

# Separation and Recycling of Ferrite Nanocatalysts from Flyash in Steel Industries

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Recently, Over 0.2 million tons per year (TPY) of flyash hazardous wastes were produced from steel industries in Taiwan and they may cause potential toxicities for environment or human beings. The flyashes are extrafine particles with toxic metals that can be leached out, bioaccumulated, and intaked into body having high risk for environment or human beings. In stainless steel/carbon steel manufacturing plants, the NiFe<sub>2</sub>O<sub>4</sub>/ZnFe<sub>2</sub>O<sub>4</sub>/MnFe<sub>2</sub>O<sub>4</sub> are major materials and can be easily separated/purified using magnetic method or ball mill unit. The NiFe<sub>2</sub>O<sub>4</sub>/ZnFe<sub>2</sub>O<sub>4</sub>/MnFe<sub>2</sub>O<sub>4</sub> nanocatalysts were also used for CO<sub>2</sub> reductive decomposition. Carbon dioxide is the main greenhouse gas of 50~60% with global warming potential (GWP) and plays a role in the greenhouse effect especially for the CO<sub>2</sub> emission from steel companies, powder generation plants, and petrochemical industries that it causes the globally attention to this issue.

The main compound of the flyash in steel industry is zinc ferrite (ZnFe<sub>2</sub>O<sub>4</sub>) and Zinc Oxide (ZnO). Ferrite catalysts were separated from flyashes with the efficiency of 70-75% using ball mill methods and magnetic separation. The XRD patterns indicated the flyash with magnetic after separate are also spinel structure. Based on FE-SEM micrographs, the flyash had most ball-like shape. The XPS spectra showed the most flyash possessed ZnFe<sub>2</sub>O<sub>4</sub>. The main structure of flyash with weak magnetic or no magnetic were spinel structure and ZnO structure. From FE-SEM analyses, the flyash with weak magnetic or no magnetic had ball-like and bar-like shape. The XPS spectra showed the most flyash possessed ZnO.

Experimentally, the NiFe<sub>2</sub>O<sub>4</sub>/ZnFe<sub>2</sub>O<sub>4</sub>/MnFe<sub>2</sub>O<sub>4</sub> synthesis by hydrothermal method. The XRD patterns indicated the NiFe<sub>2</sub>O<sub>4</sub>/ZnFe<sub>2</sub>O<sub>4</sub>/MnFe<sub>2</sub>O<sub>4</sub> catalysts are spinel structure. Based on FE-SEM and HR-TEM micrographs, the particle size ranged of 5-30 nm and uniform of NiFe<sub>2</sub>O<sub>4</sub>/ZnFe<sub>2</sub>O<sub>4</sub>/MnFe<sub>2</sub>O<sub>4</sub> nanocatalysts were found. The XPS spectra showed the most NiFe<sub>2</sub>O<sub>4</sub>/ZnFe<sub>2</sub>O<sub>4</sub>/MnFe<sub>2</sub>O<sub>4</sub> possessed Ni(II), Zn(II) and Mn(II). From the N<sub>2</sub> adsorption/desorption curves of NiFe<sub>2</sub>O<sub>4</sub>/ZnFe<sub>2</sub>O<sub>4</sub>/MnFe<sub>2</sub>O<sub>4</sub> were Type IV.

**Keywords:** Zinc/nickel/magnetic ferrite nanocatalyst, Normal/inverse spinel, Hydrothermal method, Flyash from steel industry, Magnetic separation technology.

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