ABSTRACT

Computational fluid dynamic (CFD) modelling has been applied to examine the operation of the pre-ozonation system at Wiggins Waterworks, operated by Umgeni Water in Durban, South Africa.

Ozonation is employed in water treatment process primarily to achieve the oxidation of iron and manganese, the destruction of micro-organisms and the removal of taste and odour causing compounds. It also aids in the reduction of the colour of the final water, enhancement of algae removal and possible reduction of coagulant demand.

A hydrodynamic model has been satisfactorily verified by experimental tracer tests. The effect of the gas injection was modelled by increasing the level of turbulence intensity at the ozone contactor inlet. The model prediction of the overall tracer response corresponded closely to the experimental results. The framework of ozone reaction modelling was subsequently established using values of rate constants from the literature. An accurate prediction of the ozone concentration profile requires the application of the correct ozone kinetics involved. In raw waters, the depletion of ozone is influenced by the presence of natural organic matters (NOM). The observed ozone decay was found in good agreement using the pseudo first-order rate law. By measuring the total organic carbon (TOC) as a surrogate for NOM, the experimentally determined rate constants can be calculated to account for the effects of the ozone doses and the water quality. The characterisation study also aimed to provide sufficient information on ozone depletion and to be operated easily, without the lengthy and costly analyses of a detailed kinetics study.

The predicted profile of residual ozone concentration suggests the current operating strategy can be improved to optimise the ozone utilisation. The proposed monitoring point was suggested to be at the end of second compartment where most ozone reactions have been completed. By coupling the transport equations of the target compounds with their chemical reaction rates, the concentration profile of these compounds such as ozone can be predicted in order to assist the understanding of an operation and to attain better interpretation of experimental results.