Catalytic Steam Reforming of Macro Algae Derived Oil over Supported Ni Catalysts

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Biomass has received much attention as renewable feedstock for the production of hydrogen, liquid fuels and chemicals[1]. Hydrogen is produced by catalytic steam reforming of bio-oil converted from biomass by fast pyrolysis or hydrothermal liquefaction. The objective of this work is to study activities for steam reforming of macro algae derived oil over Ni-$K_2Ti_xO_y$ based catalysts.

Liquefied oil was first produced by hydrothermal liquefaction in an auto-clave reactor. Macro algae with distilled water (1:9 weight ratio) were used for hydrothermal liquefaction at 503K in 2 hr and the main components of macro algae and liquefied oil are listed in Table 1. Further analysis showed a liquefied oil composition of $C_{0.58}H_{1.40}O_{0.12}$ + 4.86 H_2O.

In this study, Ni/$K_2Ti_xO_y$ based catalysts were prepared by wet impregnation method[2] and catalytic activity studies for new catalysts such as Ni/$K_2Ti_xO_y$/Al_2O_3, Ni/$K_2Ti_xO_y$/SiO_2, Ni/$K_2Ti_xO_y$/ZrO_2-CeO_2, Ni/$K_2Ti_xO_y$/MgO, and a commercial catalyst (FCR-4-02, Sud-Chemie) were performed. Steam reforming reaction was carried out at 873-1073K under atmospheric pressure in a fixed-bed reactor made of Inconel material. LHSV was maintained at 1 h^{-1} and product gases (H_2, CO, CH_4 and CO_2) were analyzed using GC-TCD.

According to Fig. 1, using 10% Ni/$K_2Ti_xO_y$ based catalysts, hydrogen yield was in the range of 52-63%, which was higher than the commercial catalyst, FCR-4-02 showing 37% hydrogen yield. Furthermore, more carbon gases (CO, CH_4 and CO_2) were produced in Ni/$K_2Ti_xO_y$ based catalysts (54-66%) than FCR-4-02 (43 %). Moreover, a Ni/$K_2Ti_xO_y$-Al_2O_3 catalyst showed CO yield of 47% with CO_2 yield of 3% while CO_2 yield of 34% with CO yield of 14% were observed in a Ni/$K_2Ti_xO_y$/ZrO_2-CeO_2 catalyst indicating high activity in WGS (water gas shift) reaction in a ZrO_2-CeO_2 support.

Table 1. Chemical components of macro algae and liquefied oil

Material	Elemental analysis (wt %)			Water content (wt %)
	C	H	O	
Macro Algae	20.18	3.18	75.01	10.42
Liquefied Oil	6.94	11.12	79.68	87.45

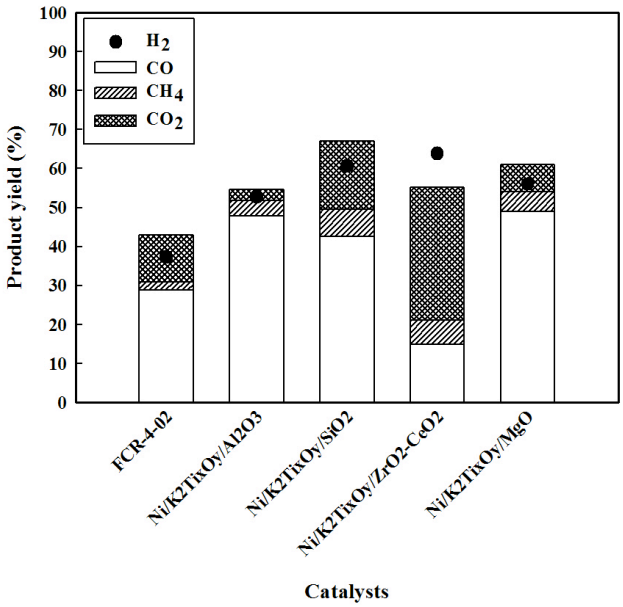

Fig. 1 Comparison of product yield over various catalysts. Reaction conditions: S/C ratio=8.38, Temperature=1073K, Time=5 hr, LHSV=1 h^{-1}

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