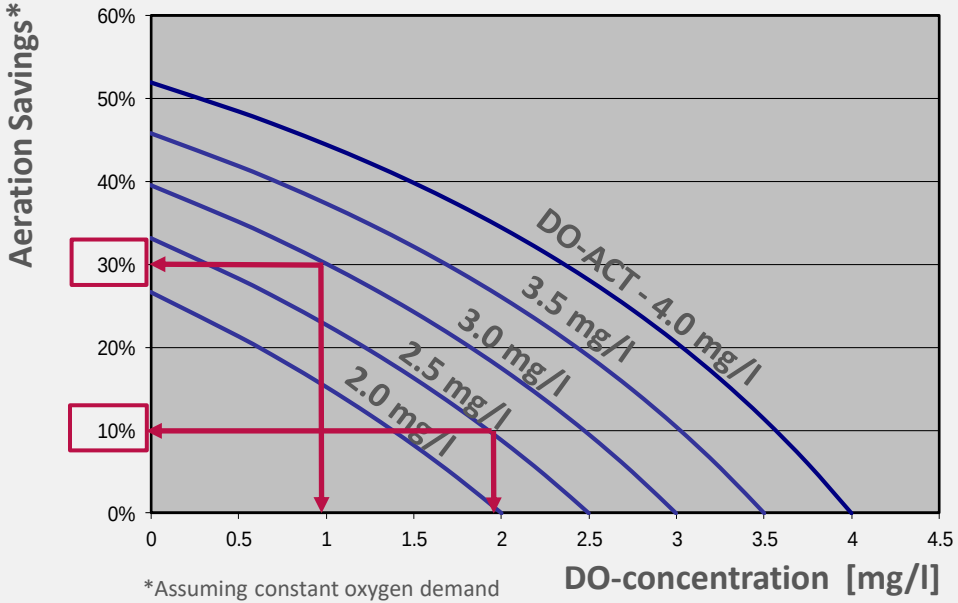
→ GOAL of this method: **Maintain lowest possible DO without process risk**

- To compensate actual load situations
  - Day and night, weekly and seasonal changes, rainfall, …

→ **Aeration controller without load-dependent algorithms must compensate load changes with a high static oxygen setpoint**

- Load changes can be easily monitored by the actual ammonia load
  - Load ↑ → NH_4-N ↑ → DO-SET ↑
  - Load ↓ → NH_4-N ↓ → DO-SET ↓

Potential savings by an Ammonia–based DO–control



*Assuming constant oxygen demand

<u>Warning for permanent low DO-SET:</u>
filamentous bacteria
(especially at low water temperature)

<u>Possible counteraction:</u>
adjust DO-SET based on
water temperature

Figures from the field: up to <u>30%</u> of savings

Direct <u>energy</u> and <u>cost</u> savings as well as <u>reduction</u> of CO_2 – footprint

Disadvantages of constant header pressure control

- Waste of energy, unnecessary costs and increased CO_2 footprint

  Why?

- Header pressure must be set on a constant high level
  - Maximum expected load situation with reserve
- Most of the time the actual load is below the maxium load

