

Modern Waste Water Treatment in Coke Making Plants

- A new way for Water Recycling!



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Motivation for Process Development in Waste Water Treatment

- Environmental aspects
 - Rising requirements for environmental protection
 - Reducing liquid wastes like Cyanide, Thiocyanate, COD, PAH, BTXE etc...
 - Water shortage also in industrial countries
- Economical aspects
 - Investment costs
 - Utility costs
- Customer
 - Individual demands

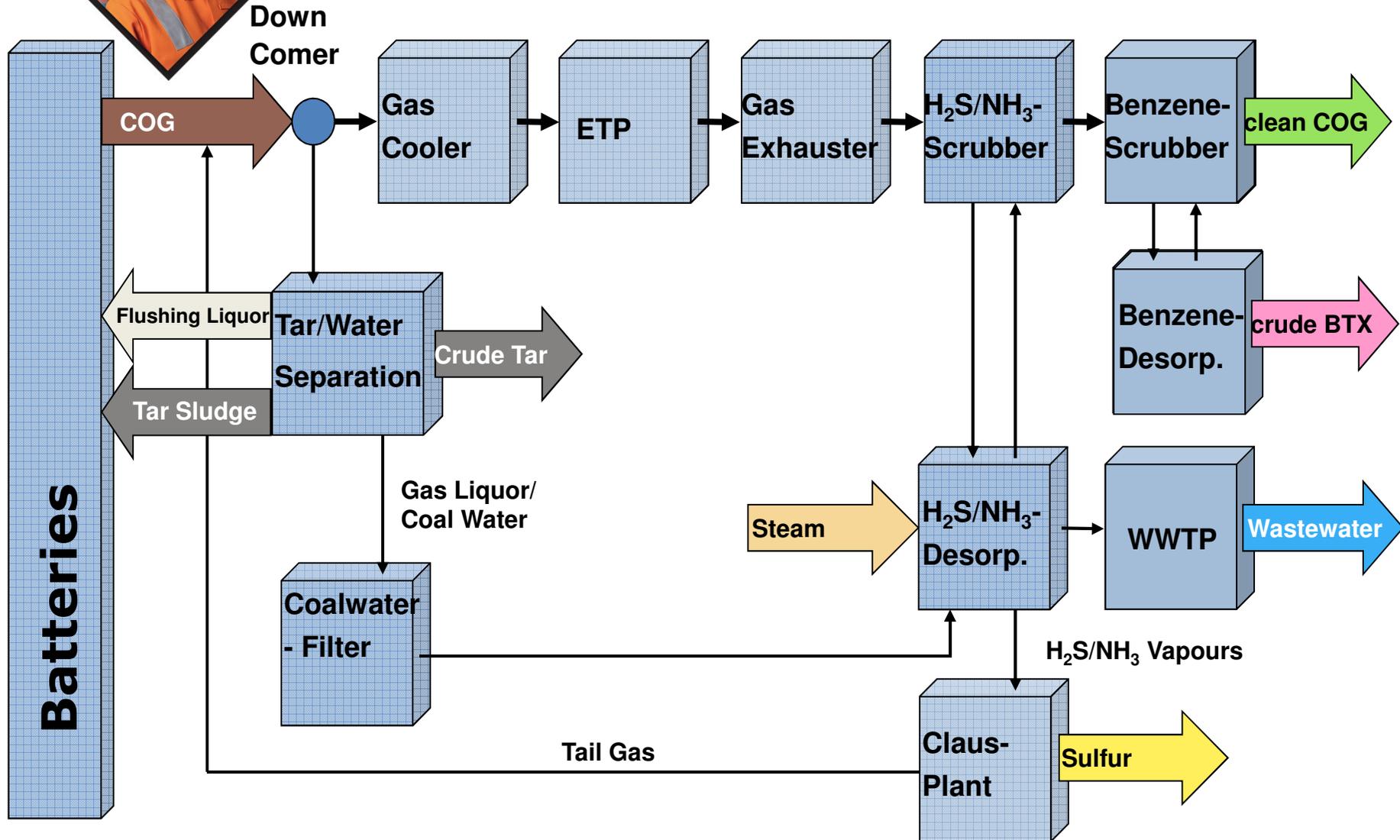
COD = chemical oxygen demand

PAH = polycyclic aromatic hydrocarbons

BTXE = benzene, toluene, xylene, ethylbenzene

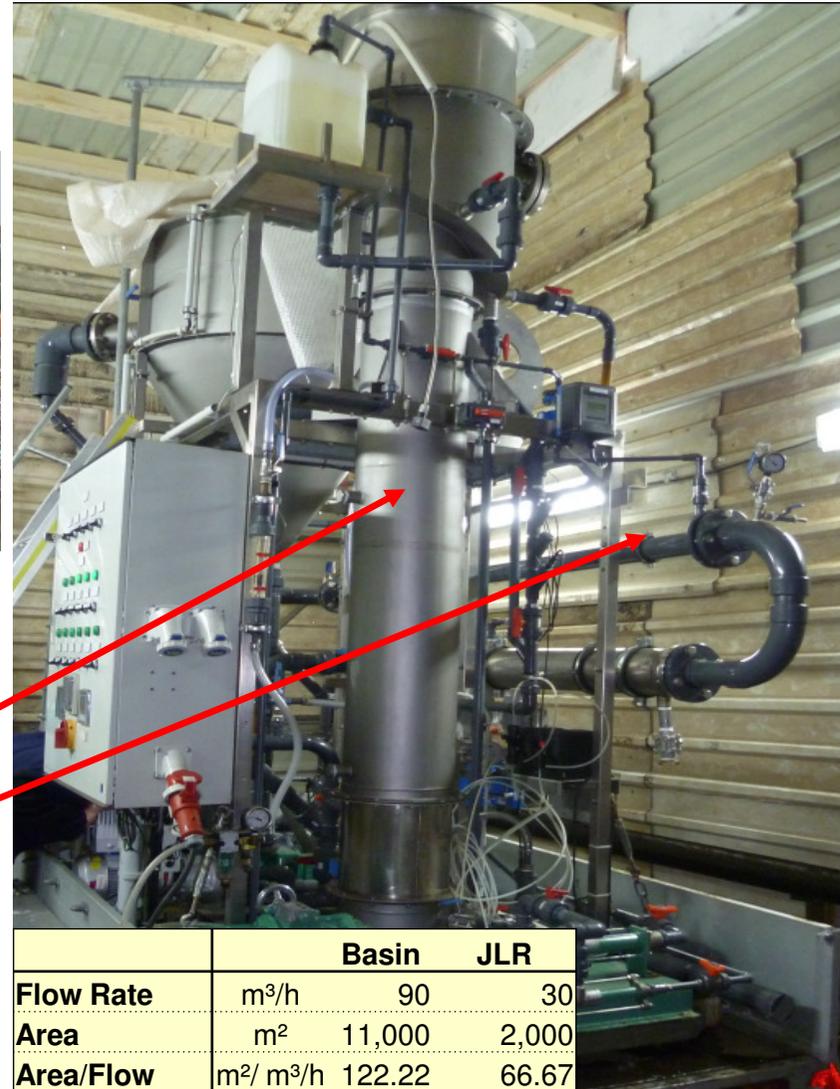


Standard Treatment of Coke Oven Gas





Coke Waste Water Treatment in the past and today



Concrete basin

Jet Loop Reactor
Membrane Filtration

- Concrete basins require much more floor space

		Basin	JLR
Flow Rate	m ³ /h	90	30
Area	m ²	11,000	2,000
Area/Flow	m ² / m ³ /h	122.22	66.67



