Developing a Langmuir-type excitation equilibrium equation to describe the effect of light intensity on the kinetics of the photocatalytic oxidation

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Developing a Langmuir-type excitation equilibrium equation to describe the effect of light intensity on the kinetics of the photocatalytic oxidation

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Abstract: The electron-hole pair is a higher energy state of catalyst atoms due to the absorption of photons and thus is viewed to be a single species in photocatalytic reactions. The excitation rate of the electron-hole pair is assumed to depend on light intensity and the unexcited coverage. The destruction rate of the electron-hole pair is proportional to the excited coverage of the electron-hole pair. A Langmuir-type excitation equilibrium equation of the electron-hole pair is derived. The adsorption, desorption and reaction of pollutants on the surface of catalyst are considered simultaneously in the conservation equation of pollutant coverage. A Langmuir-Hinshelwood type kinetics is derived that is valid for all light intensity values and reproduce the three typical dependences of reaction rate on light intensity. The present reaction rate equation is validated against the experimental data in literature. Good agreements have been obtained for light intensity regimes in literature.

Keywords: light intensity; photocatalytic oxidation; the electron-hole pair; the excitation equilibrium equation

1. Introduction