126e Post-Combustion Reduction of Nitrogen Oxide from Stationary and Mobile Sources

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Stationary and mobile combustion processes are the two major sources of emission NO. Under the sponsorship of the US Department of Energy, we have elucidated a reaction mechanism of NO reduction in fuel-rich flames similar to reburning, e.g, 1100°C and stoichiometric ratio (SR) in the range of 0.8 to 0.9 (Chen and Ma, AIChE J., 42(7), 1968, 1996; Chen and Tang, AIChE J., 47(12), 2781, 2001). This mechanism involves the proper ingredients of catalysts and carbon type, and rapid production of CO. Consequently, mixed fuels such as natural gas and lignite ash serve as very effective reburning fuels. The concept was further extended to reburning fuel components of even lower costs (Chen and Sarv, provisional application of patent, 2005).

Recently, the possibility of applying the very reaction mechanism and novel design of NO-reduction medium to the post-combustion zones of coal-fired boilers and the exhaust gas from automobile engines has been explored. These post-combustion zones are usually fuel lean, SR at about 1.1, and their temperature is usually lower than those in flames, 300 to 600°C. To validate the new concept, a flow reactor is converted to a fixed-bed reactor that contains low-cost, novel material, and NO reduction efficiency was evaluated under the aforementioned conditions. On-line analyzers and computers monitor NO, CO and CO2 of the effluent stream.

Noticeable amount of NO is reduced at 300°C. About 50% of NO is reduced at 400°C with a contact time about 0.14 s. Increasing the residence time enhances NO conversion. Data suggest that high NO reduction is accompanying high CO concentration, signifying the importance of previously revealed mechanism. Reaction rate constants have been estimated, which will allow design of catalytic reactor similar to the catalytic converter for automobile engines and that for coal fired boilers. The potential impact of this new discovery is expected to be enormous; a patent application is planned.