Tetracycline degradation using catalysts of platinum coated over CeO2 and CeO2ZrO2

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Tetracycline (TET) is an oral antibiotic used for humans and animals. European chemical agency had reported TET to be toxic to aquatic life with long-lasting effects, suspected of damaging fertility or the embrios, may cause harm to breast-fed children, and causes skin irritation.[1] TET in the environment originates from leaking and incompletely treated wastewater loaded with pharmaceuticals, due to excessive production and use. TET risks are the deterioration of useful microorganisms and the gain of antibiotic resistance of harmful bacteria.[2] As a solution for the limited conventional wastewater treatment plants, catalytic wet air oxidation (CWAO) is one of the most efficient and complete pharmaceutical wastewater detoxification processes.[3] This study focuses on TET (200 mg/L) degradation via CWAO using platinum coated over CeO_2 and CeO_2ZrO_2. Two different platinum loading at different temperatures were investigated. Catalytic experiments were followed by analyzing collected samples during running tests by HPLC-UV and TOC analysis for remaining TET and organic carbon quantification. Concerning catalysts characterization, fresh catalysts were analyzed using ICP for platinum quantification, specific surface characterization, temperature-programmed reduction, H_2 chemisorption to highlight metal dispersion, and oxygen storage capacity. Used catalysts were additionally analyzed using elemental analysis to quantify depositions over catalysts. Further analyses were performed on the best catalytic test like HPLC-MS for byproducts identification, *Vibrio fischeri* luminescence inhibition test, BOD, and BOD inhibition for toxicity evaluation. Material characterization showed that CeO_2 had the largest specific surface (144 $m^2.g^{-1}$) which stayed similar after Pt coating, even though, oxygen storage capacity increased after Pt coating and ZrO_2 doping (Pt/CeZr 188 $\mu mol.g^{-1}$). The most relevant catalytic test results showed that 1% Pt loading was much more efficient for TET degradation, due to higher metal dispersion than 2% loading. 1% Pt/CeZr reached 98% TOC

elimination with high CO_2 selectivity at 50°C atmospheric pressure. Moreover, both catalysts 1% Pt/CeZr and 1% Pt/Ce showed more than 86% TET and TOC elimination after a 3h test under room conditions. Used catalyst test revealed much slower TET degradation reaching 66% and 40% TET and TOC elimination. Used catalysts witnessed specific surface deterioration due to depositions over catalysts. Those depositions were the only deactivation agent for the catalysts. Toxicology evaluation showed that the catalyst test is efficient for water depollution.

References

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