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Dynamic and Equilibrium Adsorption Studies on Treatment of Pharmaceutical Wastewater using Commercial Charcoal based Activated Carbon

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Extended Abstract

Occurrence of pharmaceutical compounds in groundwater and surface water has become a major concern as the accumulation of these compounds in environment endanger human and aquatic life [1]. Drastic expansion in manufacturing and consumption of pharmaceutical chemicals in recent decades is owing mostly to advances in medical science and the growth in the global population. As a result, the pharmaceutical industry generates a huge volume of wastewater [2]. The nonbiodegradability of pharmaceutical-contained wastewater is one of the most significant challenges in wastewater treatment plants. Hence, the use of biological treatment in wastewater does not provide adequate treatment to fulfil the standard discharge limit. As a result, it is necessary to establish treatment approaches that reach the desired amount of elimination [3]. The selection of a treatment method depends on characteristics of wastewater, which in the case of pharmaceutical wastewater, the adsorption process, due to the simplicity of operation and high efficiency of process, has been proven to be a proper technique to deal with persistent pharmaceutical pollutants. Adsorption is separation of pollutants from a gas or liquid phase and accumulation of those compounds on a solid surface which is called adsorbent [4]. Adsorption is a physical process in which the matter adsorbs on the surface of adsorbent with weak bonds like Van der Waals forces or weak electrostatics interactions. Activated carbon is extensively employed in water treatment as an adsorbent that can remove a wide range of pollutants because of its huge surface area, non-selective nature, and low-cost of production [5].

The purpose of this study is to determine the effect of pollutant concentrations in wastewater on adsorption capacity and the rate of removal under conditions that are similar to those seen in pharmaceutical wastewater. It is also desirable to establish a model that best describes pollutant removal and adsorbent consumption through dynamic adsorption experiments to find the optimal condition. In order to achieve this goal, six pharmaceutical compounds were chosen in favour of making wastewater that mimic actual effluent from the pharmaceutical sector. Chemical oxygen demand removal is used to evaluate the process overall performance. The findings of the characterization of the adsorbent revealed that activated carbon has a highly porous structure with average pore diameter of 43Å. The results of dynamic adsorption experiments from batch studies showed that the rate of removal of pollutants is mainly controlled by rate of adsorption of pharmaceuticals on the active sites of the adsorbent and it can be best described by pseudo-second order reaction model. Furthermore, the outcome of equilibrium studies revealed that activated carbon has a considerable adsorption capacity, which makes it an excellent choice for the treatment of pharmaceutical wastewater.

Keywords: Pharmaceutical wastewater; Biodegradability enhancement; COD

References

[1] Joannis-Cassan, C., Rodriguez Castillo, A. S., Dezani, C., Gómez-Canela, C., Reoyo-Prats, B., Calas-Blanchard, C., Plantard, G. (2021). Towards an innovative combined process coupling biodegradation and photo-oxidation for the removal of pharmaceutical residues. Journal of Chemical Technology & Biotechnology, 96(3), 755-763.

[2] Mowla, A., Mehrvar, M., Dhib, R. (2014). Combination of sonophotolysis and aerobic activated sludge processes for treatment of synthetic pharmaceutical wastewater. Chemical Engineering Journal, 255, 411-423.

[3] Ghafoori, S., Shah, K. K., Mehrvar, M., Chan, P. K. (2014). Pharmaceutical wastewater treatment using granular activated carbon and UV/H2O2 processes: Experimental analysis and modelling. The Canadian Journal of Chemical Engineering, 92(7), 1163-1173.

[4] Wu, S., Qi, Y., Fan, C., Dai, B., Huang, J., Zhang, X., Chen, T., Zhou, W., He, S., Gao, L. (2017). Fe-Ni catalytic micro-electrolysis coupled with biological aerated filter for 2, 4, 6-trinitrotoluene production wastewater treatment. Journal of Cleaner Production, 156, 679-687.
[5] R.J. Perrich, R. J., Dabrowsk, A. (2001). Activated carbon adsorption for wastewater treatment.