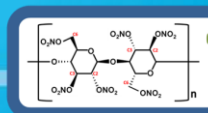
VEOLIA

- Process of treating
- Results from operation
- Operational problems



7TH NITROCELLULOSE SYMPOSIUM 2016

CHARACTERIZATION SAFETY PROCESSABILITY PERFORMANCE

Radim Staněk

Treatment of wastewater from nitrocellulose production

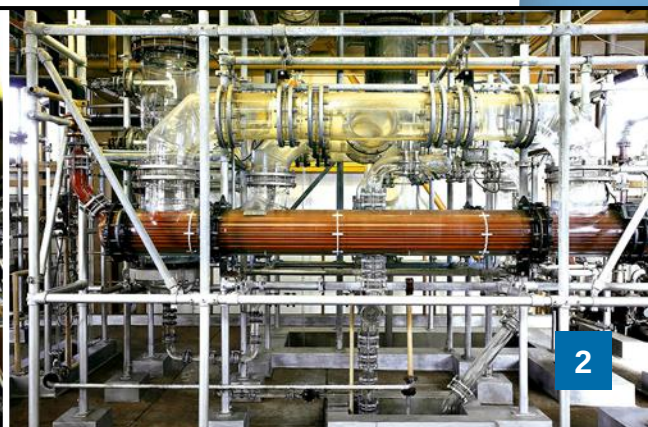
Královéhradecká provozní

Quality and Amount of Wastewater

mg/L	pH	$N\text{-}NO_3^-$	SO_4^{2-}	COD	TSS
Wastewater	1 - 2	100 - 400	1,000 – 2,000	50 - 100	0 - 30

- Volume of wastewater is about 2,000,000 m^3/year
- Temperature from 15 °C to 35°C
- It is necessary to adjust pH and remove nitrates





Princip of treatment

Neutralization by sodium hydroxide

$$HNO_3 + NaOH \rightarrow NaNO_3 + H_2O$$
$$H_2SO_4 + 2\ NaOH \rightarrow Na_2SO_4 + 2\ H_2O$$

Denitrification - bacteria use nitrate as electron-acceptor in the respiration chain instead of oxygen under anaerobic conditions:

$$12\ NO_3^- + 5\ C_2H_5OH \rightarrow 6\ N_2 + 10\ CO_2 + 12\ OH^- + 9\ H_2O$$

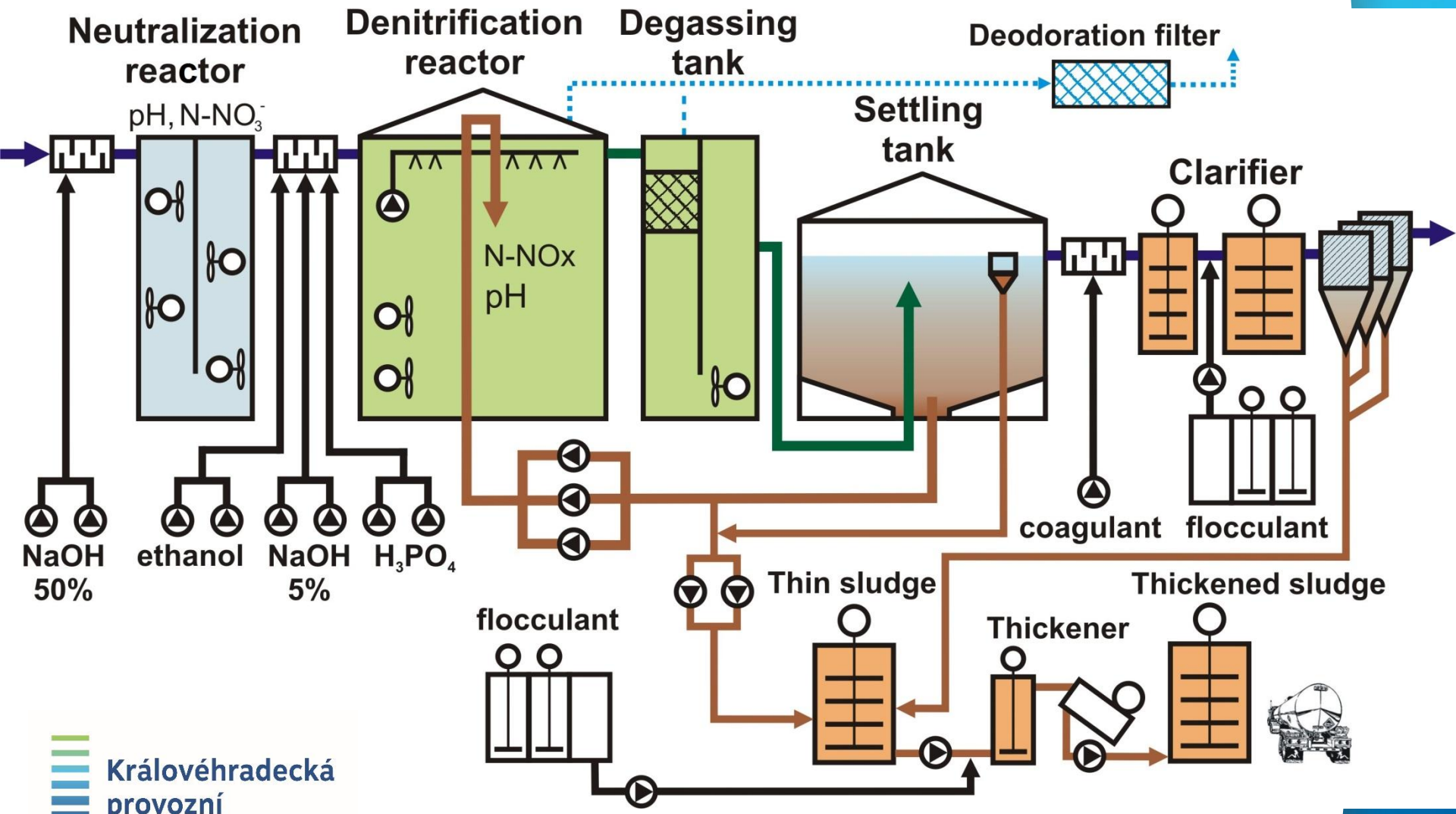
- 2.86 g COD are needed per gram of nitrate-nitrogen
- pH is increasing because hydroxide ions are produced

Complete denitrification pathway:

$$NO_3^- \rightarrow NO_2^- \rightarrow NO \rightarrow N_2O \rightarrow N_2$$

Královéhradecká provozní

Process flow scheme



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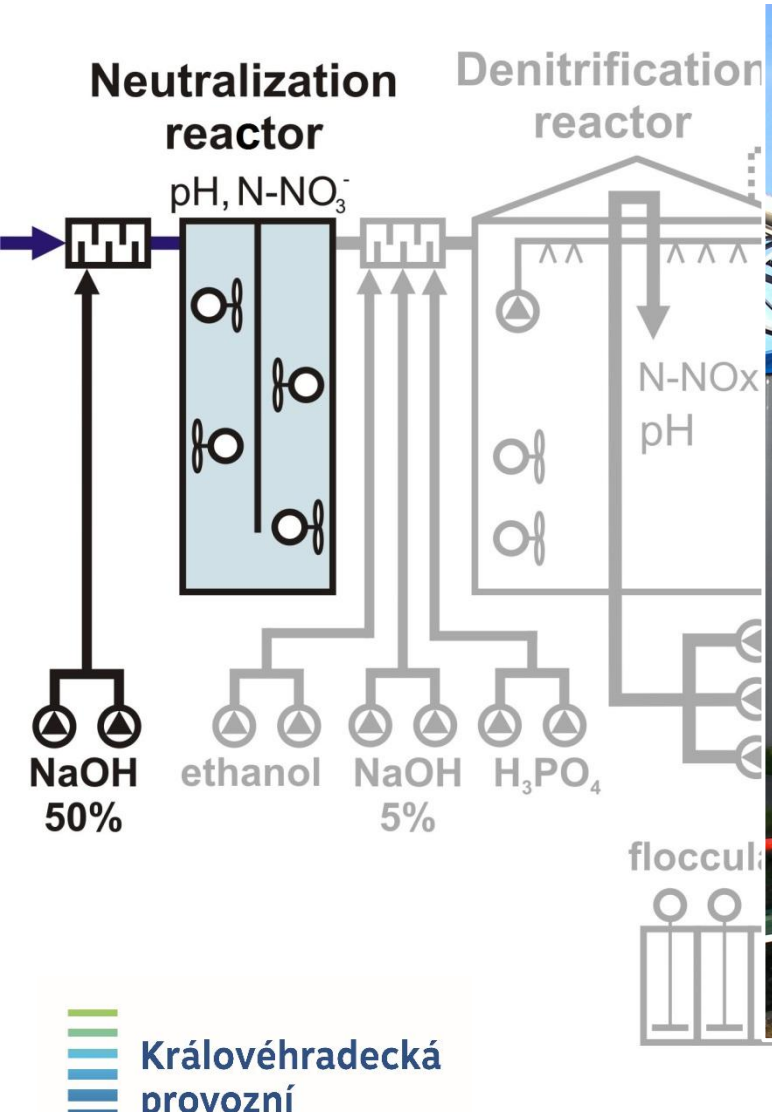
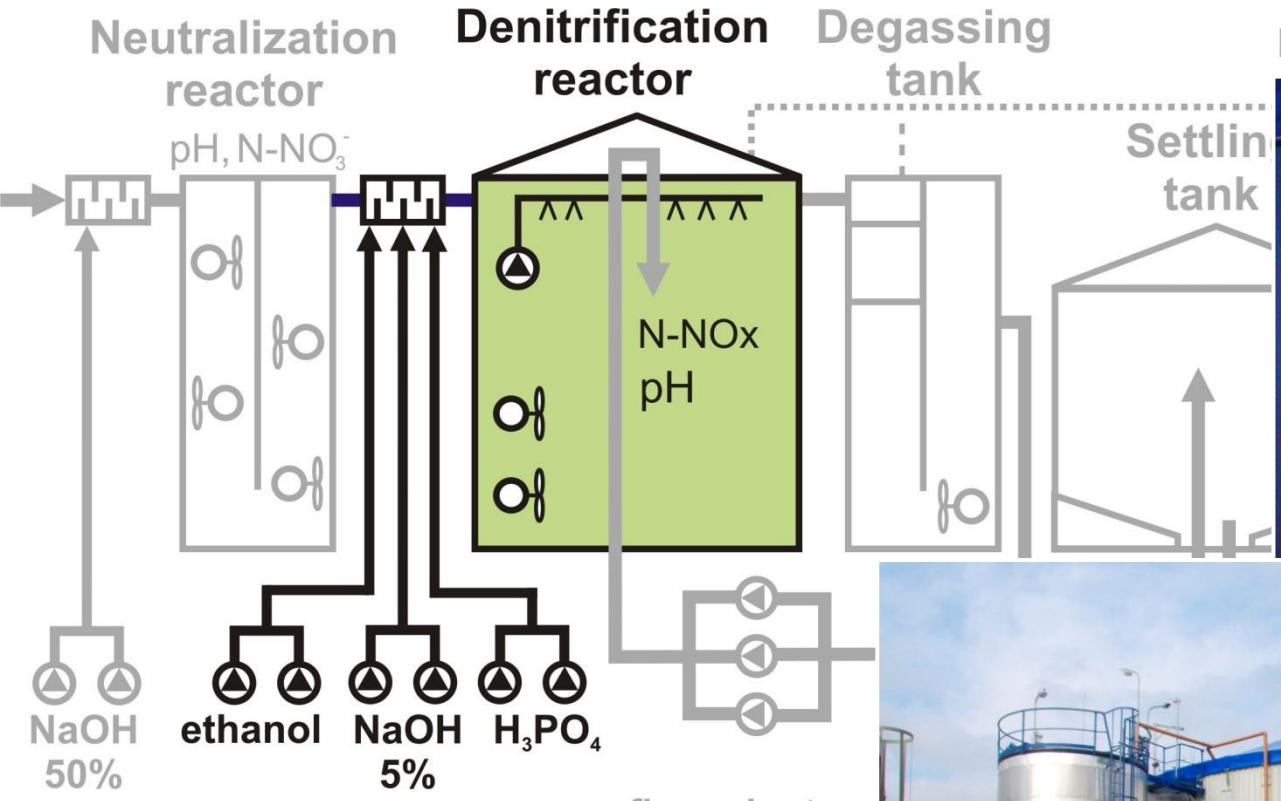
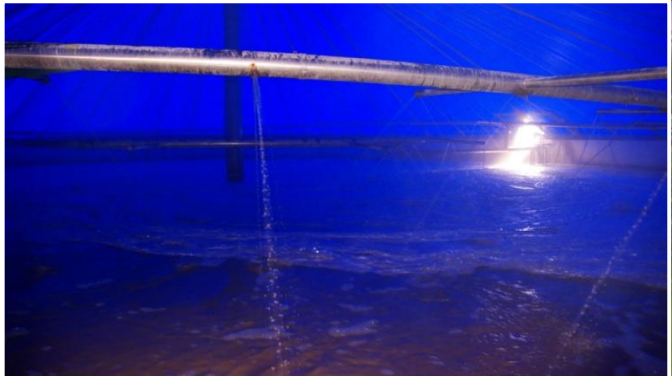
Neutralization