→ **Excess pressure → unnecessary additional energy consumption**

→ **<u>Solution:</u> Sliding header pressure control**

Sliding header pressure control

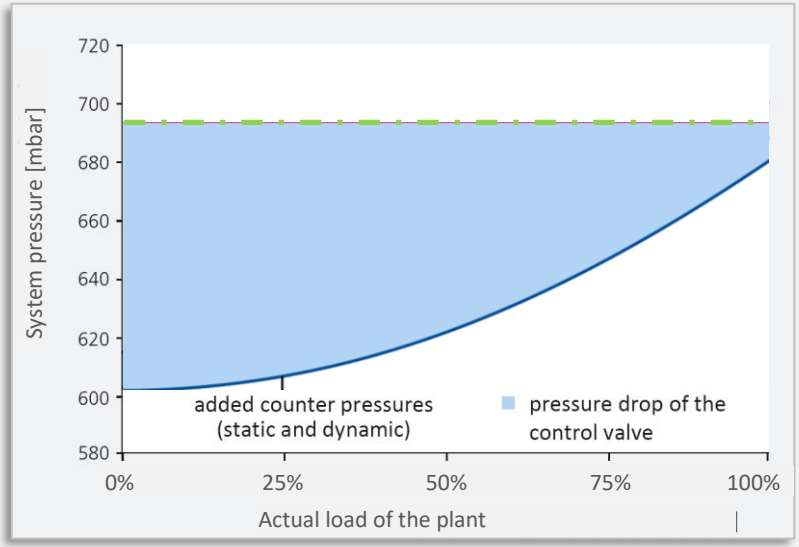
- Header pressure is automatically adjusted to current load situation
- Pressure adjustments usually performed based on the „most open valve“ (MOV)

→ **Improved performance: “Most important valve” (MIV) - strategy**

- MIV additionally considers the difference between DO-SET and DO-ACT in all tanks/zones to prevent under-aeration
  - The bigger the DO difference, the more the pressure is increased

→ **Higher process safety and reduced header pressure**

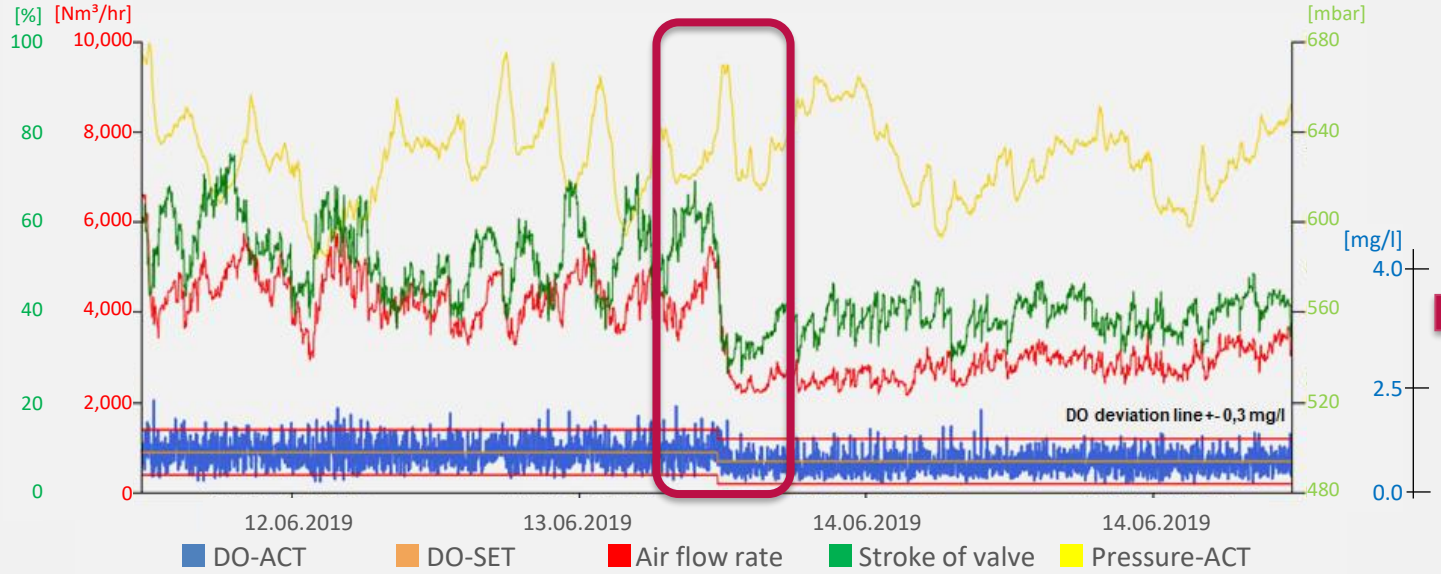
Savings constant vs. sliding header pressure control



Figures from the field: 8 - 10% savings in blower energy

Study No. I: Air flow savings due to reduction of DO

(Ammonia–based DO–control)

