

## INTISARI

Pencemaran logam, limbah dan zat kimia yang berbahaya menyebabkan kualitas dan persediaan air bersih menurun. Di sisi lain, permintaan akan air bersih terus meningkat. Beberapa industri yang berkembang di Indonesia masih banyak yang belum memiliki sarana pengolahan air limbah yang memadai. Permasalahannya pada pengeluaran dana besar untuk membuat unit IPAL (Instalasi Pengolahan Air Limbah) yang dianggap dapat mengurangi keuntungan. Hal tersebut memerlukan upaya pengolahan air limbah dengan menciptakan sebuah teknologi yang efektif dan efisien. *Microbubble generator* merupakan salah satu teknologi terbaru dan ramah lingkungan yang banyak dikembangkan saat ini. Alat ini digunakan untuk menghasilkan oksigen terlarut dalam memelihara mikroorganisme yang terdapat pada air limbah, sehingga mikroorganisme tersebut mampu melakukan dekomposisi air limbah.

Penelitian ini dilakukan pada tempat uji berukuran 280 cm x 60 cm dengan tinggi 40 cm menggunakan *microbubble generator* tipe *porous-venturi* dengan sudut *inlet* 30° sudut *outlet* 20°. Tujuan penelitian ini untuk mengetahui diameter distribusi *microbubble*, unjuk kerja *microbubble generator* (MBG), koefisien perpindahan massa volumetrik ( $K_{La}$ ) dan *chemical oxygen demand* (COD). Pengukuran distribusi *microbubble* tersebut menggunakan Phantom Control Camera dengan kecepatan perekaman 2000 fps. Data dari hasil perekaman kemudian diolah menggunakan MATLAB R2016a. Unjuk kerja MBG diukur dengan *pressure transducer* dan nilai  $K_{La}$  didapat dari data pengukuran *dissolved oxygen* (DO) menggunakan DO meter Lutron 5510. Analisis pengukuran nilai COD diambil dari limbah buatan dengan menggunakan metode refluks tertutup.

Berdasarkan hasil penelitian, perbandingan debit gas dan debit air memiliki pengaruh yang signifikan terhadap pembentukan *microbubble*. Probabilitas diameter *microbubble* terbesar terletak di sekitar 200  $\mu\text{m}$ . Unjuk kerja MBG dianalisis dari *hydraulic power* ( $L_w$ ) dan *bubble generating efficiency* ( $\eta_B$ ). *Hydraulic power* meningkat seiring peningkatan debit air ( $Q_L$ ) dan pengaruh variasi debit gas memiliki efek yang kecil terhadap  $L_w$ . Seiring itu, parameter *bubble generating efficiency* berkurang seiring dengan meningkatnya debit air ( $Q_L$ ). Peningkatan kecepatan aliran cairan ( $Q_L$ ) menyebabkan perubahan terhadap koefisien perpindahan massa volumetrik ( $K_{La}$ ). Perbandingan jarak pengukuran DO meter dari nosel MBG sejauh 60 cm memiliki nilai  $K_{La}$  lebih besar dari jarak pengukuran 180 cm. Pada pengujian air limbah buatan, penurunan nilai COD terjadi setelah proses aerasi menggunakan MBG. Namun, nilai DO terus mengalami peningkatan sehingga mencukupi suplai oksigen untuk perkembangan bakteri. Hal tersebut menyebabkan laju penguraian senyawa organik dan efisiensi pengolahan limbah secara aerobik juga meningkat.

**Kata Kunci** : *microbubble generator, porous, venturi, dissolved oxygen, image processing, hydraulic power, bubble generating efficiency, chemical oxygen demand*

## ABSTRACT

Contamination of harmful metals, waste, and chemical compound can decrease both of quality and availability of fresh water. On the other hand, the demands of fresh water are continuously increasing. Various developing industries in Indonesia are known to have qualifying water contamination management. The biggest obstacles affecting this situation is due to the great budget needed to build the installation of contaminated water management (IPAL) which is believed to decrease the profit. This situation needs a new strategy in water management by developing a highly effective and efficient technology. Microbubble generator is one new, eco-friendly technology to be developed. This equipment is utilized to produce dissolved oxygen to preserve the microorganisms living in the waste water, allowing them to decompose the waste water.

This research was held in an experiment compartment with 280 cm x 60 cm x 40 cm in size by using porous venturi microbubble generator possessing 30° inlet and 20° outlet angles. The purposes of this research are to determine the microbubble distribution diameter, the microbubble generator performance (MBG), the displacement coefficient of volumetric mass ( $K_{La}$ ) and so did the chemical oxygen demand (COD). The microbubble distribution was measured using Phantom Control Camera with the recording rate about 2000 fps. The data obtained was then analyzed using MATLAB R2016a. The performance of the MBG was measured using pressure transducer and the  $K_{La}$  value was resulted from the measured dissolved oxygen (DO) data by using DO meter Lutron 5510. The measurement analysis of COD values was taken from artificial waste using closed reflux method.

Based on the obtained results, the comparison of gas and water flowrate was significantly affecting the microbubble formation. The results also indicated that the highest bubble probabilities was approximately 200  $\mu\text{m}$ . The performance of MBG was analyzed from the value of hydraulic power ( $L_w$ ) and bubble generating efficiency ( $\eta_B$ ). The hydraulic power was inclining as the water debit increase ( $Q_L$ ) and the effect of the gas debit variation was showing a little effect towards the  $L_w$ . In addition, the bubble generating efficiency parameter was decreasing as the water debit increase ( $Q_L$ ). The increasing rate of the fluid flow ( $Q_L$ ) affected the changing of displacement coefficient of volumetric mass ( $K_{La}$ ). The DO meter distance comparison from the MBG nosel as far as 60 cm was possessing the bigger  $K_{La}$  value compared to the measured distance of 180 cm. In the test of artificial wastewater, the reduction of COD value occurs after aeration process using MBG. However, the value of DO increases so sufficient oxygen to supply for bacterial development. This causes the rate of decomposition of organic compounds and the efficiency of aerobic waste treatment also increases.

**Keywords:** microbubble generator, porous, venturi, dissolved oxygen, image processing, hydraulic power, bubble generating efficiency, chemical oxygen demand.