Magnetic zerovalent iron nanoparticles for adsorbable organic halides (AOX) removal from pulp and paper mill effluents

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1. Introduction – During the pulp bleaching process in pulp and paper (P&P) industry, several organochlorine compounds are formed. Some of these compounds are estimated collectively as adsorbable organic halides (AOX) and, depending on their molecular weight, they are considered mutagenic and toxic for the environment and living organisms [1]. Several physical, chemical and biological processes can be used for the removal of these recalcitrant compounds, although not all economically viable. In recent decades, nanoparticles technology has been successfully used in environmental applications to remove pollutants and help to mitigate their toxicity [2] being zerovalent iron nanoparticles (nZVI) one of the most widely used. When organochlorine compounds are present, the role of nZVI is to reduce the reactive species to less toxic compounds. The magnetic properties of nZVI facilitate their recovery process by applying a magnetic field that allows their easy separation and its further reuse [3]. The objective of the present work is the optimization of AOX removal conditions from pulp and paper mill bleaching effluents using magnetic nZVI particles.

2. Experimental – Taguchi method was applied to design the experiments, in order to get relevant information with a limited number of experiments. A bleaching effluent (D0 effluent) from P&P industry was tested with synthesized nZVI to remove AOX, while studying various operational parameters such as pH, hydrogen peroxide concentration, UV light and nZVI dosage. Some of the tests were performed to evaluate the influence of the system used: UV light and hydrogen peroxide were tested separately and also combined together.

3. Results and Discussion – Concerning the impact of the variables used to map S/N ratios, it was observed that the presence of nZVI is vital, being the most relevant parameter studied as its absence in the media under treatment compromises AOX removal. The system type is also very important, being the combination of UV and hydrogen peroxide the best strategy to obtain AOX removals above 70 %. The pH is the less relevant parameter regarding the AOX removal with nZVI particles. However, when the pH of D0 effluent was increased (need to add alkalis), AOX removal reaction becomes faster in the systems containing only hydrogen peroxide (AOX removal > 60 %) as compared to systems combining both UV light and hydrogen peroxide. The magnetic properties of nZVI particles allowed their recovery and reuse: at very low pH values, the particles were partially dissolved, with 55 % of recovery; at higher pH values, the particles do not dissolve and are fully recovered.

4. Conclusions – It is possible to remove AOX from P&P industry bleaching effluents, using nZVI particles without the need of UV light. Furthermore, their easy recovery and reuse allowed by their magnetic properties contributes to reduce operational costs and demonstrates the potential of this technology to remove recalcitrant and toxic pollutants.

5. References

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