A nanoporous SBA-15 as adsorbent for removal of Organic Pollutants from Wastewater

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Abstract

Santa Barbara Amorphous (SBA-15) nanoporous silica was prepared using Tetraethylorthosilicate TEOS as silica precursor, Pluronic P123 as template, and characterized by means of X-ray diffraction (XRD), scanning electron microscopy (SEM), BET surface area and fourier transform infrared (FTIR) spectroscopy.

The adsorption behavior of methylene blue from synthetic wastewater onto mesoporous SBA-15 was studied. Both batch and continuous systems were studied. Batch experiments were carried out to measure the adsorption as a function of contact time, initial concentration (15-110 mg/l), pH (3-11) and adsorbent dose (0.1-2.3g/l) to specify the optimum operation condition. The equilibrium of the process was achieved

within 20 min. Adsorption isotherms were fitted with the Langmuir, Freundlich and Temkin models. The equilibrium data were best represented by the Langmuir isotherm model with higher correlation coefficient R^2 value of (0.990). The kinetics of the MB sorption on SBA-15 were examined by using pseudo-first and pseudo-second order kinetics models. The kinetics analysis manifested that the overall adsorption process was successfully fitted with the pseudo-second-order kinetic model.

In continuous studies, the adsorption of methylene blue from synthetic wastewater onto SBA-15 in fixed bed was investigated and breakthrough data of the dye was determined. This research is run in small scale column with an internal diameter of 0.7 cm and 35 cm height at constant temperature and pH value. The effect of bed height (3, 6, 9 cm), flow rate (0.6, 1.0,1.4 ml/min) and initial MB concentrations (40, 70, 100 mg/l) on breakthrough curves were investigated. It is found that breakthrough time increases with increasing bed height, but decreases with increasing methylene blue inlet concentration and flow rate. Thomas and Yan models were used to determine the kinetic constants and to predict the breakthrough curves. The experimental data showed a better fit to Thomas adsorption model.

In order to find out the possibility of reuse SBA-15, desorption study was also carried out in this investigation. SBA-15 can be effectively recovered by calcinations and reused fourteenth times in batch system and five times in continuous system without significant loss in removal of methylene blue from aqueous solution. The long reuse life of SBA-15 makes it an efficient adsorbent for removal of methylene blue from wastewater at high potential for application in industry.