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TRICHLOROETHYLENE REMOVAL FROM AQUEOUS SYSTEM BY ULTRASONICATION, CATALYTIC BIO-OXIDATION AND BIOMASS SORPTION

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Introduction

The application of biological processes for organochlorinated removal from wastewater is well known, however, few studies are known to be addressed to their use in the field of drinking water treatment. In addition, ultrasonication is also an efficient advanced oxidation process for organic micropollutants degradation. This study showed that the combination of these two methods, in the same treatment flow, can assure advanced removal of trichloroethylene (TCE) or other pollutants and also good disinfection of water. Laboratory tests emphasized 97-98% TCE removal efficiency in case of biological treatment with activated granular sludge or activated algae.

Materials and methods

Five experimental tests were performed to remove TCE from the aqueous system:
(1) biological treatment with activated granular sludge - microfiltration - ultrasonication; (2) biological treatment with activated granular sludge and catalytic bio-oxidation (laccase-aeration) - microfiltration - ultrasonication; (3) biological treatment with activated granular sludge and catalytic bio-oxidation (laccase-aeration) - settling - ultrasonication; (4) biological treatment with activated algae (mainly *Chlorella* sp.) - microfiltration - ultrasonication; (5) biological treatment with activated algae (mainly *Chlorella* sp.) - settling - ultrasonication.
The main operating parameters were as following: activated sludge: 100-400 mg d.w./L; enzyme: laccase from *Trametes versicolor*, 2 140 U/L); activated algae biomass: 100-400 mg d.w./L; initial TCE concentration: 1280÷7641 µg/L; reaction time of the biological treatment: 2÷4 h; ultrasonic energy: 50÷200 kJ (Sonics-Vibracell VCX500 was the ultrasonic generator working on the stable 20 kHz frequency for all experimental tests).

Results and conclusions

Figure 1 shows the maximum TCE removal efficiencies obtained for the optimum identified treatment flow: *biological treatment* (with activated sludge or activated algae - maximum 400 mg d.w./L), 1 h reaction time) - *microfiltration* (phase separation with 0.45 µm membrane) - *disinfection* (ultrasonication, 50 kJ).

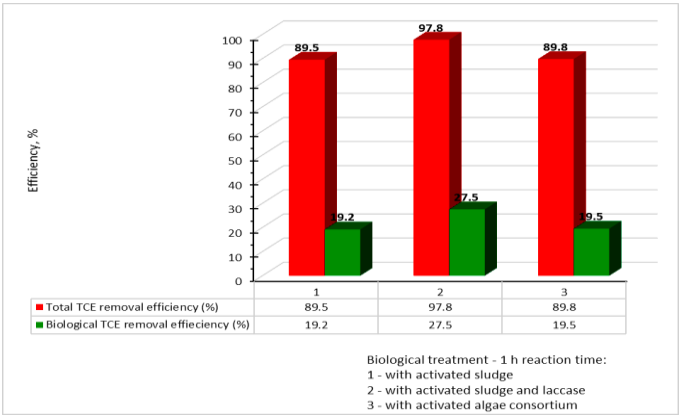

Fig 1. The evolution of TCE removal efficiencies vs. biological treatment method

In the case of 1280 μg TCE/L (initial concentration) and 1 h reaction time, the total TCE removal efficiency (biological and aeration) and the biological treatment efficiency were almost similar between the tests performed with activated granular sludge (1) - 89.5% and 19.2%, respectively and the tests conducted with activated algae (3) - 89.8% and 19.5%, respectively. Better efficiencies were recorded for the comparative tests performed with activated sludge and laccase enzyme: 97.8% global TCE removal efficiency, biological treatment efficiency being 27.5%, with the lowest value of residual TCE concentration (28.6 μg/L).

At the operation time of 4 h, the biological treatment with activated algae led to residual TCE concentration below the admitted limit (< 10 μg/L).

The ultrasonic disinfection tests of the resulted effluents from the biological treatment phase were conducted both after the settling phase (lowest energy-consuming separation phase) and after microfiltration. 50 kJ ultrasonic energy was able to assure after microfiltration application an advanced removal of aerobic germs from both biological treatment systems (activated sludge *vs.* activated algae). The residual aerobically microbial load was as following: (1) microfiltration phase separation: max. 3 CFU/mL; (2) settling phase separation: 1600 CFU/mL (activated algae) - 3200 CFU/mL (activated sludge) (at 22°C) and 7 CFU/mL (activated sludge) - 29 CFU/mL (activated algae) (at 37°C). The settling stage involved chlorine addition (over 0.5 mg Cl_2/L).

The main conclusion of this research is that applied biological treatment with activated sludge or activated algae biomass followed by ultrasonication treatment, performed in the above-mentioned conditions, could be considered as an efficient method for water treatment with TCE content.

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