Hydrogen Production from Catalytic Gasification of Waste Wood Polymer Composite using Different Low-Cost Catalysts

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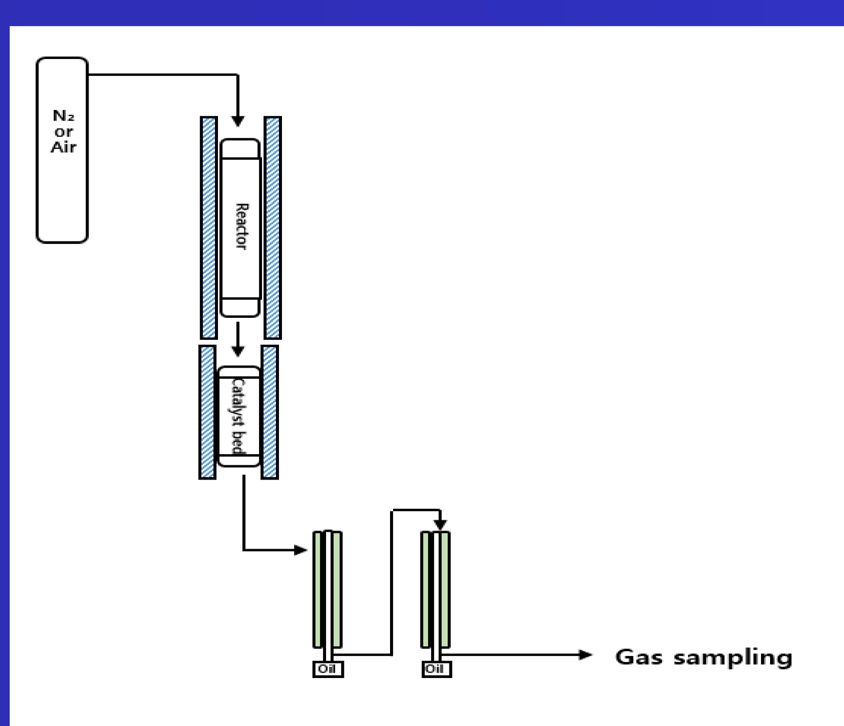
Introduction

Wood-plastic composite (WPC) is a material made of wood fibers and plastic, which has higher mechanical strength and is more environmentally friendly than conventional wood. WPC can be reused many times, but when it loses its durability, it is discharged into solid waste. Converting it into a useful and high-energy density material through gasification processes could be an effective solution to this problem. Dolomite, Olivine, and Red mud are known as cost-effective catalysts compared to zeolite, and effective in removing tar during gasification. The purpose of this study was to produce bio-hydrogen through gasification experiments using low-cost catalysts such as dolomite, olivine, and red mud.

Results & Discussion

➢ Schematic diagram of a gasification reaction system



- Carrier gas : Air
- Experimental conditions
  - Catalyst : Feedstock (C/F) : 0.1, 0.2
  - Ni loading : 10wt%
  - Equivalence Ratio : 0.2, 0.25, 0.3
  - Temperature :700, 750, 800℃

Figure: Diagram of the gasification reaction setup

➢ Catalyst characterization

Catalyst	S_{BET} (m^2/g)	Total pore volume (cm^3/g)
Dolomite	17.59	0.17
Olivine	0.69	0.002
Red mud	30.09	0.21

