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The ozone mass transfer characteristics and ozonation of pentachlorophenol in a novel microchannel reactor

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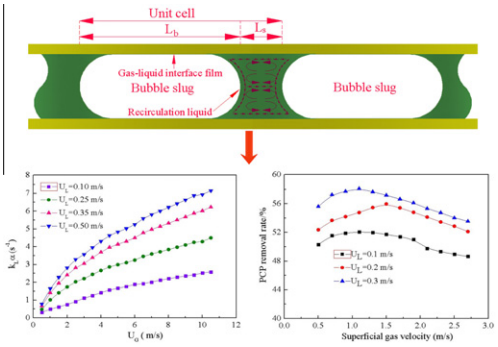
HIGHLIGHTS

- Correlations of $k_L\alpha$ with Sh_L, Re_G, Re_L, Sc for different flow patterns were proposed.
- Gas–liquid interfacial area was determined by chemical adsorption method.
- k_L at different U_G, U_L values were evaluated based on interfacial area determined.
- The reaction rate between PCP and O_3 fell in the instantaneous regime.
- Both mass transfer and residence time dominated PCP removal rate in microchannel.

GRAPHICAL ABSTRACT

The simplified geometry model of gas–liquid two-phase reaction in the microchannel reactor employed, in addition, the evolution of $k_L\alpha$ and PCP elimination rate with superficial liquid and gas velocities were shown above. The results revealed that the use of microchannel reactor could lead to noticeable enhancement in both mass transfer efficiency and the pollutant degradation efficiency.



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ABSTRACT

A "T" junction microchannel was employed to investigate the ozone mass transfer characteristics without chemical reaction taking place in the solution firstly. The correlations of the experimental $k_L\alpha$ values with dimensionless numbers: Sh_L, Re_t, Re_L, Sc for Taylor, slug–annular and churn flow regimes were proposed through a least square regression method. The gas–liquid interfacial area was determined by chemical adsorption method in the present work. The results indicated that the effect of superficial liquid velocity on the interfacial area was insignificant compared with that of superficial gas velocity. And on the basis of the interfacial area determined above, the liquid side ozone mass transfer coefficient under varied superficial gas and liquid velocities was calculated. The mass transfer rate was accelerated in the presence of PCP in solution. The reaction rate between PCP and O_3 was proved to fell in the instantaneous regime based on the experimental results of E_{O3} increasing with either liquid PCP concentration or the reciprocal interfacial ozone concentration, $(C_{O3,L,i})^{-1}$. In addition, further studies indicated that dissociation of PCP and the elevation of the average mass transfer driving forces caused by increasing pH and gaseous ozone concentration, respectively, availed the degradation of PCP in the microchannel.

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