

Cranfield University

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Disinfection Of Swimming Pool Water

**School of Industrial and Manufacturing Science
School of Water Sciences**

PhD Thesis

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Academic Year 2002-2003

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Supervisor

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October 2003

**This thesis is submitted in partial fulfilment of the requirements for
the Degree of Doctor of Philosophy**

Abstract

Results from this study, which has investigated the impact of the treatment technologies of chlorination, ozonation and UV irradiation on pool water quality are reported. The aim of the study was to evaluate the effect of these technologies in an unbiased way using a unique protocol, and to calculate a mass balance across the pool system. Data refer to a protocol based on operation of a 2.2m³ capacity pilot swimming pool, which allows the comparison of technologies applied with reference to the propensity to generate the chlorinated disinfection by-products (DBPs) of chloramines and trihalomethanes (THMs). The protocol makes use of a specially developed body fluid analogue (BFA), containing simulant endogenous organic matter, with a soiling analogue consisting of commercial humic acid (HA). Using this analogue, levels of organic carbon (OC) and chloramines similar to those recorded in real pools have been obtained, along with somewhat lower levels of THMs.

Results revealed conventional chlorination leads to steady-state TOC and DBP levels following an equilibrium period of 200-600 hours, with concentration values which are dependent upon BFA loading rate. Following equilibration nitrate is the only DBP accumulating in the pool water, accounting for between 4% and 28% of the ammoniacal nitrogen loaded into the pool depending upon the operating conditions (primarily the Cl:N ratio). Both UV irradiation and ozonation, the latter combined with downstream adsorption, provide a similar efficacy in reducing chloramine levels, with their effect on THM and nitrate formation being highly dependent on the pH level and chlorine dose rate.

This study builds on previous experimentation by including a more rigorous analysis of ozone-GAC with respect to DBP formation, a unique analysis of UV irradiation and a more comprehensive mass balance calculation of C, Cl and N across the pool. The study has established that no accumulation of carbon takes place in the pool, contrary to postulations made in previous published studies, and that the balance between the chloramines and THM DBPs is significantly affected by the HA loading.

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Acknowledgements

Firstly I would like to say thank you to Simon Judd for his supervision throughout my time at Cranfield and especially for all the help with the big words.

I would also like to thank the technical staff in the Water Sciences department for their support with laboratory analysis.

Thanks also to PWTAG for their advice and especially to those members who provided materials and maintenance for the model pool for free. Thanks also to Hanovia for providing and installing a UV machine.

Thanks lastly to EPSRC and PWTAG for providing funding for the research.

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Abbreviations

CAs	Chloramines
DBP	Disinfection By-Product
DCA	Dichloramine
DCAA	Dichloroacetic Acid
DOC	Dissolved Organic Carbon
GAC	Granular Activated Carbon
HA	Humic Acid
HAAs	Haloacetic Acids
HLc	Henry's Law Constant
ISRM	Institute of Sport and Recreation Management
MCA	Monochloramine
NOM	Natural Organic Matter
OIM	Organic and Inorganic Matter
PWTAG	Pool Water Treatment Advisory Group
TOC	Total Organic Carbon
THMFP	Trihalomethane Formation Potential
tTHM	Total Trihalomethane
USEPA	United States Environment Agency