Treatment of primary sewage sludge by Wet Air Oxidation: Quantification of pharmaceutical micropollutants and microplastics before and after treatment

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1. Introduction

Microplastics (MPs) are plastic fragments lower than 5 mm that are detected in the environment and causing various effects on aquatic and terrestrial organisms [1]. Several research articles have recognized Municipal Wastewater Treatment Plants as important sources in sewage sludge (SS) of polyethylene and polypropylene beads, polyester, polyamide and other types of microplastics [2]. On the other hand, the occurrence of emerging organic micropollutants (OMPs) in SS has been widely reported; nevertheless, their fate during sludge treatment remains unclear [3]. Traditional disposal methods of SS include landfill, incineration, and agricultural application. However, these methods have their own limitations (land restrictions, secondary pollution, etc.). Therefore, there is an urgent need for an environmentally friendly SS disposal technology to 1) solve the SS treatment problem and 2) ensure the destruction of MPs and OMPs. Wet Air Oxidation (WAO) is an environmentally friendly treatment of sewage sludge (SS) that has attracted a lot of attention. Under WAO conditions, near or above the critical point of H_2O (374 °C and 22 MPa) and in presence of oxygen, water becomes an excellent solvent for organic compounds, leading to a rapid oxidation kinetics by *in-situ* generation of hydroxyl radicals (OH•). Organic compounds are then degraded exothermically. This process accelerates the degradation kinetics of organic waste while generating short chain carboxylic acids and other biodegradable by-products. This study investigates the WAO of primary SS as a green energetic valorization technology in a batch lab scale reactor (only the subcritical conditions were applied since they are sufficient for degrading SS). However, only the quantification and degradation results of pharmaceutical micropollutants and microplastics will be presented.

2. Materials and Methods

Primary SS were collected from the wastewater treatment plant at Longueuil City near Montreal (QC, Canada) with a dryness of 4,5 %. Samples were collected in 20 L capacity polypropylene containers and stored at 4 °C until further use. WAO tests were performed using 450 ml TOP-INDUSTRIE batch reactor at 280 °C. The cylindrical reaction cell is made of inox with a titanium coated inner surface (5.8 cm diameter × 15.5 cm length). For the experiments, the solution was prepared by mixing 56 ml of SS with 54 mL of water to have a desired initial COD of 35 000 gO_2/L (≈ 24 % of reactor's volume). The reaction cell is heated to the required temperature using a heating coil system, then compressed air (oxygen source) was injected as oxidant with a stirring speed maintained at 1500 rpm during 10 min of treatment time. Transformation products of organic contaminants generated by WAO were identified by both gas chromatography-quadrupole mass spectrometry (GC-QMS) and liquid chromatography-quadrupole-time-of flight mass spectrometry (LC-QqTOFMS). For GC-QMS, both quantitative (targeted) and qualitative (nontargeted) analysis was performed according to a previous method [4]. For LC-QqTOFMS, only a nontargeted analysis was carried out according to a method developed previously [5] with minor modifications. For the transformation of microplastics, inverted optical microscopy and GC-QMS (target and untargeted) was employed.

3. Results and discussion

During this study, several key parameters were evaluated such as treatment time, initial COD, amount of injected oxygen and temperature, but these results are confidential. Results on the quantification and degradation of pharmaceutical micropollutants and microplastics will be presented during the symposium. The analyses are still in progress at the time of submitting this abstract.

4. Conclusions

The length Primary sewage sludge treatment by WAO was investigated in this work. Interesting results on the degradation of pharmaceuticals and microplastics will be presented during the symposium.

References

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