Figure: BET surface area and Total pore volume analysis of catalysts

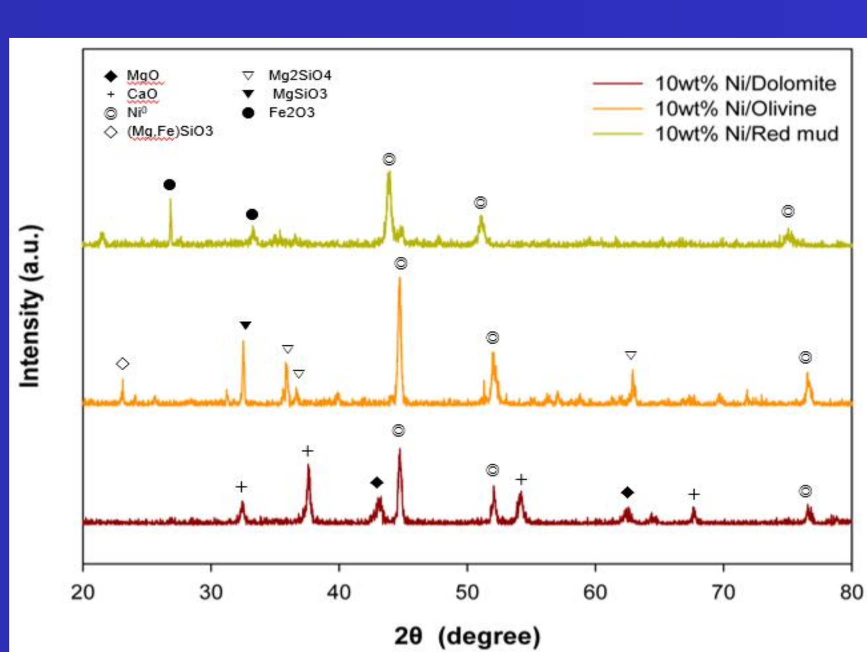


Figure: XRD profile of different catalysts.

- The structure of Ni⁰ patterns appear at 44.5°, 53°, and 76.5°
- The intensities of peaks suggest that the larger S_{BET} and pore size of red mud and dolomite compared to olivine was beneficial for the enhancement of Ni dispersion.

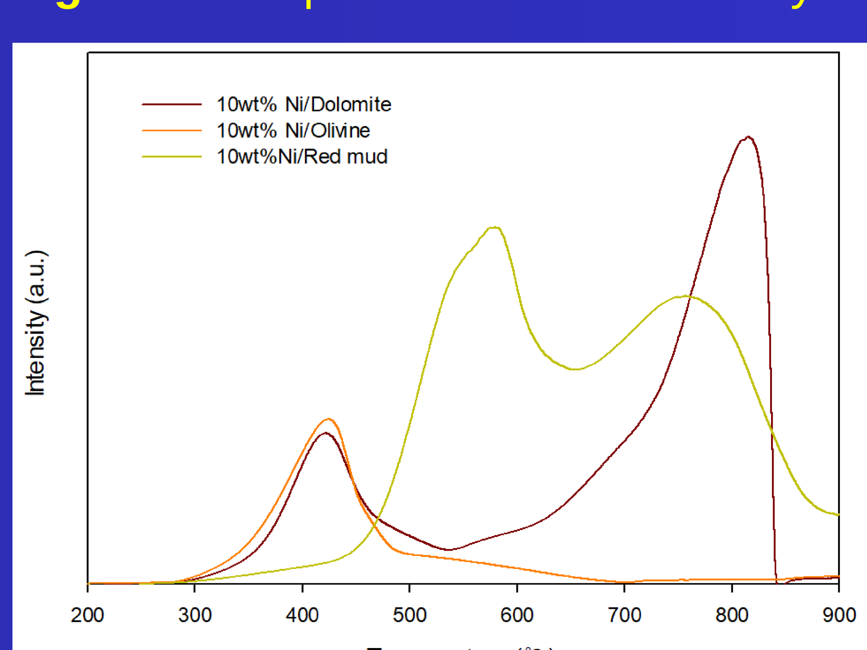
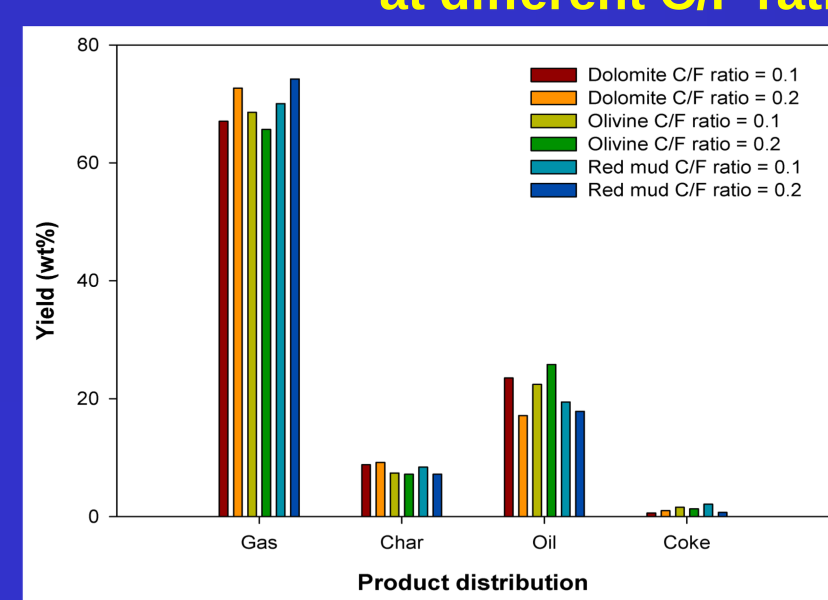