Jet Loop Reactor





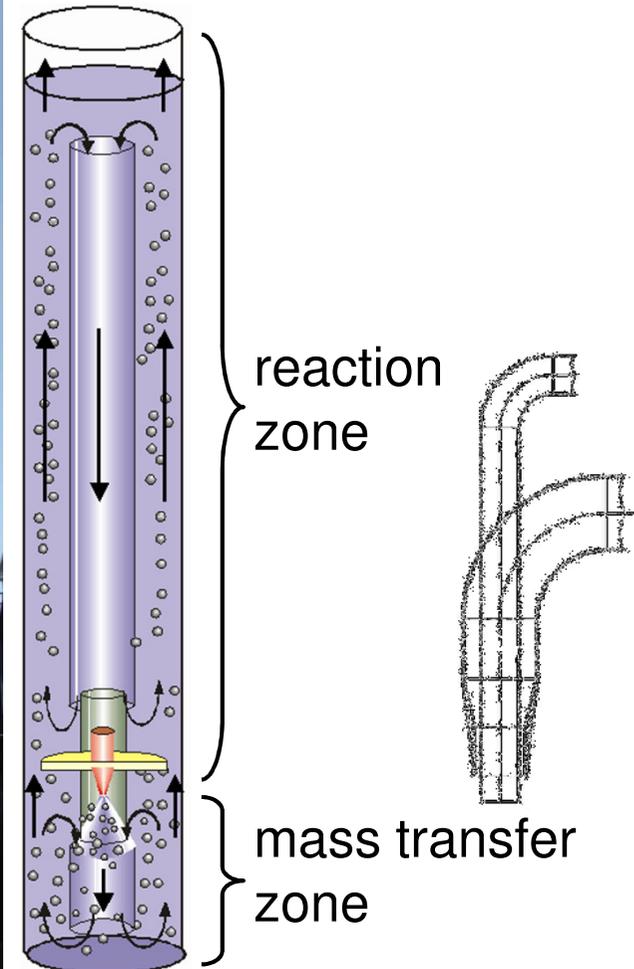
Membrane Filtration





Function of a Jet Loop Reactor (JLR)

- Reaction zone
 - nutrients delivered by the optimized mass transfer are degraded by the bacteria
- Mass transfer zone
 - two component jet nozzle produces dispersed air bubbles → great surface for mass transfer
 - a lot of turbulence → increases the mass transfer

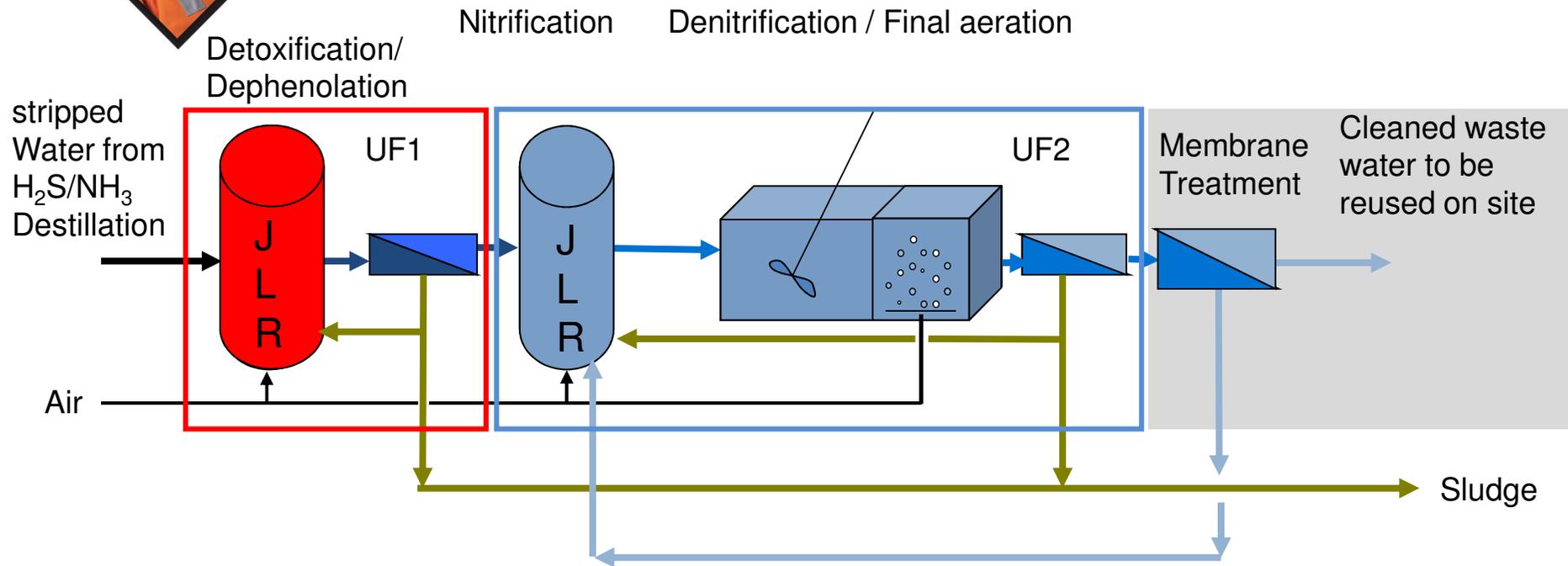


Optimized mass transfer → lower retention time



Coke Waste Water Treatment today

JLR & Ultra- (UF) & Membrane Filtration



Detoxification: $\text{HCN (Cyanide) and SCN (Thiocyanide)} \rightarrow \text{NH}_3$

Dephenolation: $\text{C}_6\text{H}_5\text{OH (Hydrocarbon)} \rightarrow \text{CO}_2 + \text{H}_2\text{O}$

