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Reaction Mechanism on Denox by Vacuum Ultra Violet Irradiation

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Abstract

Emission of nitrogen oxides (NO_x) from stationary combustors and ship diesel engines has been regulated for environmental pollution control and public health. Selective catalytic reduction (SCR), an efficient treatment technology, has been used world-wide for NO_x removal in large-scale combustors such as coal-fired power plants. In SCR systems, nitric oxide (NO) reacts with injected molecular ammonia in the presence of a catalyst and oxygen at a temperature of around 350 °C at which NO converts to molecular nitrogen and water. A drawback of SCR systems in application to incinerators and ship diesel engines is that they are particularly costly because frequent replacement of the catalyst is required owing to catalyst poisoning by sulfur dioxide, plugging and erosion by ammonium bisulphate, and deposition of ash, amongst others.

We have been developed an original deNO_x reactor using vacuum ultraviolet (VUV) of 172 nm wavelength. The advantages of the deNO_x system are no catalyst, ammonia free and low temperature reaction. The photochemical reactor using the VUV may be able to apply to waste incinerators and ship exhausts.

In this study, reaction mechanism of deNO_x by the VUV were investigated to find a rate-controlling reaction step. The rate constants of photochemical reactions were measured in NO/N_2, NO_2/N_2, $NO/O_2/N_2$, and $NO/O_2/H_2O/N_2$ gas systems using a VUV photochemical reactor. The photochemical reactor had an inner diameter of 80 mm, and the length was 100 mm. An outer diameter of the excimer lamp was 40 mm, therefore, the gap length between the lamp and the inner wall of the reactor was 20 mm. The power density of the VUV lamp was 27 mW/cm^2 at the lamp surface.

Some elemental reactions on deNO_x by VUV irradiation were suggested by experimental results. The reaction mechanism were verified by elemental chemical reaction simulation using CHEMKIN. The simulation results were good agreement with the experimental results. The reaction rate constant and the reaction mechanism on deNO_x by VUV irradiation were elucidated.