UNIVERSITY TEKNOLOGI MARA

ASSESSING OXYGEN UPTAKE RATES IN SEWAGE TREATMENT SYSTEM

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ABSTRACT

Aerobic biological treatment of wastewater needs a sufficient supply of oxygen for it to proceed properly. Untreated wastewater if discharged into receiving waters would have a serious impact on the quality of the environment and a hazard to public health. The study assessed the oxygen uptake rate (OUR), which represents the consumption of dissolved oxygen over time of the biodegradation of organic substrates by micro-organisms in the activated sludge treatment process, and its relationship with wastewater conditions, oxygen mass transfer and oxygenation efficiencies. Though OUR is a significant parameter for wastewater treatment process, very few relevant data are available to local wastewater treatment plants. Measurement of OUR was carried out by a respirometric method and the OUR values, determined by linear regression of the DO data points, has values ranging from 2.5 – 9.5 mg/L.h. The effects of wastewater conditions on the OUR profile showed a close and direct relationship with the dissolved oxygen content, the mixed-liquor volatile suspended solids and the biochemical oxidation demand loading, indicating that OUR can complement them as a control parameter in the activated sludge process, but OUR can be regarded as more superior since it is directly indicative of respiratory metabolic process by aerobic biomass. Aeration systems employing diffused-air and mechanical surface aeration systems were used for the assessment of transfer of atmospheric oxygen to the mixed liquor. The mass transfer coefficient for oxygen, ranging from 0.80 to 1.46 per hour for the aeration systems, were derived from the measured OUR values and incorporated into the field oxygen transfer rate for subsequent conversion into standard oxygen transfer rate (SOTR) which can serve as an important control parameter for the wastewater aeration process. The adequacies of oxygen supply for the wastewater treatment process by both the different aeration systems were assessed, and oxygenation efficiencies of the aeration systems for the diffusers and mechanical aerators vary from 1.12 to 1.26 and 1.06 to 1.19 $kgO_2/kW.h$ respectively, indicating that energy consumption for the aeration process was optimal. The OUR measurement by respirometry was found to be simple and practical enough to be introduced for implementation into local wastewater treatment plants to monitor daily operational control, system performance and aeration efficiency. An on-line monitoring of OUR can have a potential for incorporation into larger local treatment plants already equipped with the Supervisory Control and Data Acquisition System for more efficient wastewater treatment process monitoring and management.

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INTRODUCTION

1.1 BACKGROUND

Communities produced liquid wastes from water supplied to their households, institutions and industries after being used. The wastewater, or sewage, comprising a complex mixture of dissolved and suspended organic materials, if left untreated would accumulate, turn septic and decompose causing serious negative environmental and health impacts (Metcalf & Eddy, 2004).

In Malaysia, sewerage services provided in the form of waterborne sewerage systems were introduced as far back as the 1930s, but the development was slow and confined to only a few major towns (Chin, 2008). With the rapid growth of population and good network of piped water and the country's urbanization process since the 1960s, better WSS systems were undertaken to phase out the less satisfactory disposal systems, such as septic tanks, bucket, pit latrines and pour flush systems. The implementation of WSS was further enhanced by the Local Government Act 1976 which prohibited waste disposal into streams, water courses or public drains and to maintain public health.

The Environmental Quality (Sewage & Industrial Effluents) Regulations (1979) was enacted in 1979 to regulate effluent discharges from the sewerage systems and industrial wastewater treatment systems to ensure compliance with effluent standards imposed by the Government. This led to increasing focus on the environment and public health aspects in designing and constructing sewerage systems to meet the need of the time. In the 1980s, the sewerage treatment capability in all major urban centres in the country was enhanced with the introduction of modern sewerage systems like rotating biological contactors, extended aeration activated sludge and aerated lagoons. Major developments of the sewerage services sector in Malaysia during the later part of the twentieth century from the 60s to 2005 witnessed the most rapid and significant modernization of the sewerage facilities during the 1990s (Ujang, 2006).