Nitrification: $\text{NH}_3 \rightarrow \text{NH}_2\text{OH} \rightarrow \text{NOH} \rightarrow \text{NO}_2^- \rightarrow \text{NO}_3^-$

Denitrification: $\text{NO}_3^- \rightarrow \text{NO}_2^- \rightarrow \text{NO} \rightarrow \text{N}_2\text{O} \rightarrow \text{N}_2 \uparrow$



Advantages and Disadvantages of JLR and membrane technology

Advantages

- + less floor space required
- + lower retention time
 - ⇒ smaller treatment reactors
 - ⇒ lower recycle streams
- + the waste water can be reused

Disadvantages

- C-Source for Denitrification required



Experiences during Commissioning and Assistance of a german Waste Water Treatment Plant

- Consequences of a too old sludge age
 - Reduced ultrafiltration flow rate → feed waste water amount must be reduced
 - A great portion of dead biomass is existent. Biomass generates extracellulare polymere substance which causes a reversible membrane fouling
 - Sludge shows no settlement
- **Continually centrifuging and intensive membrane cleaning could remove the fouling**

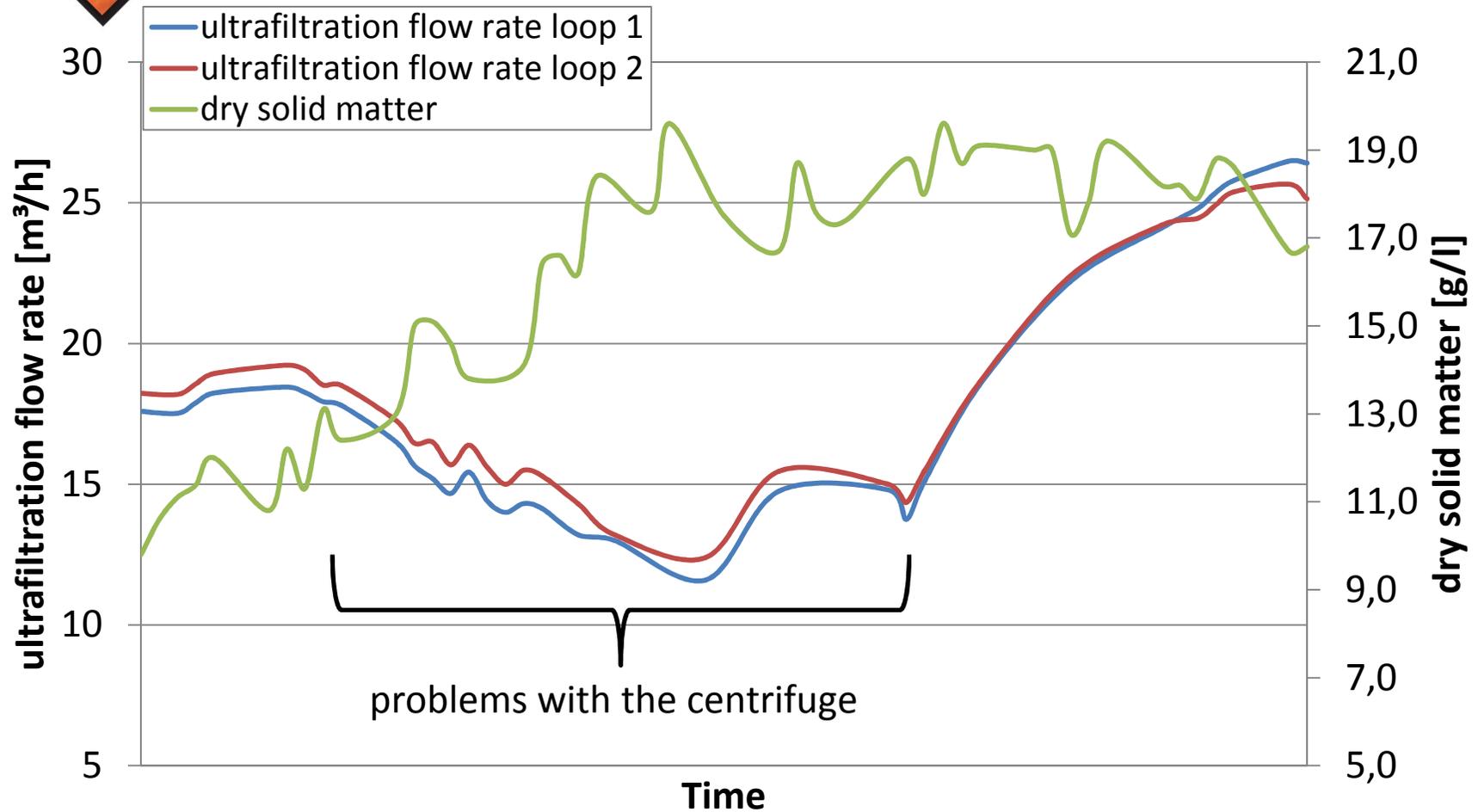


Experiences during Commissioning and Assistance of a german Waste Water Treatment Plant