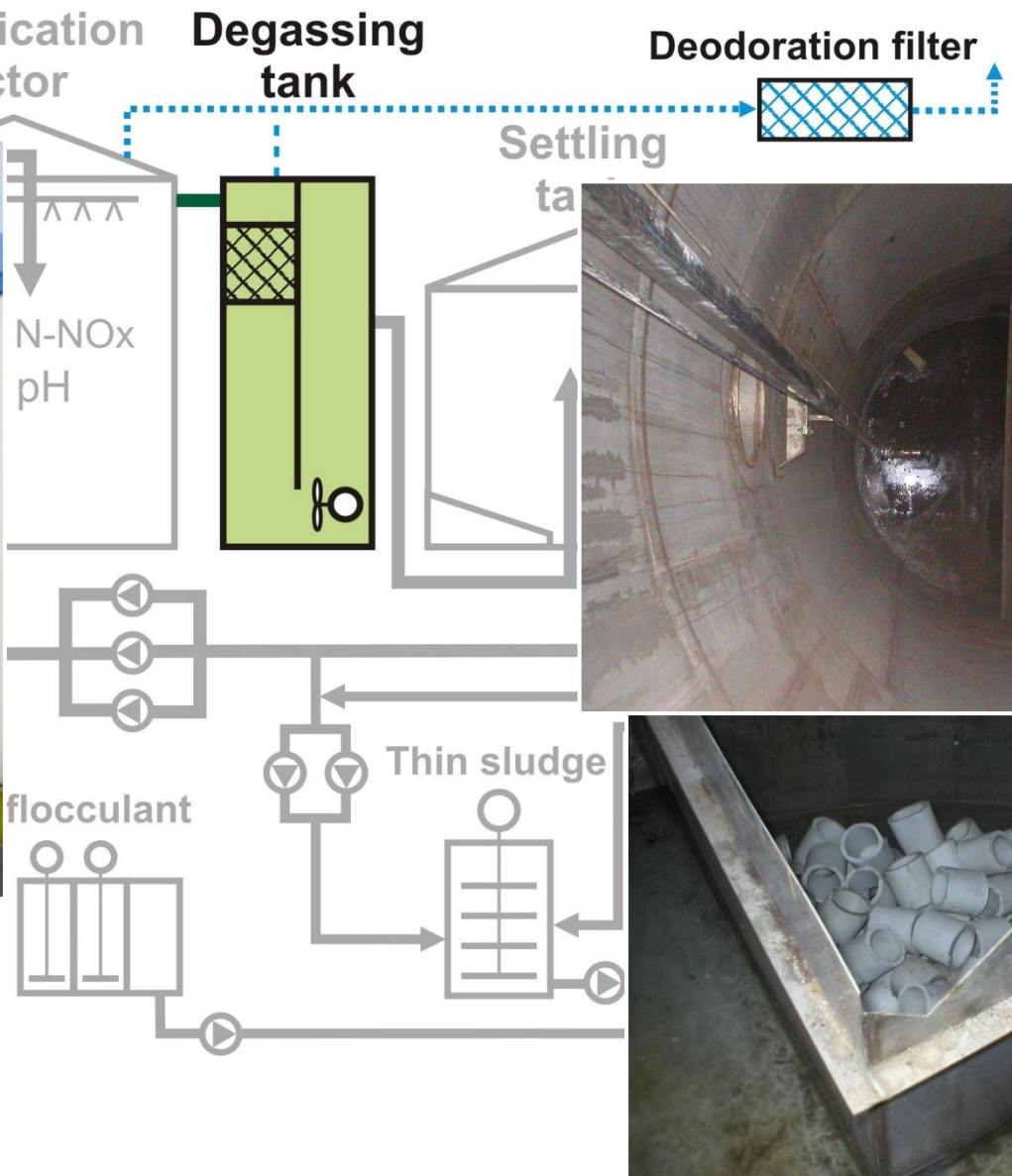
Královéhradecká provozní

Denitrification



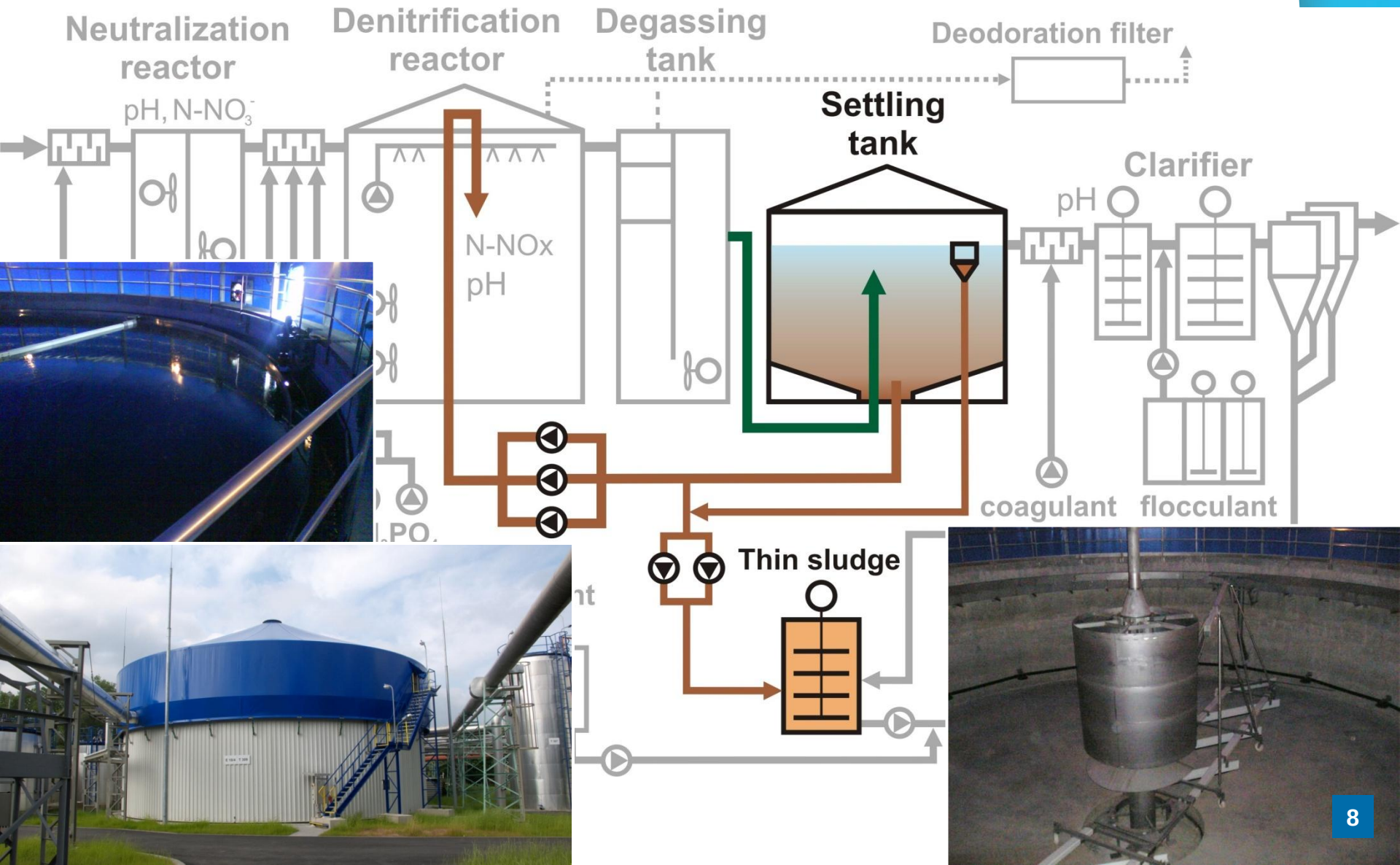


Degassing

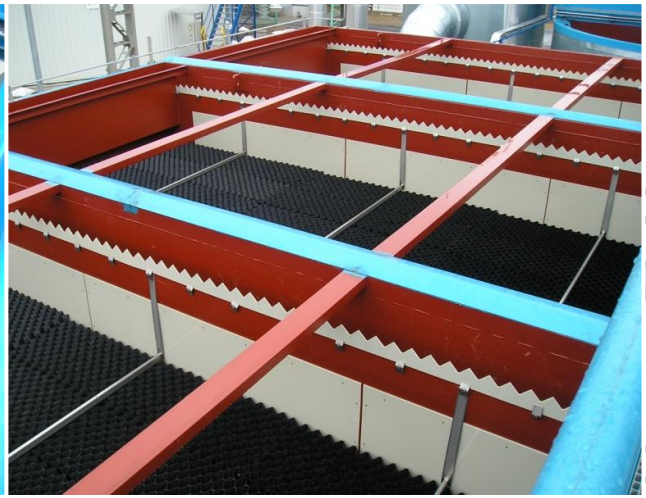


Královéhradecká provozní

Separation of Sludge



Tertiary Treatment



Neutralization Denitrification Degassing Deodoration filter

Clarifier

pH

coagulant flocculant

Thin sludge

Thickened sludge

Thickener

Sludge Management

Hydraulic and mass loading

Volume of wastewater	
5200 m^3 /d	60 L/s (40 – 100 L/s)

Acidity	NaOH			ratio
kmol/d	m^3 50%/d	t 100%/d	kmol/d	mol NaOH/mol acidity
176	8,0	6,0	150	0,80

20% of acidity is neutralized by hydroxide ions produced in denitrification.

Δ $N\text{-}NO_3^-$	ethanol	Total consumed COD		ratio
t/d	m^3/d	t/d	PE	t COD/t N
1.1	2.4	3.8	32,000	3.6

Královéhradecká provozní

Technological Parameters

Sludge concentration (MLSS)	2 - 3	g/L
Organic part of sludge (VMLSS)	80	%
Excess sludge production	0,9	T SS/day
Return sludge flow	50	L/s
Hydraulic retention time	6 – 8	hours
Sludge retention time	8 - 12	days

- Concentration of sludge is slightly lower then in classical activated sludge system.
- The organic part of the sludge is larger due to absence of suspended solids in the influent.

Královéhradecká provozní

Wastewater quality

mg/L	$N\text{-}NO_3^-$	$N\text{-}NH_4^+$	COD	BOD	TSS	pH
Influent	240	0.4	100	25	20	1.5
Effluent	10	0.2	50	10	30	6 - 8

- Removal of nitrates and adjustment of pH
- High operation costs

Operational problems

1) **Severe inhibition of denitrification process**
   - Loss of ability to reduce nitrates
   - Stopping the wastewater flow into WWTP
   - Inhibitions lasted 8 - 48 hours

2) **Poor sedimentation properties of sludge**
   - Problems with separation of the sludge in the settling tank
   - Restriction of wastewater volume

Královéhradecká provozní

Inhibition of denitrification

Nitrous gases above the surface of the denitrification reactor.