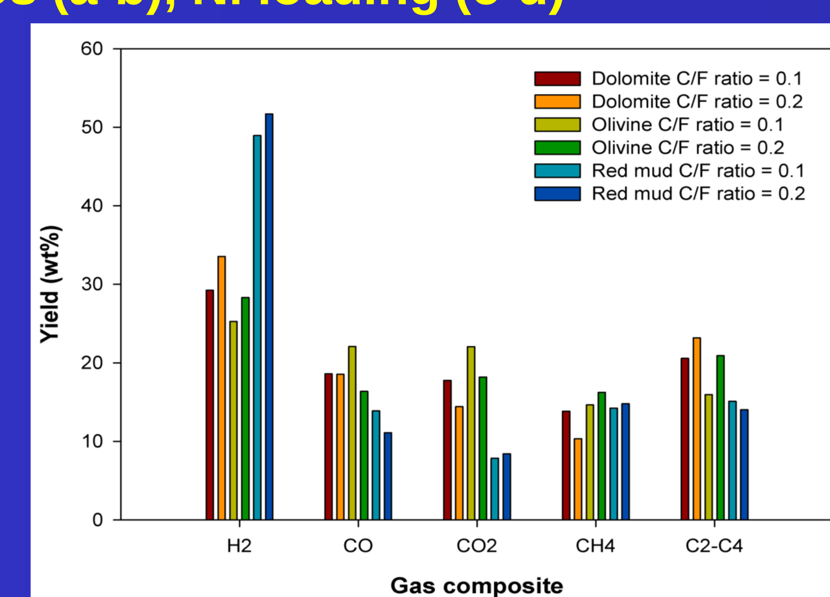
Figure: H_2-TPR profile of different catalysts.

- At 400-600°C : Indicates the large volume of NiO located on the external surface of the support
- Above 600°C : The diffusion of small NiO into the catalyst pore pore and strong metal-support interaction

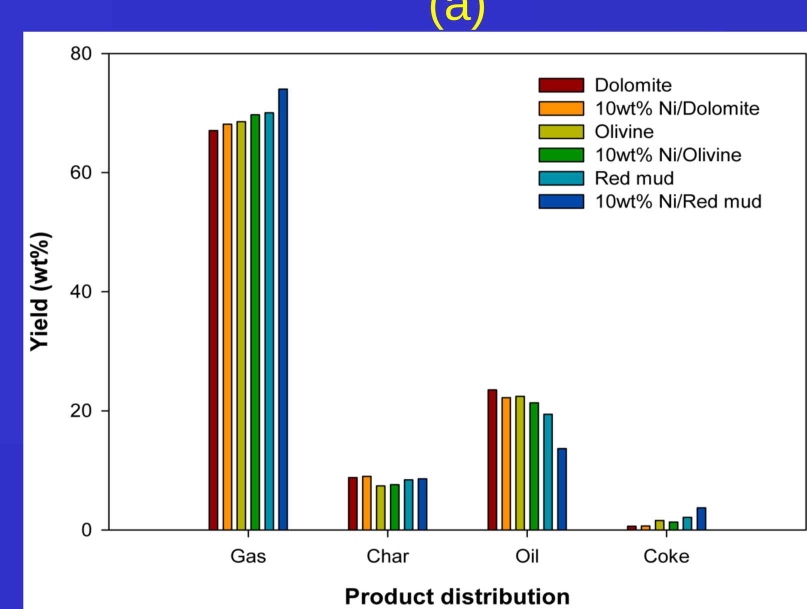
➢ Product distribution and gas composition using low-cost catalysts at different C/F ratios (a-b), Ni loading (c-d)



