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曝气增氧微气泡-水界面和水体表面的氧传质的计算分析

Calculated analysis of oxygen transfer from air bubble-water interface and turbulent water surface in microporous aeration systems

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中文摘要:

在水产养殖池塘中微孔曝气充氧系统日益受到关注，为了探究微气泡-水界面与水表面湍动对氧传质的贡献，在不同曝气流量、不同淹没水深条件下进行了水体底部微孔曝气增氧试验。基于氧体积传质理论，采用美国土木工程协会推荐的计算模型和两区氧传质模型进行耦合求解，计算得到了水体底部微孔曝气增氧过程中气泡-水界面和水表面湍动扩散氧体积传质速率。对温度修正后的体积传质速率进行分析，结果表明，在一定的淹没水深下，气泡-水界面和水表面湍动扩散氧体积传质速率均与曝气流量成正比；而在一定的流量下，气泡-水界面和水表面湍动扩散氧体积传质速率与水深成反比。针对于浅型养殖池塘，随着曝气管淹没水深的增加，虽然水表面传质的贡献率有所下降，但是其贡献仍然很大，占到了80%以上。结合微孔曝气式增氧系统具有能耗较低、安装简单等优点，采用微孔曝气式增氧系统对浅型水域增氧和湍动混合具有较大优势，值得推广采用。

英文摘要:

Abstract: Micro porous aeration systems for increasing dissolved oxygen concentration in an aquaculture pond are receiving more and more attention. In order to explore the contribution of a micro bubble-water interface and the turbulent water surface to oxygen mass transfer, after placing a disc which was made of a curled micro porous diffuser tube in the middle bottom of an experimental pond, a series of re-oxygenation experiments were conducted under the conditions of different aeration flow and submerged water depth. Based on the theory of oxygen volume mass transfer, the calculation model recommended by the American Society of Civil Engineering (ASCE) was coupled with the Two-Zone oxygen transfer model, and then the two kinds of oxygen volume mass transfer coefficients across the micro bubble-water interface and across the turbulent water surface during the re-oxygenation process in the bottom of the experimental pond were calculated. After water temperature correction, the values of oxygen volume mass transfer coefficients across the micro bubble-water interface and across the turbulent water surface were found to be in a relationship with the aeration flow and submerged water depth of micro porous diffuser tube. Under a certain submerged depth of micro-porous tube, the bubble-zone volumetric mass transfer coefficients and the surface re-aeration-zone volumetric mass transfer coefficients are proportional to the diffused airflow rate. However, under a certain diffused airflow rate, the two zone mass transfer coefficients are inversely proportional to the water depth. For shallow aquaculture ponds, with the increase of submerged water depth of micro-porous tube, though the contribution of water surface to oxygen mass transfer has been weakened a little, however, the ratio of contribution on re-oxygenation still accounts for more than 80%. Combining micro porous aeration systems has the advantage of low energy consumption and simple installation, using the micro porous diffuser system to increase dissolved oxygen concentration and water turbulent mixing in shallow water has a greater advantage, and is worth popularizing.

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