Design Project - SIE 2023

TREATMENT OF AMMONIUM IN CONSTRUCTION WASTEWATER

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CONTEXT

The road tunnel in the Swiss Alps is beginning to show the weight of the years and needs a complete renovation. The construction of a new tube will not only enhance safety but also provide a fallback solution in case of incidents or maintenance work in one of the tubes. Due to the intense workload in the mountain area with preserved nature around the construction site, the wastewater produced by the construction must be properly treated and managed. The problem lies in the fact that the proposed treatment method for construction wastewater effectively removes NO_2^-, but it is not suitable for ammonium removal.

The view on the river by the construction site and landfill

OBJECTIVES

The main requirments for the ammonium tratment are:

- On/off treatment
- Low reaction time
- Cost efficiency

METHOD

REACTIONS DURING BREAKPOINT CHLORINATION

$$HOCl + NH_3 \rightarrow NH_2Cl + H_2O$$
$$HOCl + NH_2Cl \rightarrow NHCl_2 + H_2O$$
$$HOCl + NH_2Cl \rightarrow NCl_3 + H_2O$$
$$2NH_3 + 3\,HOCl \rightarrow N_2 + H_2O + 3H^+ + 3Cl^-$$

REACTION OF NITRITE OXIDATION WITH CHLORINE TO NITRATE

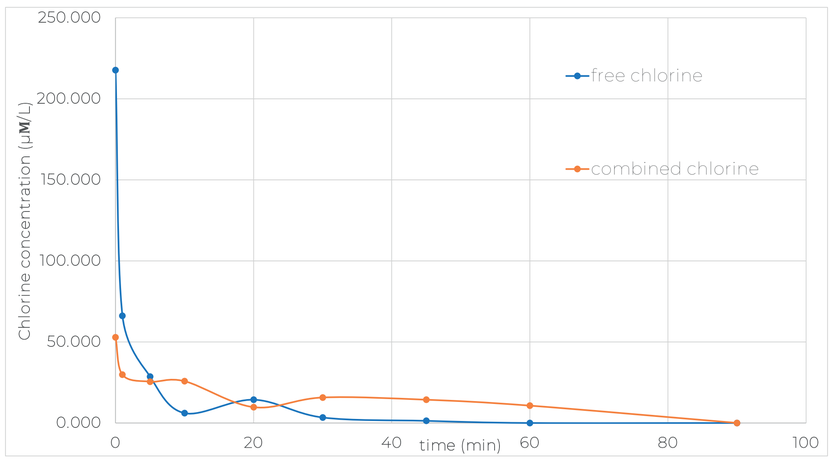
$$NO_2 + HOCl \rightarrow NO_3^- + H^+ + Cl^-$$

Measurements of NH_4^+, NO_2^- in samples → Calculation of concentration for breakpoint chlorination → Assessment of different concentrations close to C by measuring NH_4^+, NO_2^-, free/combined chlorine after 2 hours → Determination of optimal Chlorine dose: 1.2C → Performance of kinetic experiment: chlorine as function of time (1 hour) → Measuremnet of NH_4^+, NO_2^-, in new samlples with high ammonium concentration → Calculation of new concentration of breakpoint chlorination → Kinetic experiment with 1.2C for new samples → Additional measurements of NH_4^+ after removal of chlorine with thiosulfate

RESULTS

LOW NH_4^+

Concentrations of free and combined chlorine during reaction with 1.2C chlorine dose, as a function of time



NH_4 and NO_2, free and combined chlorine average concentrations after 2h of reaction with different concentrations of chlorine

		0.8 C	C	1.2 C	1.5C	2C
NH_4^+	*mN/l*	21.4	7.1	0.0	0.0	0.0
NO_2^-	*mg/l*	0.0	0.0	0.0	0.0	0.0
Combined chlorine	*µM*	75.9	57.8	-	-	-
Free chlorine	*µM*	-	-	16.5	83.5	183.8

Initial concentrations of NH_4 and NO_2 for new samples with higher concentrations

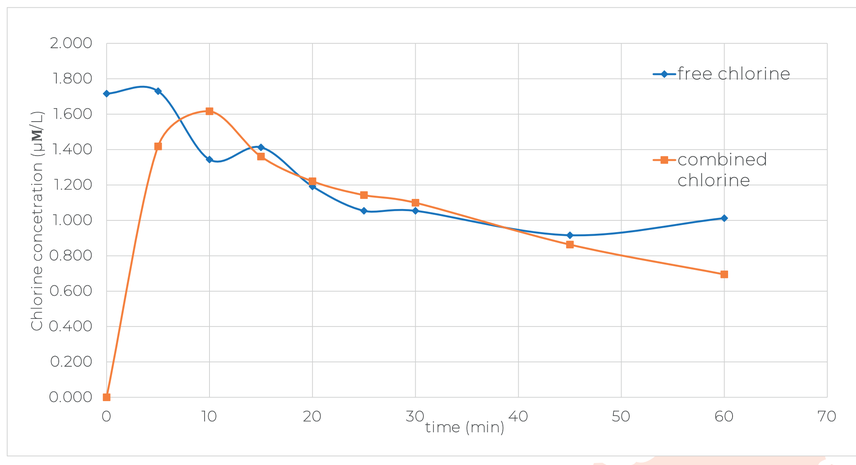
NH_4^+ *mN/l*	NO_2^- *mg/l*
185.7	10.9

Concentrations of NH_4 and NO_2 for new samples with higher concentrations

NH_4^+ *mN/l*	NO_2^- *mg/l*
2.4	0.1

HIGH NH_4^+

Concentrations of free and combined chlorine during reaction with 1.2C chlorine dose, as a function of time



CONCLUSIONS

- **Ammonium and nitrite are effectively removed from wastewater using a concentration 1.2 times the stoichiometric breakpoint concentration**
- **Chlorine removal is needed, when its concentration is high, for the accuracy of the NH4+/NO2- measurements**
- **Presence of residual chlorine is observed especially for the samples with high ammonium concentrations, that must be treated**

NH4+ concentration after 5' reaction with 1.2C and for high ammonium concentration samples

NH_4^+ *mM*	Removal %
0.003	99.9

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