Removal of ammonia by high-frequency ultrasound wave (1.7 MHz) combined with TiO$_2$ photocatalyst under UV radiation

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ABSTRACT

This study aims to use high-frequency ultrasound wave combined with ultraviolet radiation and titanium dioxide as a photocatalyst for ammonia removal. The performances of several treatment methods including aeration, ultraviolet, ultrasound, ultrasound–aeration, ultrasound–ultraviolet, ultraviolet–titanium dioxide–aeration, and finally ultrasound–ultraviolet–titanium dioxide were compared. The results clearly indicated the superiority of ultrasound–ultraviolet–titanium dioxide (US/UV/TiO$_2$) system over other treatment processes. The effect of various variables including initial ammonia concentration, pH, TiO$_2$ dosage, liquid height, UV intensity, and ultrasound frequency were investigated in the US/UV/TiO$_2$ system. The results show that the removal efficiency of ammonia reduced as the initial ammonia concentration and liquid height increased. However, increase in TiO$_2$ dosage caused an increase in removal efficiency. In addition, the optimum removal efficiency of US/UV/TiO$_2$ system for ammonia was obtained at pH 11. After 120-min sonication by high-frequency ultrasonic wave and UV radiation in conjunction with TiO$_2$, almost 100% ammonia removal was achieved. In addition, the results demonstrated that the UV intensity has significant influence on the removal efficiency of ammonia in the US/UV/TiO$_2$ system. The presented results show that high-frequency ultrasound plays the main role in the US/UV/TiO$_2$ system owing to its ability to generate atomization and acoustic streaming.

Keywords: Ultrasound (US); High frequency; Ultraviolet (UV); TiO$_2$; Ammonia removal