Modeling effects of manganese, zinc and lead from industrial wastewaters on microbial activities in facultative waste stabilization ponds

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The work embodied in this thesis is based on an experimental set-up that involved the study of the effects of manganese (Mn^{2+}), zinc (Zn^{2+}) and lead (Pb^{2+}) metal ions on microbial growth kinetics by following the rate of change of bio-mass concentration during batch experiments of artificial laboratory scale Waste Stabilisation Ponds (WSPs). Different concentrations of Mn^{2+} reactors keeping all environmental parameters constant(pH, light intensity, basic nutrients).The combined effects of Mn^{2+} , Zn^{2+} and Pb^{2+} ions were determined by mixing these metallic ions in equal ratios of 1/1/1, 5/5/5, 10/10/10 and 20/20/20 mg/l of Mn^{2+} , Zn^{2+} and Pb^{2+} ions, respectively. Inocula seeded to the system were obtained from Vingunguti primary facultative pond system used to treat industrial wastewater. A synthetic feed solution containing 210 mg/I glucose (corresponding to 180 mg/I and 300mg/I respectively) served as sources of carbon The analyses were done at the Environmental Engineering Laboratory at the prospective College of Engineering and Technology (pCET) and in the Microanalysis Laboratory, in the Chemistry Department, Faculty of Science, University of Dar es Salaam. The laboratory experiments showed that a rise in the concentration of the heavy metals increases the mortality rate of heterotrophic bacteria, and vice versa. Experimental data showed that Zn^{2+} ions were less toxic than Mn^{2+}, Zn^{2+} ions. Moreover, bio-kinetic parameters were not adversely affected by the presence of Zn^{2+} ions up to a concentration of 10 mg/I in the sediment. However, for $Mn^{2+,}$ this was true for a concentration of less than 10mg/I. For Pb^{2+} ions, the bio-kinetic parameters were slightly unaffected until a threshold Pb^{2+} ion concentration of 5 mg/I in the sediment was reached. However, a concentration of 10 mg/I and

higher, caused serious upsets in the system. Introduction of equal ratios of heavy metal ions Mn^{2+}, Zn^{2+} and Pb^{2+} to wastewater for treatment using FWSP produced serious upsets on algae and heterotrophic bacteria as represented by growth. The negative effect caused by these combinations is higher in inhibitory effect compared to Mn^{2+}, Zn^{2+} and approximately equal with Pb^{2+} ions singly. Results obtained from combined effects of Mn^{2+} , Zn^{2+} and Pb^{2+}ions concentrations of 1/1/1, 5/5/5 and 10/10/10 mg/I were equal to that ofPb^{2+} ions alone. Results obtained indicates that even at a higher concentration of 20 mg/I there is a slight change but not significant between the combined (Mn^{2+} , Zn^{2+} and Pb^{2+} and the P132+ ions alone system. An ecological model describing the effect of heavy metals on microbial activities in WSP as represented by growth has been developed and supported by experimental data. Validation of the model showed that there is a good agreement between measured and simulated results with a good correlation coefficient (0.7984 5 R2 0.9971). This indicates that the model structure and the complexity developed are adequate enough to predict the effect of heavy metals on algae and heterotrophic bacteria as represented by growth in facultative WSPs in the tropics.