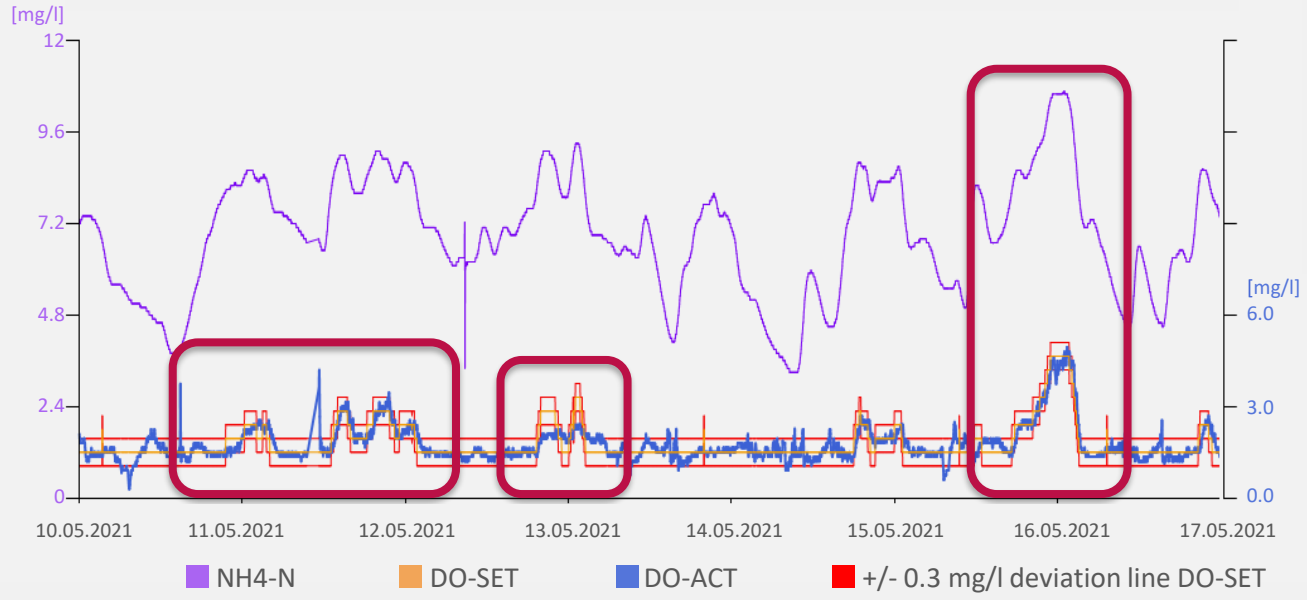


Reducing the DO-SET from 0.9 to 0.7 mg/l

Energy savings: 2.5%

Study No. II: Ammonia-based Aeration Control (ABAC)

