

A comparative study of granular activated carbon and sand as water filtration media with estimation of model parameters

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Abstract. The use of Granular Activated Carbon (GAC) and naturally occurring silica (Sand) as filtration media in water and waste water treatment systems is very common. While GAC offers the additional functionality of being an “adsorptive” filter for dissolved organics it is also more expensive. In this paper we present an experimental evaluation of the performance of a bed of GAC for colloid removal and compare the same with that from an equivalent bed of Sand. The experiments are performed in an “intermittent” manner over extended time, to “simulate” performance over the life of the filter bed. The experiments were continued till a significant drop in water flow rate through the bed was observed. A novel “deposition” and “detachment” rate based transient mathematical model is developed. It is observed that the data from the experiments can be explained by the above model, for different aqueous phase electrolyte concentrations. The model “parameters”, namely the “deposition” and “detachment” rates are evaluated for the 2 filter media studied. The model suggests that the significantly better performance of GAC in colloid filtration is probably due to significantly lower detachment of colloids from the same. While the “deposition” rates are higher for GAC, the “detachment” rates are significantly lower, which makes GAC more effective than sand for colloid removal by over an order of magnitude.

Keywords: water purification; activated carbon; empirical model; filtration; transient model

1. Introduction

The use of granular activated carbon (GAC) is common in the purification of water. These materials are typically derived from coconut shells or palm shells (Mohammed *et al.* (2015)) or even uncommon materials like pomegranate peel (Rouabeh and Amrani (2012)). In addition to being a natural adsorptive material for many organic pollutants, GAC is also an excellent media for the removal of fine colloids. However, during use, GAC filters (Chatterjee and Gupta (2014)), columns and beds, can get clogged due to the deposition of colloidal matter on its surface. The phenomena of clogging of granular beds or columns with age is similar in systems as diverse as large sand based filtration plants to small powdered activated carbon based home use potable water filters. The mechanisms of sediment deposition and the resultant reduction of water flow due to clogging is similar across the above processes. This phenomenon may also be observed when

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