Superior Composite Oxide Catalysts for Combustion of Volatile Organic Compounds

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Introduction

Volatile organic compounds (VOC), along with sulfur oxides, nitrogen oxides and ammonia, are among the major contributors to environmental pollution. The primary sources of VOC are emissions from industrial processes and transportation exhaust. In the manufacture of most consumer products, some processing steps involve the use of organic compounds. These VOC may be solvents for pigments, silicones, coating materials, or unreacted feedstock or decomposition products, such as hexane, toluene, alcohols and alkanes.

Catalytic combustion is an efficient approach for VOC abatement at mild temperatures (300-500°C). Typical commercial VOC combustion catalysts are Al_2O_3-supported Pt and Pd, coated on monoliths. Due to the high cost of the precious metals and poor tolerance to Si and P poisons, alternative low-cost transition metal oxide catalysts have been actively investigated in recent years, including perovskites and mixed transition metal oxides [1-3]. In this abstract, NexTech will report excellent VOC combustion performance on composite oxide catalysts at low temperatures.

Materials and Methods

The composite oxide catalysts were prepared using a deposition-precipitation approach. The catalyst testing was run in a fixed bed reactor under the conditions of 200-400°C, 0.05-0.5% VOC and balance air. The gas compositions were analyzed by GC and mass spectroscopy.

Results and Discussion

The testing data indicated that composite oxide catalysts could oxidize VOC (e.g., propane, butane, hexane, butene, toluene and propanol) to CO_2 and H_2O at 200-250°C and gas

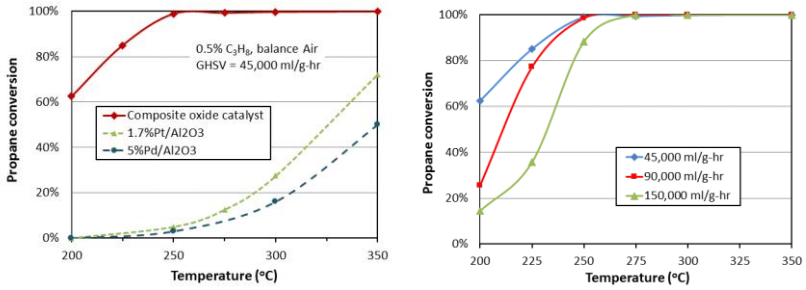

Figure 1. Propane combustion on composite oxide catalyst and PGM catalysts.

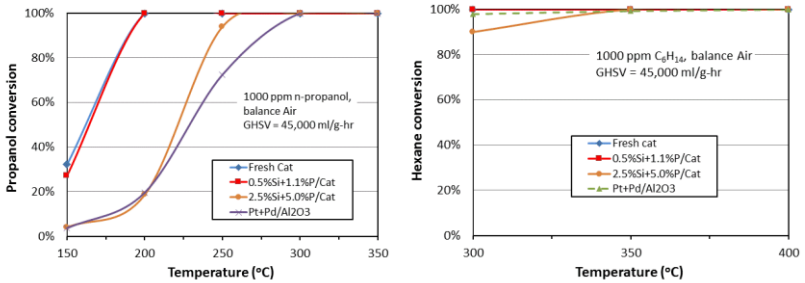

Figure 2. Effect of Si and P poisons on VOC combustion activities.

hourly space velocities of 45,000-150,000 ml/g-hr. The temperature for complete conversion of VOC on the composite oxides was 100-150°C lower than that on conventional precious metal catalysts under the same reaction conditions (Fig. 1). Thermal treatment of the catalysts at 600°C decreased combustion activity slightly, but 100% propane conversion was still achieved at 300°C. The oxide catalysts were also more tolerant to silicon and phosphorous, two common impurities in VOC stream, than the precious metal catalysts. 100% conversion was achieved at 200°C for n-propanol and 300°C for hexane on SiO_2 and P_2O_5 poisoned composite oxide catalyst (Fig. 2). Preliminary lifetime testing results indicated that the catalyst was stable in VOC combustion reactions. Deactivation was not seen during 860 hrs on stream. In addition, TEM analysis showed that nano-size particles (5-10 nm) and sub-micron size (0.05-0.2 micron) were formed on the catalysts (Fig. 3). The nano-sized particles contributed to the high combustion activity. The above results have demonstrated that the low-cost transition metal oxides are good catalyst candidates for VOC removal.

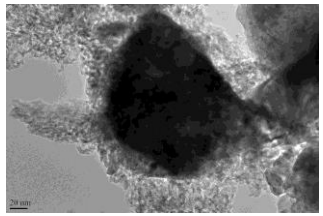

Figure 3. TEM image of the catalyst

Significance

Substitution of NexTech's composite oxide catalysts could drastically reduce VOC combustion system cost and operation cost as compared to conventional PGM catalysts.

References

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