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A Newly Designed Rotating Flow Tube Reactor for Studies of Liquid-Phase Uptake of Reactive Gas Species

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Coated-wall flow tube reactors are frequently used to study gas uptake and heterogeneous or multiphase kinetics under laminar flow conditions. Due to the technical feasibility of wall coating for solid/semisolid phase, investigations of uptake of gas species on various solid/semisolid surfaces have already been conducted through the coated-wall flow tube technique. However, regarding measurements of gas uptake on liquid surfaces, normally it is difficult to achieve an evenly dispersed coating of liquid at the tube wall through traditional coating method (especially for liquid with low viscosity), complicating the derivation of basic kinetic parameter such as the uptake coefficient. In this study, we designed a liquid-coated-wall flow tube which can be easily adopted for gas-liquid interaction investigations. An evenly dispersed thin liquid film was formed on the inner wall of the rotating flow tube reactor and this apparatus was further applied to investigate the uptake kinetics of gaseous reactive gases on liquid surfaces. Considering that gaseous SO_2 plays an important role in the formation of sulfate in atmospheric aerosols, it is necessary to study the uptake of SO_2 on liquids, to simulate the uptake kinetics of SO_2 on ambient liquid-phase aerosols. Here, the uptake coefficient of SO_2 on water solutions with different pH values (from 0 to 14) was measured and the uptake coefficient was determined. The results were comparable to previous studies. With this designed rotating flow tube reactor, further investigations can also be performed for measurements of uptake of other reactive gaseous species at the gas-liquid interface reflecting the real atmospheric conditions.