Treatment Characteristics and Prediction Models for the Removal of Typical Groups of Odourants by Activated Carbon Adsorption or Oxidation in Drinking Water Treatment Plants

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Abstract

Taste & Odour (T&O) issue has been a hot topic for the drinking water industry for a long time. We studied three categories of typical odourants in drinking water, i.e. (1) alcohols, aldehydes, ketones, and esters (ODNRs) (17 odourants); (2) pyrazines (5 odourants); (3) chlorophenols (CPs) (7 odourants). The treatment characteristics of 29 odourants by powdered activated carbon (PAC) adsorption and three common oxidants, i.e. chlorine, chlorine dioxide and potassium permanganate were tested in this study. The predicting models for adsorption isotherm and oxidation rate constant were established based on these results.

For AC adsorption, the pseudo-second order model could well describe the kinetic data while the Freundlich model and Langmuir model fitted the isotherm data well. Adsorption isotherm prediction models for different kinds of odourants based on physical and chemical parameters was also established. The models revealed that $\log K_{oc}$ had a positive linear relationship with the adsorption capacity for ODNRs and pyrazines, while dipole and surface tension were negatively related. The adsorption capacity for CPs was positively connected with pK_a and molar refractivity.

For oxidation, both chlorine and potassium permanganate were effective in removing most ODNRs while chlorine dioxide seemed to be ineffective. 3-methyl-1-butanol, dodecanol, and menthol could not be oxidized by chlorine, chlorine dioxide, or potassium permanganate. All CPs studied could be effectively removed by the oxidants whereas all pyrazines studied could be oxidized by neither oxidant. The model to predict the oxidation rate constant was established depending on molecular connectivity index (MCI). The model revealed the relationship between rate constant and lower order MCI and higher order valence MCI.

The results of this study will be used to add the treatability cycle around the classical T&O wheel and to guide the operation of drinking water treatment plants.