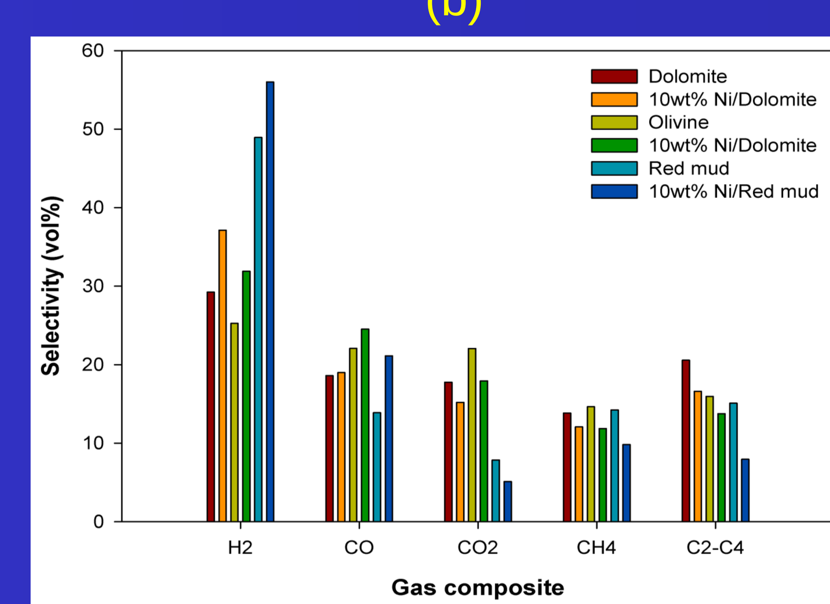
(a)



(b)

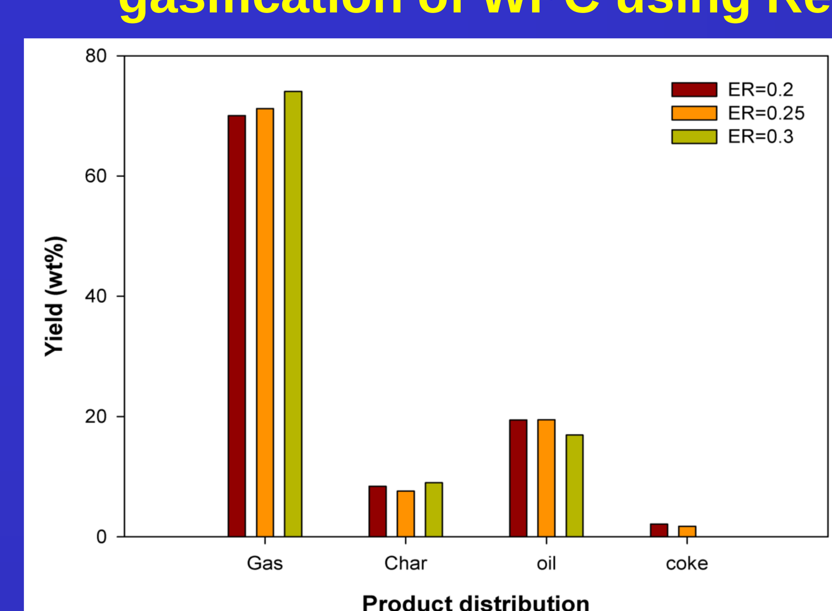


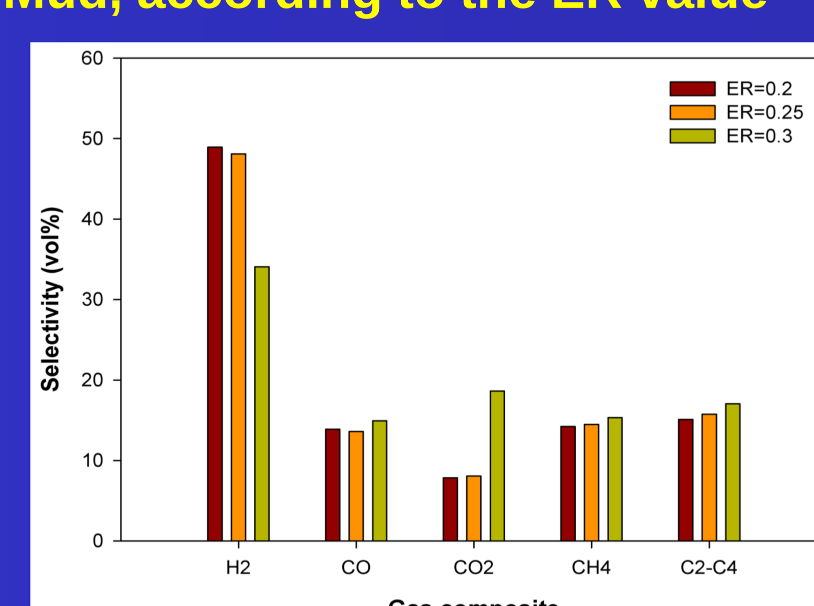
(c)



