Synthesis of magnetic biochar for utilization in Fenton based process

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Biochar is low-cost carbon rich material produced from biomass via various thermochemical processes under oxygen-limited conditions including pyrolysis, hydrothermal carbonization, flash carbonization, and gasification. A number of studies have highlighted the benefits of using biochar in terms of energy production, soil amendment, waste management and greenhouse gas reduction (Tan et al., 2017). Moreover, recent researches on biochar are focusing on potential application of biochar such as the removal of organic and inorganic pollutants from waste water and other recently developed application fields, such as fuel cell, supercapacitor, and hydrogen storage (Sun et al., 2016). Although biochar is a potential candidate to be used as an alternative carbon material, its practical applications are restricted due to limited functionality and efficiency. Therefore, various activating techniques should be applied such as chemical and physical activation, surface functional group change, metal oxides impregnation, functionalization in order to improve its application in different fields. The separation of biochar which requires filtration, centrifugation and other time consuming methods, is one of the main issue for application of biochar in wastewater treatment. In contrast, magnetic biochar is an efficient approach which can be easily separated from the aqueous solution by magnetic separating techniques. Adsorption of pollutants from wastewater via Fe based magnetic biochars has been reported in the literature (Park et al., 2018). After adsorption process, the necessity of desorption and decomposition step to recover the magnetic biochar lowers its economic advantages. Fenton process, an advanced oxidation process, have shown great potential for the treatment of wastewaters. Fenton process is based on oxidation of organic pollutants in wastewater by hydroxyl radicals generating by Fe catalysts. In literature, only limited studies have attempted to remove of organic compounds via Fenton process by using Fe based magnetic biochar (Park et al., 2018; Zhang et al. 2018; Gu et al., 2013, Rubeena et al., 2018).

In this study, magnetic biochar was prepared from two phase olive oil mill wastes by impregnation method followed by pyrolysis at two different temperatures (500 ºC and 700 ºC). Magnetic biochars (MBC) were then applied for methylene blue (MB) degradation by Fenton reaction. $FeSO_4$ and Red Mud (RM; as received, HCl treated and H_2SO_4 treated), which is a byproduct of aluminum company, were used as Fe source.

The Fenton oxidation reactions were performed in a 250mL conical flask with a shaking speed of 150 rpm. 0.1 g of MBC was suspended in 100 mL of Methylene Blue (100 mg/L) aqueous solution. 0.2mL of the 3% H2O2 was added to initiate the degradation reaction. pH was adjusted to 3.0 with 10% HCl solution. Fe concentrations of MBC were found to be between 15% and 19%. All MBCs obtained by two different Fe sources showed magnetic properties. Results showed that the pyrolysis temperature, Fe source and acidic treatment of red mud had an influence of MBC activity. MM removal up to 91% was achieved in presence of MBC obtained with Red mud (HCl and H_2SO_4 treated) at 700 ºC. Increase in pyrolysis temperature led to improve the activity of MBC obtained with RM whereas adverse effect was observed in case of $FeSO_4$. Biochar obtained from untreated RM showed very poor degradation efficiency. MM removal took place within 1 hour, further increases in reaction time did not result in considerable removal. For example, MBC from H_2SO_4 treated RM at pyrolysis temperature of 700 ºC (RM- H_2SO_4-700) decomposed 85% of MM in 1 hour whereas removal of 95% MM was achieved at the end of 24 hour.

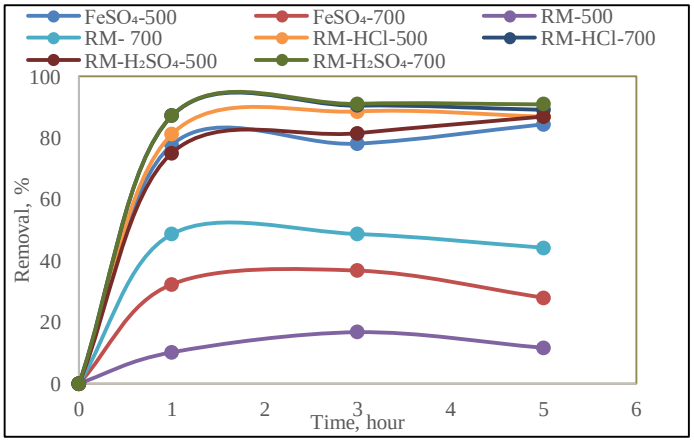

Figure 1. Removal of methylene blue removal with different MBCs.

As a conclusion, a low cost and environmentally friendly magnetic biochar was successfully produced from red mud and olive mill waste. Results offers that magnetic biochar has a great potential to apply in Fenton oxidation for removal of organic pollutants.

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