Results: quick adaptation of DO-concentration to new requirements due to AI



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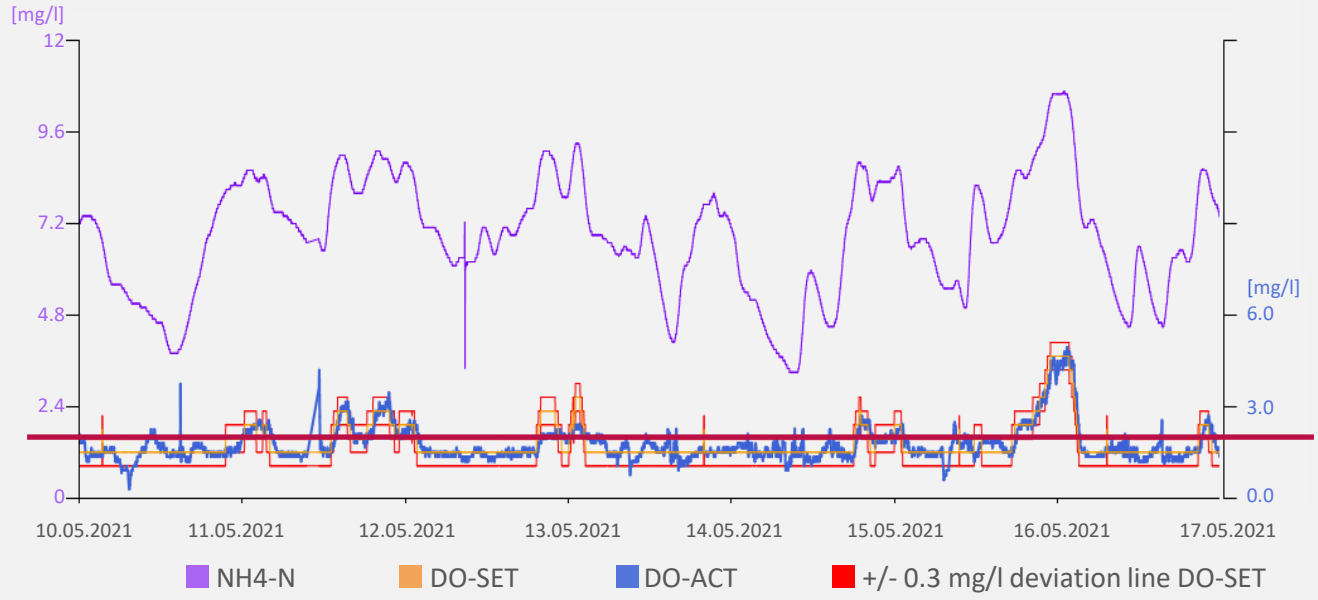
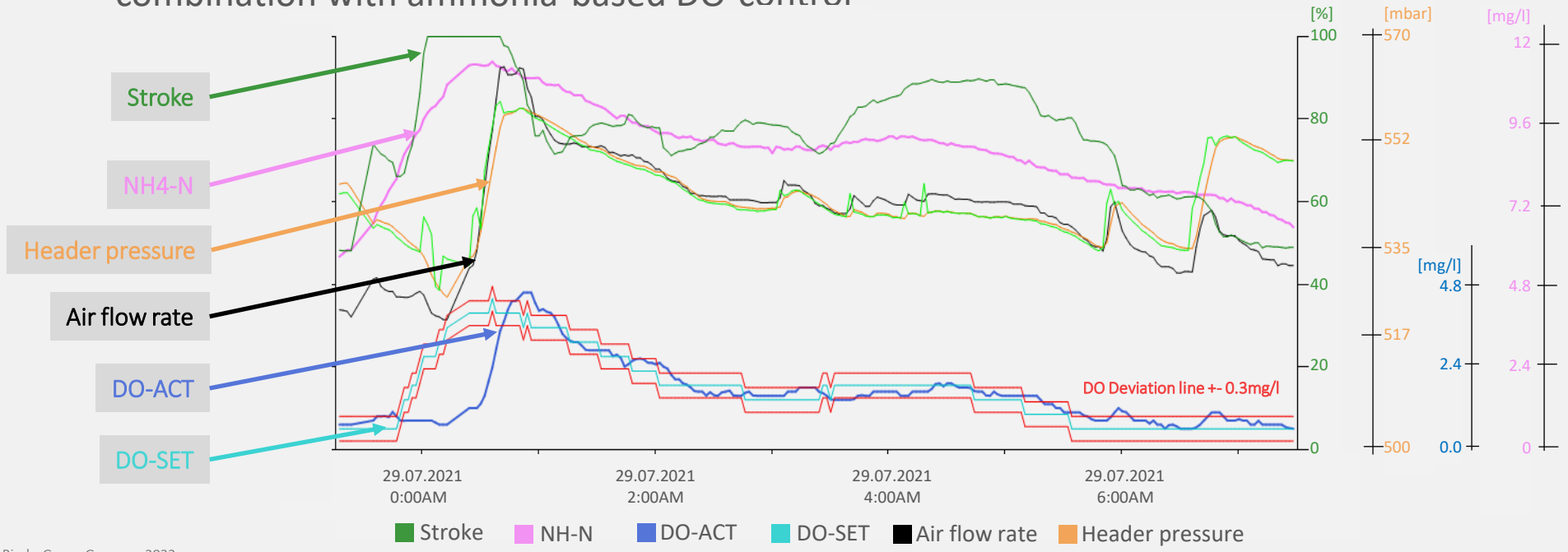


Aeration savings: 30%!

