Modification of Lakra (Pakistani) Coal by Chemicals Washing and Heat Treatment and Its Application for Removal of Organic Acids (Prop Ionic Acid and Chloroacetic Acid) from Aqueous Solution

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ABSTRACT

In the present study, Lakra coal was heat treated and washed with different chemicals ($KMnO_4$ (0.5M), NaOH (0.1M), HNO_3 (0.1M), HCl (0.1M), and H_2O_2 (0.1M)) and investigated as adsorbent for the removal of organic acid pollutants such as propionic and chloroacetic acids from aqueous solution. The results revealed that virgin coal despite of evacuating for generating porosity the adsorption of both acids near to nil. Pre-treatment of coal samples with a variety of chemicals increased the adsorption capabilities as compared to virgin coal. $KMnO_4$, HCl and HNO_3 treated samples showed maximum adsorption among all the samples. Prominent pores generation was observed in the treated samples shown by SEM images of virgin and variously treated coal samples. The aforementioned chemicals also reduced ash, volatile matter, sulphur and ash contents of the coal. At 210 minutes maximum adsorption capacities for chemicals modified coal samples were observed and above no appreciable change was found. The results showed that kinetics of sorption properties of organic acids fitted well with Lagergern pseudo second order model with high correlation coefficiency (r^2) for modified coal samples. For the adsorption of both propionic acid and chloroacetic acid Langmuir model best described the adsorption process. It is concluded that only heat treatment of the coal cannot increase the adsorption capacity for effective adsorption pre-treatment with either of the chemical would be more effective.

Keywords: Organic pollutants acids, Chemicals treated coal, Adsorption, Kinetic study

INTRODUCTION

Pollution of the environment caused by industrial wastewater is a common problem faced by many countries. Due to awareness of the environmental deterioration wastewater treatment has gained considerable attention over the years. A number of pollutants including inorganic and organic i.e. propionic and chloroacitic acids are added to the sewerage water by various industries, causing serious water pollution. These acids are not only dangerous for human life but also have fatal effects on aquatic life. For strict environmental compliance the chemical industries globally facing challenges of wastes disposal though some industries do have conventional wastewater treatment plants. However, most of the organic pollutants cannot be removed by conventional wastewater treatment because of their stability towards light as well as to aerobic digestion. Adsorption has been found to be a superior technique for organic pollutants control (Ayranci and Duman, 2006; Liu et al., 2009; López-Velandia et al., 2014; Cheng et al., 2017).

Keeping in view the adverse health hazards associated with organic acids like propionic and chloroacetic acids wastewater must be processed for retention of these acids before such water is added to fresh water streams (Li et al., 2013). Like for strong mineral acids like hydrochloric acid these organic acids should be treated with similar care (Bada and Potgieter-Vermaak, 2008).

Organic compounds present in industrial wastewater are toxic, non-biodegradable and difficult to be removed by biological treatment processes. In order to meet strictly with environmental regulations, the technologies like solvent extraction, chemical oxidation and activated carbon adsorption has been applied to remove toxic and non biodegradable organic compounds from portable as well as domestic and industrial wastewater supplies. Amongst the candidate retention methods, activated carbon adsorption has been proved effective for organics removal from water supplies (Sun et al., 2018; Zhang et al., 2018). Energy efficient, clean, responsive to market demands and intrinsically safe are basic requirements of a chemical process. Zero waste chemicals generation, use of less hazardous chemicals, low energy consumption, recyclable materials are now a days the aims of chemical industries and they are driving towards more environmentally friendly processes. Development of different means, techniques, processes and methods for the removal of these pollutants is the challenge for scientist. Adsorption being a surface phenomenon depends on narrow particle size distribution, specific surface area, and porosity of an adsorbent (Sun et al., 2010; Ugurlu and Karaoglu, 2011; Hussein et al., 2016; Sun et al., 2018).