

**ADSORPTION AND BIOLOGICAL FILTRATION
OF
MICROCYSTINS**

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Abstract

For removal of microcystins (liver tumor promoting cyanotoxins) from drinking water granular activated carbon (GAC) filtration has been shown to be a very promising treatment option. It is not only an efficient adsorbent for microcystins but also can be operated as a biological reactor in which bacterial degradation of the toxins can occur extending the life-time of this application.

However, the competitive adsorption of coexistent natural organic matter (NOM) in all natural water sources would cause early breakthrough of microcystins and a lag-phase with uncertain length occurs prior to initiation of biodegradation. This project aimed to investigate the individual microcystin removal abilities by adsorption and biodegradation during GAC filtration in order to better understand the overall efficiency of this application. The simultaneous elimination of NOM in GAC filters was also investigated. In addition, to facilitate the biological removal of microcystins, the research aimed to identify the potential effect of key operational conditions on the degradation efficiency.

In this study microcystin removal in GAC filtration was divided into the adsorption and biodegradation phases. Effective adsorption of the toxins lasted only a short term in virgin GAC filters and the breakthrough behaviour was able to be modelled by the homogenous surface diffusion model (HSDM). The presence of biofilm on the surfaces of GAC resulted in a lower mass transfer coefficient (K_f) and lower adsorption kinetics of microcystins. In the biodegradation phase enhanced or complete removal was evident that was mainly due to biological metabolism. However, the highly efficient biodegradation of the toxins was difficult to predict in GAC filtration. Biodegradation was found to be easily affected by many operational factors.

NOM removal in GAC filters demonstrated specific features in this study due to the relatively high organic content in the Australian water. The adsorption efficiency decreased rapidly as the adsorption capacity became saturated.

Statement of Originality

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List of Publications

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Glossary of Abbreviations and Acronyms

AC	Activated carbon
Adda	3-amino-9-methoxy-2,6,8-trimethyl-10-phenyldeca -4,6-dienoic acid
BGAC	Biological granular activated carbon
DOC	Dissolved organic carbon
EBCT	Empty bed contact time
GAC	Granular activated carbon
HPLC	High performance liquid chromatography
HPSEC	High performance size exclusion chromatography
HSDM	Homogenous surface diffusion model
K_f	Film mass transfer coefficient
m-LA	Microcystin-LA
m-LR	Microcystin-LR
MW	Molecular weight
NOM	Natural organic material
PAC	Powdered activated carbon
SEM	Scanning electron microscopy
UV	Ultraviolet
UVA ₂₅₄	Ultraviolet absorbance at 254nm wavelength
WTP	Water treatment plant
TCE	Trichloroethylene
THMs	Trihalomethanes