Possible causation: Nitric oxide

- Denitrification intermediate
- Free radical
- Toxic to bacteria

Královéhradecká provozní

Theory of formation of nitric oxide

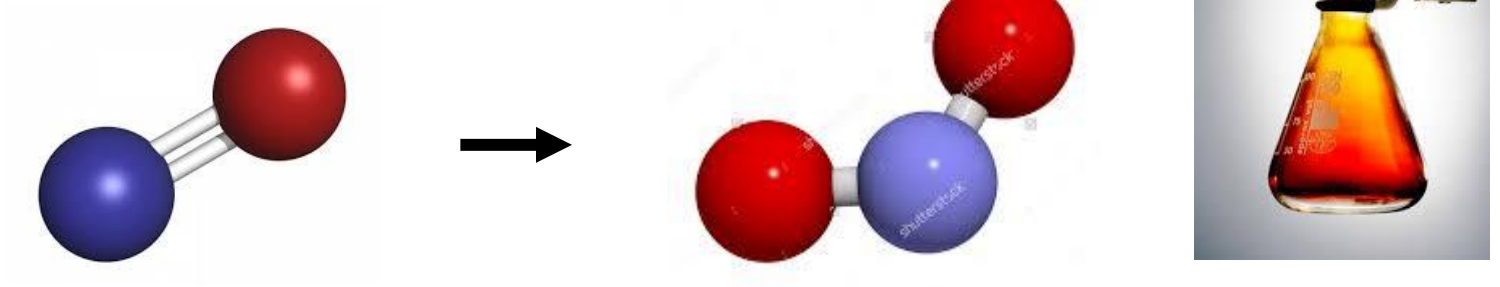
High nitrates loading, low pH → accumulation of NO

NO_3^- >>> NO_2^- >> **NO** (aq) > N_2O > N_2

After reaching solubility limit

NO (aq) → NO (g)

NO (g) + ½ O_2 → NO_2 (g)

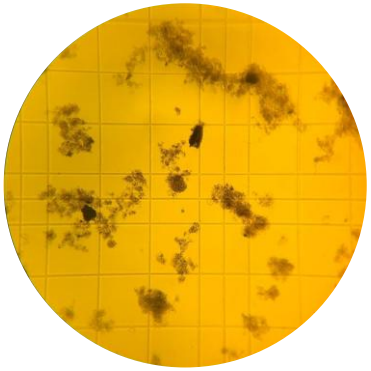


Královéhradecká provozní

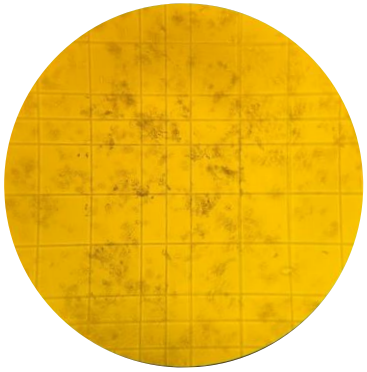
Poor sedimentation properties of sludge

Zoogloeal bulking = excessive amount of extracellular polymers. Polymers retain large amount of water and prevent the sludge flocs approaching to each other closely.

- slow sedimentation velocity
- poor dewatering



Normal sludge



Zoogloeal sludge

Normal activated and zoogloeal sludge

After 30 minutes

After 2 hours

Královéhradecká provozní

Solution attempts

- Dosing of weighting material (milled limestone)
- Dosing of coagulant (Ferric Sulphate) and flocculant
- Partial change of substrate (Brenntaplus VP1)
- Dosing of micronutrients (Vithane)
- Decrease of sludge concentration in reactor

poor sedimentation vs. inhibition

Královéhradecká provozní

Thank you for your attention

Královéhradecká provozní