Bench- and Pilot-Scale Evaluation of SCR and Other Catalytic Technologies

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Summary

The performance and economic effectiveness of SCR catalysts and other environmental catalysts depend on many specific factors including fuel and flue gas composition, nature and the amount of catalyst, and operating parameters. Aging and poisoning are also primary factors affecting catalyst performance. The results of earlier and current GE-EER studies show that accurate assessment of catalyst cost-effectiveness often requires exposure times on the order of several thousand hours and big catalyst samples. GE-EER has developed bench- and pilot-scale test facilities to study the performance of new environmental catalysts and compare catalysts available on the market. The bench-scale facility is attached to a 0.1 MMBtu/hr burner and is designed to screen a variety of catalysts and select optimum operating conditions for specific applications. Currently, the bench-scale facility allows simultaneous evaluation of up to five small catalyst coupons, or a single catalyst sample with a volume of up to 1500 cm^3. The pilot-scale facility is designed to simultaneously test up to eight different full-scale catalyst bricks with a cross section 15x15 cm under identical operating conditions. The facility is attached to a 4 MMBtu/hr boiler simulator capable of firing gas, oil or coal. Both facilities provide accurate control over crucial operating conditions, such as temperature and space velocity. Numerous injection and sampling ports are used for precise tailoring of flue gas composition for trace compounds of interest, including hazardous air pollutants and catalyst poisons. The diagnostic equipment includes gas analyzers and FTIR spectrometer. The analysis can be performed both on dry- and hot/wet basis.

Several experimental programs are being conducted in these facilities. Ammonia guard catalyst and advanced SCR catalysts designed for operation with alternative reducing agents (i.e., hydrocarbons instead of ammonia) are tested at bench scale. The goal of these tests is to demonstrate the ability of new catalysts (oxo-complexes with d-metals) to achieve over 90% NO_x reduction with ammonia slip lower than 2 ppm. The mechanism of NO_x reduction by methane and propane is discussed. Initial experimental data on NO_x reduction and ammonia removal are presented.

At pilot scale, industrial CO oxidation catalysts are being tested for their activity on aldehyde removal from natural gas engine exhaust stream. The primary goal of these tests is to demonstrate the performance of commercially available oxidation catalysts in removing formaldehyde. Eight catalyst samples (both on metal and ceramic substrates) from three different manufacturers are compared for their efficiency in removing formaldehyde and CO, aging properties over the testing period (four months), and effect of flue gas composition. The tests demonstrated that leading catalysts providing about 95% CO oxidation could also oxidize 60-75% formaldehyde. Parametric tests revealed the effects of operating parameters on performance of catalysts, including effects of space velocity, catalyst temperature, inlet formaldehyde concentration, and minor flue gas constituents.