ABSTRACT

Microbubble is defined as bubble whose diameter is smaller than one millimeter and greater than one micrometer. Its micro size offers numerous advantages in comparison to the conventional size bubble, such as in terms of higher gas-liquid contact area and very slow rising velocity. Recently, the interest in the application of microbubble has rapidly grown in various industrial processes.

This research was conducted to investigate microbubble bubble generator (MBG) performance for biological wastewater treatment. Parameters to be evaluated for the performance of microbubble generator are diameter of the bubbles, oxygen volumetric mass transfer coefficient, and removal concentration of pollutant represented by chemical oxygen demand (COD). Measurement of bubble diameter and oxygen volumetric mass transfer coefficient was conducted on a rectangular transparent glass box for visualization. Air and water were used as the working fluids. The ranges of air and water flow rates were set at 0.1 – 1 lpm and 30 – 80 lpm, respectively. Bubble diameter was measured using digital image processing method, and oxygen volumetric mass transfer coefficient was measured using the dynamic modeling method. The MBG testing for wastewater treatment was conducted in a pond with lengths of 3 m, and width of 3 m which contains artificial wastewater with depth 0.4 m. Four MBGs were used for generated bubble. The total ranges of air and wastewater flow rates at MBG inlet were set at 2 – 4 lpm and 160 – 240 lpm, respectively. The concentration of pollutant represented by chemical oxygen demand (COD) was measured periodically.

The study confirmed that the bubble diameter, oxygen volumetric mass transfer coefficient, and COD removal were affected by water flow rate and air flow rate into the MBG. Increasing water flow rate causes decreasing bubble diameter, improving uniformity of bubble size distribution, increasing oxygen volumetric mass transfer coefficient, and increasing COD removal rate. By using dimensional analysis, the empirical correlation of volumetric mass transfer coefficient, average bubble diameter, and bubble diameter distribution, was proposed. The correlation showed that liquid Reynolds number played the most important role .

Keywords: microbubble generator, bubbles diameter, oxygen volumetric mass transfer coefficient, COD, dimensional analysis.

INTISARI

Microbubble didefinisikan sebagai gelembung yang diameternya lebih kecil dari satu milimeter dan lebih besar dari satu mikrometer. *Microbubble* mempunyai keuntungan dibandingkan dengan gelembung ukuran konvensional yaitu luas kontak gas-cair yang lebih tinggi dan kecepatan naik yang sangat lambat. Saat ini, aplikasi *microbubble* semakin menarik perhatian para praktisi untuk dijajaki kemungkinan aplikasinya dalam berbagai proses industri.

Penelitian ini dilakukan untuk mengevaluasi kinerja *microbubble generator* (MBG) untuk pengolahan air limbah secara biologis. Parameter yang digunakan untuk mengevaluasi kinerja *microbubble generator* adalah diameter *bubble*, koefisien perpindahan massa volumetrik oksigen, dan pengurangan kadar polutan yang dinyatakan sebagai *chemical oxygen demand* (COD). Pengukuran diameter gelembung dan koefisien perpindahan massa volumetrik oksigen dilakukan pada bak kaca transparan. Udara dan air digunakan sebagai fluida kerja. Inlet MBG diatur dengan debit udara antara 0,1-1 lpm dan debit air antara 30 - 80 lpm. Diameter *bubble* diukur menggunakan metode pemrosesan *image* digital dan koefisien perpindahan massa volumetrik oksigen diukur menggunakan metode pemodelan dinamis. Pengujian *microbubble generator* untuk pengolahan air limbah dilakukan di kolam dengan panjang 3m, dan lebar 3m yang berisi air limbah buatan dengan kedalaman 0,4 m. Empat buah MBG digunakan untuk menghasilkan *bubble*. Debit total udara antara 2 - 4 lpm dan debit total air limbah antara 160 - 240 lpm. Pengukuran kadar polutan yang dinyatakan sebagai *chemical oxygen demand* (COD) dilakukan secara berkala.

Hasil penelitian menunjukkan bahwa diameter *bubble*, koefisien perpindahan massa volumetrik oksigen dan laju pengurungan COD dipengaruhi debit air dan udara. Peningkatan debit air menyebabkan penurunan diameter *bubble*, distribusi ukuran *bubble* lebih seragam, peningkatan koefisien perpindahan massa volumetrik dan peningkatan laju pengurangan COD. Dengan menggunakan analisis dimensi, diusulkan korelasi empiris diameter rata-rata *bubble*, distribusi diameter *bubble* dan koefisien perpindahan massa volumetrik. Korelasi menunjukkan bahwa angka Reynolds cairan memainkan peran paling penting.

Kata kunci: microbubble generator, diameter bubble, koefisien perpindahan massa volumetrik, COD, analisis dimensi.