Performance of Cu-Zn mixed oxide catalysts for medium temperature water-gas shift reaction

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The demand of hydrogen has increased since rising demand for high value products in petrochemical industry and fuel cell technology have been developed. In particular, there has been a lasting interest toward WGS process for producing hydrogen [1,2]. The conventional WGS process is composed of two-stage reactors, high temperature shift (HTS, 350-450 °C), and low temperature shift (LTS, 180-270 °C). Fe-Cr based catalyst and Cu-Zn based catalyst have been used for HTS, and LTS reaction, respectively. However, the conventional two steps reactor requires large volume, 70 vol.% of whole system [3,4]. Therefore, there have been increasing interests for emerging new catalytic process operated in a single step at medium temperature shift (MTS). Steel industry could produce many by-product gases such as Coke Oven Gas (COG), Blast Furnace Gas (BFG), and Linze Donawitz Gas (LDG). Those gases were emitted into the atmosphere after used to fuel in power plant. However, 200 million ton of the gases can be reused. In particular, LDG gas might suitable for WGS reaction because the gas contains the highest CO components, 61vol.% [5]. In this study, we evaluated MTS catalyst by WGS reaction using LDG and compared its activity with that of commercial catalyst.

Figure 1 shows CO conversion of as-prepared catalyst and commercial catalyst with various steam/carbon(S/C) ratios (S/C ratio = 2.0, 2.5, 3.0). Both catalysts showed 99.9% of CO conversion at low temperature region (< 250 °C) because of the exothermic nature of the WGS reaction. Over the temperature the CO conversion of commercial catalyst was decreased rapidly by 450 °C. However, the CO conversion of as-prepared catalyst maintained by 350 °C and the conversion was decreased slightly by 450 °C. Outlet temperature of reactor on MTS process becomes about 400 °C by exothermic. At this temperature, the as-prepared catalyst showed higher activity than that of commercial catalyst and S/C ratios have been less impact on CO conversion. With commercial catalyst of HTS, and LTS catalysts, WGS reaction needs steam more than 3 times of total carbon moles in reaction gases for coking prevention. The commercial catalyst showed 97.8% CO conversion at 400 °C with S/C 3.0. However, the as-prepared catalyst showed 99.9% CO conversion at 400 °C with S/C 3.0 and even showed 99.9% CO conversion with lower S/C ratio 2.0.

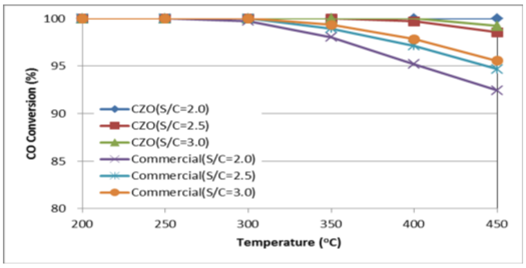

Fig.1 Comparison of CO conversion with various S/C ratio

In this study, we synthesized Cu-Zn mixed oxide by co-precipitation for MTS catalyst toward WGS reaction. The CO conversion of commercial catalyst showed 99.9% by 250 °C and over the temperature the activity was decreased regardless of S/C ratios. However, the CO conversion of as-prepared catalyst maintained 99.9% from 200 °C to 450 °C with S/C 2.0. From the results, as-prepared catalyst could be used for MTS catalyst toward WGS reaction.

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