Materials and Methods

depending on the horsepower requirements. For these two, two catalyst technologies are used, one where there is an excess of oxygen is available, leading to primarily CH_4 combustion, and for the rich-burn engines, a three-way catalyst (TWC) approach is used. In terms of reducing CH_4 emissions, the operating conditions differ significantly, as do the kinetics and selectivities.

Results and Discussion

Since the two engine types have significantly different exhaust conditions, namely different CH_2O ratios, the effect of high, stoichiometric and sub-stoichiometric O_2:CH_4 ratios were evaluated. Pt-based catalyst performance was significantly affected by the O_2 level, while Pd was not. An example of Pt/Al_2O_3 performance in terms of conversion as a function of temperature is shown in Figure 1. As shown, there is a significant difference in performance for fuel-lean and fuel-rich conditions and mechanistically this was of course related to surface oxygen coverage, with Pt metal being active and thus increasing O_2 levels having a negative effect. Similar trends were observed with the Pt/Pd catalyst, but not with the Pd-only catalyst. Again, for the latter this is due to O coverage, with PdO the active site. The trend with Pt/Pd was not a simple averaging of the effect on Pt and Pd individually, and the kinetics/mechanism of this system is still being developed. NO and NO_2 were both found to positively affect CH_4 conversion performance for fuel-rich conditions, but inhibited performance, albeit only slightly, under fuel-lean conditions. The former is related to the NOx acting as an oxidant, while the latter is due to site competition. CH_4 is a known reductant for NOx reduction [4], as was also observed in this study. Interestingly, under fuel-rich conditions, significant quantities of “byproduct” NH_3 were generated due to reaction between the CH_4 and NOx. Further comparisons between Pt, Pd and Pt/Pd blended catalysts will be made with regards to O_2, CH_4 and NOx concentration effects.

Significance

Exhaust conditions encountered in compressor stations vary between fuel-lean and fuel-rich (CH_4-to-O_2 stoichiometric ratios) depending on the engine used. This study compares the efficacy of Pt, Pd and Pt/Pd catalysts under these different conditions and compares the kinetics between the sample types. Furthermore, the effect of other exhaust components, specifically NOx, has been evaluated and byproduct formation rates determined.

References