World Academy of Science, Engineering and Technology
International Journal of Chemical and Molecular Engineering
Vol:12, No:09, 2018

Removal of VOCs from Gas Streams with Double Perovskite-Type Catalyst

Authors : Kuan Lun Pan, Moo Been Chang

Abstract : Volatile organic compounds (VOCs) are one of major air contaminants, and they can react with nitrogen oxides (NOx) in atmosphere to form ozone (O3) and peroxyacetyl nitrate (PAN) with solar irradiation, leading to environmental hazards. In addition, some VOCs are toxic at low concentration levels and cause adverse effects on human health. How to effectively reduce VOCs emission has become an important issue. Thermal catalysis is regarded as an effective way for VOCs removal because it provides oxidation route to successfully convert VOCs into carbon dioxide (CO2) and water (H2O(g)). Single perovskite-type catalysts are promising for VOC removal, and they are of good potential to replace noble metals due to good activity and high thermal stability. Single perovskites can be generally described as ABO3 or A2BO4, where A-site is often a rare earth element or an alkaline. Typically, the B-site is transition metal cation (Fe, Cu, Ni, Co, or Mn). Catalytic properties of perovskites mainly rely on nature, oxidation states and arrangement of B-site cation. Interestingly, single perovskites could be further synthesized to form double perovskite-type catalysts which can simply be represented by A2B'B"O6. Likewise, A-site stands for an alkaline metal or rare earth element, and the B′ and B″ are transition metals. Double perovskites possess unique surface properties. In structure, three-dimensional of B-site with ordered arrangement of B'O6 and B"O6 is presented alternately, and they corner-share octahedral along three directions of the crystal lattice, while cations of A-site position between the void of octahedral. It has attracted considerable attention due to specific arrangement of alternating B-site structure. Therefore, double perovskites may have more variations than single perovskites, and this greater variation may promote catalytic performance. It is expected that activity of double perovskites is higher than that of single perovskites toward VOC removal. In this study, double perovskite-type catalyst (La2CoMnO6) is prepared and evaluated for VOC removal. Also, single perovskites including LaCoO3 and LaMnO3 are tested for the comparison purpose. Toluene (C7H8) is one of the important VOCs which are commonly applied in chemical processes. In addition to its wide application, C7H8 has high toxicity at a low concentration. Therefore, C7H8 is selected as the target compound in this study. Experimental results indicate that double perovskite (La2CoMnO6) has better activity if compared with single perovskites. Especially, C7H8 can be completely oxidized to CO2 at 300oC as La2CoMnO6 is applied. Characterization of catalysts indicates that double perovskite has unique surface properties and is of higher amounts of lattice oxygen, leading to higher activity. For durability test, La2CoMnO6 maintains high C7H8 removal efficiency of 100% at 300oC and 30,000 h-1, and it also shows good resistance to CO2 (5%) and H2O(g) (5%) of gas streams tested. For various VOCs including isopropyl alcohol (C3H8O), ethanal (C2H4O), and ethylene (C2H4) tested, as high as 100% efficiency could be achieved with double perovskite-type catalyst operated at 300℃, indicating that double perovskites are promising catalysts for VOCs removal, and possible mechanisms will be elucidated in this paper.

Keywords : volatile organic compounds, Toluene (C7H8), double perovskite-type catalyst, catalysis
Conference Title : ICOCC 2018 : International Conference on Organometallic Chemistry and Catalysis
Conference Location : Paris, France
Conference Dates : September 20-21, 2018