DO–SET: 2.4 mg/l

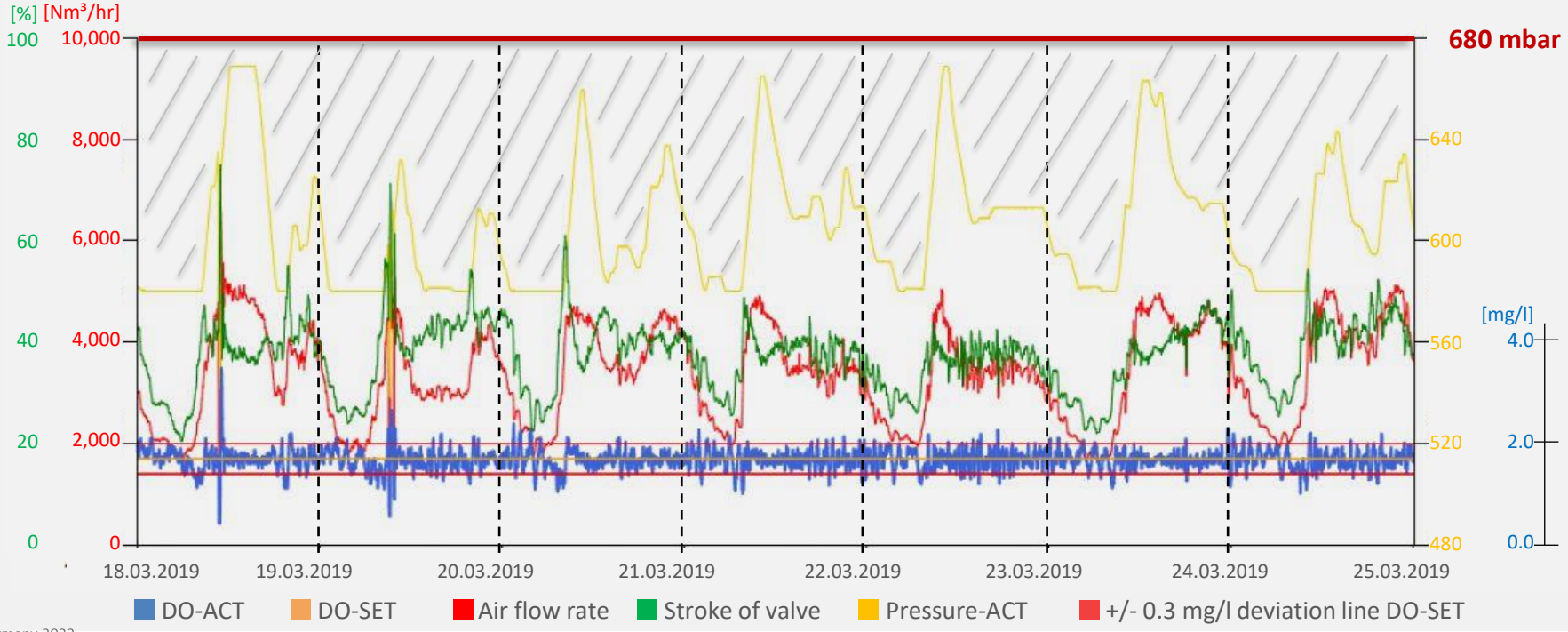
Study No. III: Heavy Rainfall event reaction

Results: Quick elemination of ammonia with sliding header pressure in combination with ammonia-based DO-control

