Redox characteristic of $Fe_{2-x}Ni_xMnO_4$ spinel structure for chemical looping combustion

Byeong Sub Kwak[1], No-Kuk park[2], Jeom-In Baek[3], Ho-Jung Ryu[4], Misook Kang[1]*
[1,2]*Yeungnam University, Gyeongsan, Republic of Korea*
[2]*KEPCO Research Institute, Daejeon, Republic of Korea*
[3]Korea Institute of Energy Research, *Daejeon, Republic of Korea*

*E-mail: mskang@ynu.ac.kr

In order to capture emitted CO_2, there are three technology to capture CO_2 such as the pre-combustion, the oxy-fuel combustion, and the post-combustion. Among them, the chemical looping combustion (CLC), which is one of the oxy-fuel combustion, has good advantage that there is no NOx generation and requirement of the separation equipment [1]. In this CLC system, in order to supply the oxygen, metal oxides are used as oxygen carrier. Therefore, the oxygen transfer performance of metal oxides is important. The metal oxides Mn, Fe, Co, Ni and Cu are mainly used as oxygen carrier, and various mixed oxides are used to improve their performance [2-4]. These particles do not have a specific structure and mainly exist as complex oxide.

In this study, the spinel structure, AB_2O_4, as an oxygen carrier particles were synthesized and used. In general, the spinel structure is known to be one of the reasons of catalyst deactivation because of its stability. However, the spinel structure contains 32 oxygen atoms per unit cell, therefore it is considered to be useful as an oxygen carrier.

In this study, Mn, Fe, and Ni were used as A or B site metals. The particles were synthesized by sol-gel method and the calcination temperature was 1300 ℃.

The structure of the synthesized particles were analyzed by X-ray diffraction (XRD) and the results are shown in Fig.1. The peaks of the all particles were observed at 2θ = 18.496, 30.204, 35.593, 37.317, 43.360, 53.653, 57.128, and 62.739° and assigned to the (111), (022), (113), (222), (004), (224), (115), and (044) planes of spinel structure, respectively.

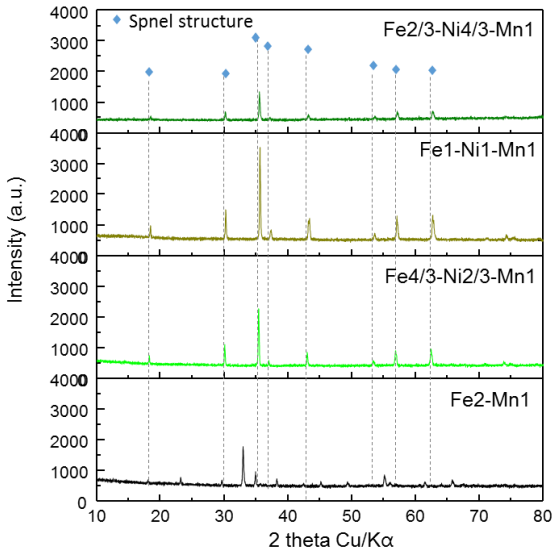

Fig.1 XRD patterns of particles

Fig.2 is the results of the redox cycle test for the particles under H_2-N_2/air at 850℃ for 10 times. The tri metal spinel structure particles showed higher oxygen transfer performance than the bimetal, and the capacity was about 18 wt%.

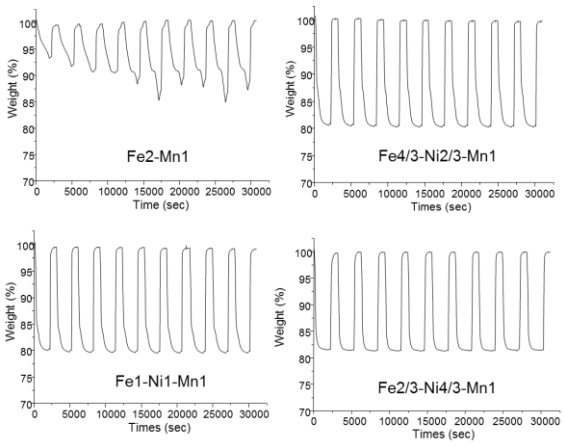

Fig.2 Redox cycle of synthesized particles

REFERENCES

[1] C. Linderholm, A. Lyngfelt, A. Cuadrat, and E. Jerndal, Fuel, 102 (2012) 808.
[2] Y. Larring, M. Pishahang, M.F. Sunding, and K. Tsakalakis, Fuel, 159 (2015) 169.
[3] B.S. Kwak, N.-K. Park, S.O. Ryu, J.-I. Baek, H.-J. Ryu, and M. Kang, Chem. Eng. J., 309 (2017) 617.
[4] Q. Imtiaz, M. Broda, and C.R. Müller, Appl. Energy, 119 (2014) 557.