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AMMONIA REMOVAL FROM AQUEOUS SYSTEMS BY DIRECT SONOLYSIS AND CHLORINATION

Mihai Stefanescu, Valeriu Badescu, Ionut Cristea

National Research and Development Institute for Industrial Ecology- ECOIND, Bucharest, 71-73 Drumul Podu Dambovitei Street, district 6, mihaixstefanescu@gmail.com, Romania

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Introduction

Sonolysis effects are based on ultrasonic cavitation which means generation of very reactive radical especially hydroxyl radical. Its high oxidation potential makes sonolysis one of the best advanced oxidation methods for removal of micropollutants from drinking water sources. Ammonia ions are often present in groundwater sources and must be removed because it favors microorganism development. Chlorination and biological nitrification are the well-known methods for ammonia removal from drinking water.

This paper emphasized the alternative of ultrasonic and chlorination for advanced removal of ammonia ions.

Laboratory tests have shown 80% ammonia removal efficiency for 9 mg NH_4^+/L initial concentration for 8.5 reaction pH.

Materials and methods

Ultrasonic energy and amplitude, pH reaction, ammonia initial concentration and chlorine presence are the main parameters of the process: pH: 7 and 8.5; initial ammonia concentrations: 9 - 103 mg NH_4^+/L; ultrasonic energy: 50 - 500 kJ; ultrasonic amplitude: 25 – 75%; chlorine dose (stoichiometric): 6 g Cl_2 : 1 g NH_4^+.

Sonics – Vibracell VCX 500 was the ultrasonic generator working on the stable 20 kHz frequency for all experimental tests.

Direct sonolysis tests were performed in order to establish the influence of the main opperating parameters (energy, amplitude, initial ammonia concentration, pH reaction. The evaluation of the proposed ammonia removal method, based on sonolysis and chlorination, was made in the following conditions: separately tests with chlorination and sonolysis + chlorination; reaction pH: 7 and 8.5; initial ammonia concentration: 9,1 mg NH_4^+/L; ultrasonic energy: 300 kJ; ultrasonic amplitude: 25%; chlorination time: 15 min.

Results and conclusions

Table 1 emphasized the ammonia efficiency removal with opperating conditions.

The analyze of table data lead to the following conclusion:

- only chlorination at stoichiometric dose leads to 10% ammonia removal;
- only direct sonolysis leads to 6-7% ammonia removal for both pH values;
- in case of US + chlorination system, al low chlorine dose corresponding to stoichiometric ratio between Cl_2 and NH_4^+, the ammonia removal efficiency rises to 80%, the lowest concentration being 1.8 mg NH_4^+/L at pH = 7;

- lower ammonia initial concentration could be more efficiency diminished and there is the possibility to associate biological nitrification of groundwater with sonolysis in order to remove residual ammonia and microorganisms;
- the increase of reaction pH value will rise the efficiency of ammonia removal because of stripping phenomenon.

Table 1. Ammonia removal yield in ultrasonic field with or without chlorination

No.	Sample	Sonolysis time, min.	Chlorination time, min.	pH	NH_4^+ residual, mg/l	Efficiency, %
1	CL	-	15	8,5	8,2	10
2	C1	15	-	7	8,6	6
3	C1B	15	-	7	-	-
4	C1C	15		7	1,83	80
5	C1CB	15		7	-	-
6	C2	15	-	8,5	8,5	7
7	C2B	15	-	8,5	-	-
8	C2C	15		8,5	2,73	70
9	C2CB	15		8,5	-	-

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