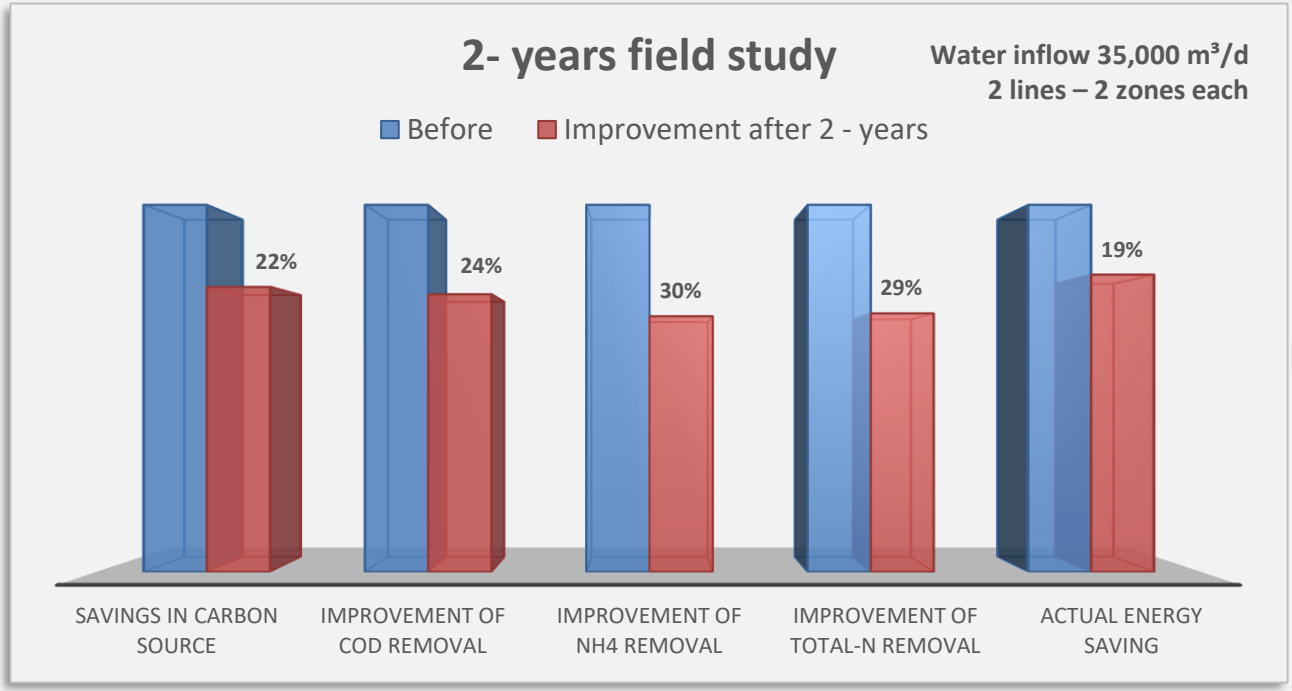


Study No. IV: Savings due to flexible header pressure

Results: 9.2% energy savings, header pressure runs between 590 and 670 mbar



Study No. V: Further effects of Ammonia–based DO-control and sliding header pressure control



Results: Reduction of total nitrogen in the effluent with **19%** less energy consumption plus **22%** savings in chemicals

Yearly cost savings (USD):

Chemical savings: **76,430 $**
Electricity savings: **145,965 $**
Cost savings 1 year: **222,395 $**

Cost savings in 20 years:
> 4,400,000 $

Conclusions

- Advanced aeration controller and load-depending control functions
  - Quality of treated water can be improved and concentrations in the effluent equalized
  - Consumption of energy and chemicals can be reduced
  - Operational costs OPEX, carbon footprint and process risk can be reduced
  - Load changes can be identified on base of NH_4-N
- Reduction of total-N (proven in field)
  - Precise aeration control: **15 – 30%**
- Energy savings (proven in field)
  - Precise aeration control: **10 – 30%**
  - Sliding header pressure: **8 – 10%**
  - Ammonia-based DO-SET: **8 – 20%**

Thank you for your attention

We are looking forward to your visit
at our booth B2-G16 in the German Pavillon!