- Consequences of a too low dry solid matter
 - A too low dry solid matter is also not desirably → degradation rate will be reduced, limiting values might be failed
 - **To prevent fouling and to reach the limiting values continually centrifuging and a high dry solid matter is necessary**
- During the time it showed that although a high dry solid matter was existent a high ultrafiltration flow rate could be reached
 - **Important continually centrifuging**



Experiences during Commissioning and Assistance of a german Waste Water Treatment Plant

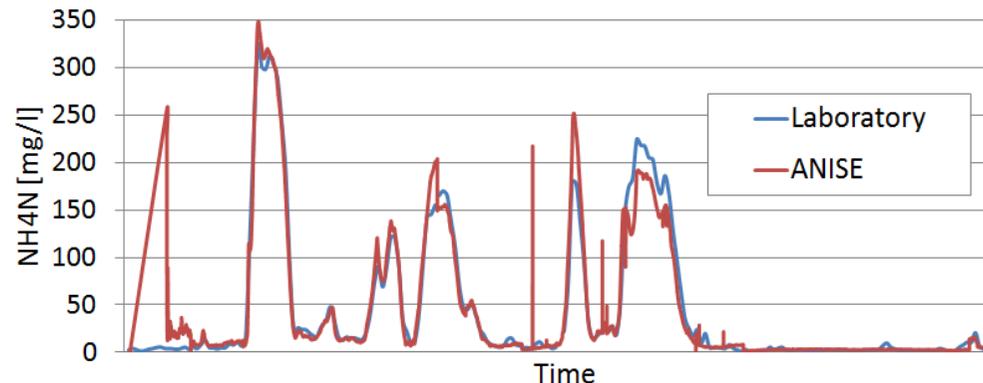




Experiences during Commissioning and Assistance of a german Waste Water Treatment Plant

■ Automation Optimization

- Wet-chemical online analyzers have high maintenance requirements and need a huge amount of chemicals
- Ammonia and Nitrate sensors (ANISE and Nitratrax) were successfully tested, need less maintenance and no chemicals



- Two different Oxygen sensors (LDO and Oxymax) have been tested → Both sensors are suitable



Experiences during Commissioning and Assistance of a german Waste Water Treatment Plant

- Reachable degradation rates

Parameter	Max. Degradation rate [%]
Free Cyanide	98%
Thiocyanate (SCN)	98%
COD (chemical oxygen demand)	95%
Phenol	> 99%
Ammonia (NH ₄ -N)	> 98%
Nitrogen composed of NH ₄ -N, NO ₃ -N, NO ₂ -N	> 95%
Sulfide	> 99%



Experiences during Commissioning and Assistance of a german Waste Water Treatment Plant

- Reachable outlet values

Parameter	Reachable Outlet values [mg/l]
pH-Value	6-9
Suspension	Very small amounts because of the UF
COD	≤ 80
Ammonium-Nitrogen	≤ 2
Nitrogen composed of NH ₄ -N, NO ₃ -N, NO ₂ -N	≤ 7
Total Phosphor	1 (depends on phosphoric acid dosage)
Mineral Oil	Very small amounts because of the UF
Volatile Phenole	≤ 0,03
Sulfide	≤ 0,04
Benzol	« 0,05
Free Cyanid	≤ 0,03
PAHs	« 0,05
Benzo(a) Pyren	« 0,25 µg/L



Experiences during Commissioning and Assistance of a german Waste Water Treatment Plant

■ Conclusion

- Continually centrifuging and intensive membrane cleaning could remove fouling
- To prevent fouling and to reach the limiting values continually centrifuging and a high dry solid matter is necessary
- Ammonia and Nitrate sensors (ANISE and Nitratrax) produce reliable results, don't need chemicals and require less maintenance than wet-chemical online analyzers
- With the Jet Loop Reactor and Membrane Waste Water Treatment high degradation rates and low outlet values can be reached and the cleaned water can be reused



Thank You



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