Investigation of the aging effect on the activity of a wiremesh oxidation catalyst as an emission control device for 4-stroke gasoline carburetor motorcycles

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Over one million motorcycles operating in the city of Tehran, capital of Iran, account for significant emissions of carbon monoxide (CO), volatile organic compounds (VOCs) and particulate matter (PM). Oxidation catalysts, as exhaust aftertreatment system of motorcycles, can reduce emissions of CO, VOC and PM. Due to the specific features of motorcycles under study, such as ultra-rich combustion and significant lubricating oil burning selection of an active, durable and cost-effective exhaust catalyst is a challenge. In addition, stability of such catalyst over high mileage needs to be investigated. In the present work, oxidation of CO and propylene (as a representative of VOCs) over a commercial Pt-Pd-based wiremesh catalyst is studied in a flow reactor set-up under simulated conditions relevant to 125 cc 4-stroke gasoline carburetor motorcycles. The effect of high-temperature hydrothermal aging is investigated using Temperature-Programmed Oxidation (TPO) tests along with catalyst characterization. To evaluate the effect of air-fuel ratio on the fresh catalyst activity, TPO tests were run for CO and C_3H_6 oxidation under ultra-rich, rich, stoichiometric, and lean conditions (corresponding to lambda values of 0.6, 0.8, 1.0, 1.2, respectively). It was found that increasing oxygen concentration shifts the light-off profile toward lower temperatures. Self- and mutual inhibition effects of CO and propylene was observed on the TPO profiles, consistent with previous results. The fresh catalyst was characterized using FE-SEM. An accelerated aging procedure, was conducted by exposing the sample to 10% water vapor at 900°C. Activity tests for the aged catalyst showed that by switching from ultra-rich toward lean condition, the CO and C_3H_6 light-off curves were shifted toward lower temperatures indicating the beneficial role of oxygen on the catalyst activity. It was found that the aging process shifts the light-off toward higher temperatures. The extent of deactivation under the rich and ultra-rich conditions were more significant compared to stoichiometric and lean conditions. According to the FE-SEM analysis, the aging increased the particle size range from 10-29 nm to 23-70 nm indicating particle agglomeration leading to catalyst deactivation. Our results suggest that injecting secondary air in the motorcycle exhaust gas can be used as a practical technique for enhancing CO and hydrocarbon oxidation efficiency over a Pt-Pd-based wiremesh catalyst.

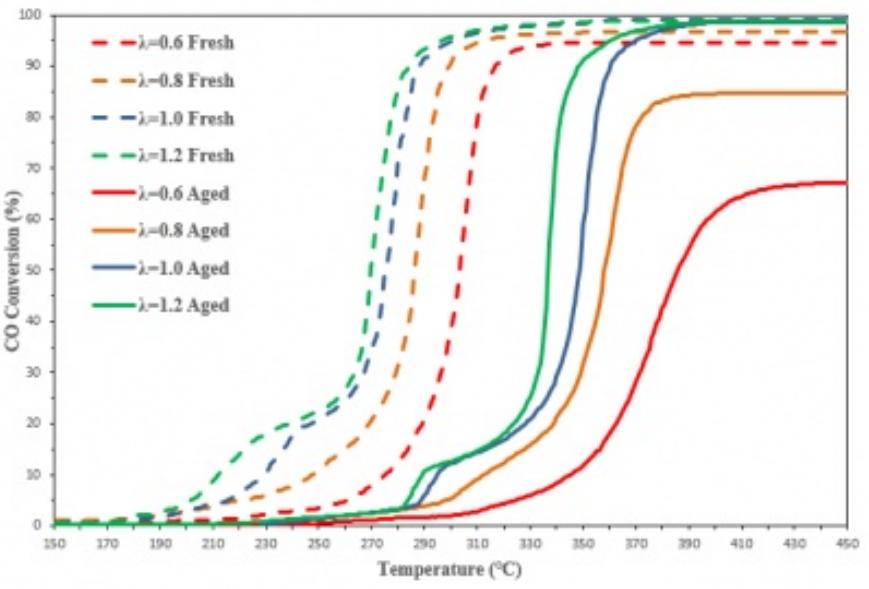

Fig. 1- CO conversion in the presence of C_3H_6 as a function of temperature at different air:fuel ratios; fresh catalyst (dashed line) vs. aged catalyst (solid line)