Hydrogen peroxide decomposition kinetics in aquaculture water

Hydrogen peroxide (HP) is used in aquaculture systems where preventive or curative water treatments occasionally are required. Use of chemical agents can be challenging in recirculating aquaculture systems (RAS) due to extended water retention time and because the agents must not damage the fish reared or the nitrifying bacteria in the biofilters at concentrations required to eliminating pathogens. This calls for quantitative insight into the fate of the disinfectant residuals during water treatment. This paper presents a kinetic model that describes the HP decomposition in aquaculture water facilitated by microbial enzyme activity. The model describes how the hydrogen peroxide removal declines and eventually stops at relatively low chemical oxygen demand (COD) concentrations. It is hypothesized that this is due to an enzyme deficit because it is destructed due to the reactive radicals created during the HP decomposition. The model assumes that the enzyme decay is controlled by an inactivation stoichiometry related to the HP decomposition. In order to make the model easily applicable, it is furthermore assumed that the COD is a proxy of the active biomass concentration of the water and thereby the enzyme activity. This was, however, not measured. The model developed successfully described the removal of HP in aquaculture water from three types of RAS and model parameters are estimated. The model and the model parameters provide new information and are valuable tools to improve HP application in RAS by addressing disinfection demand and identify efficient and safe water treatment routines.