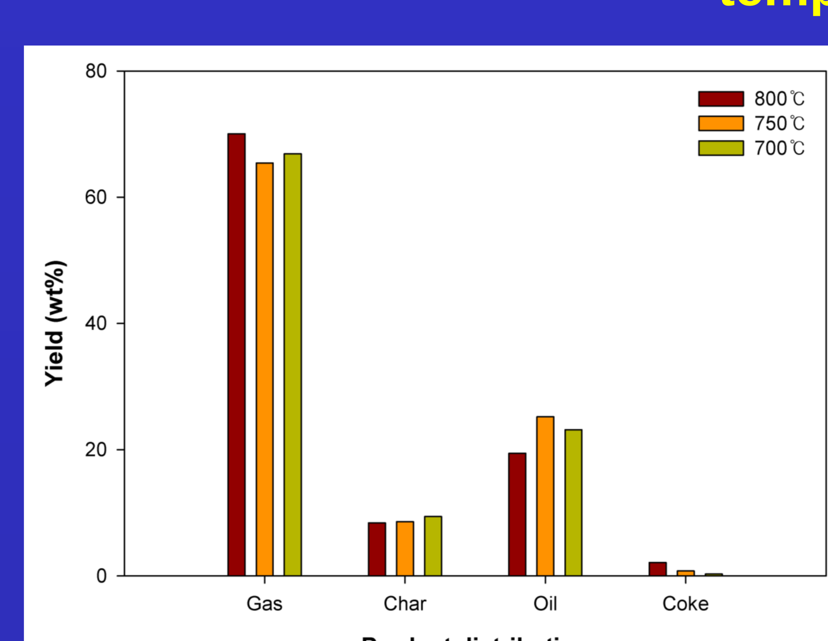
(d)

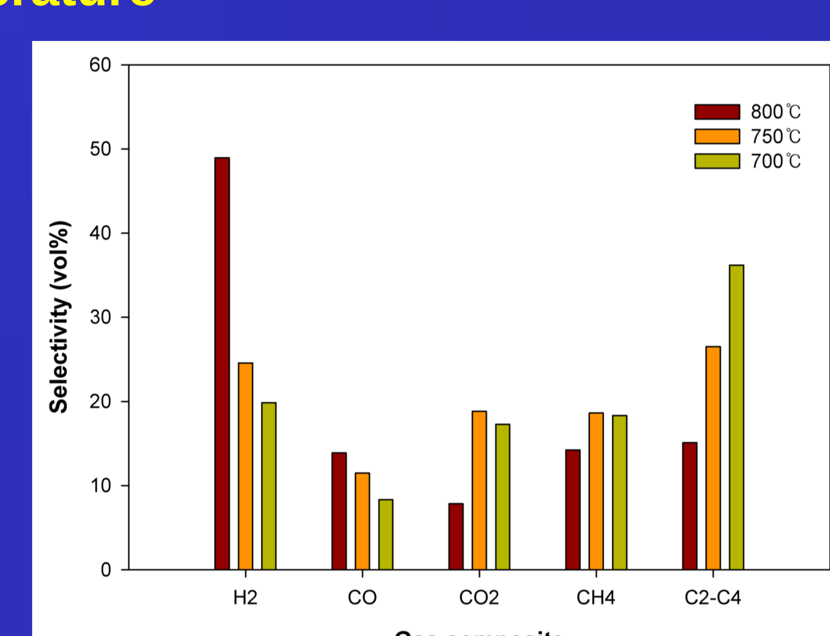
➢ Product distribution and gas composition during catalytic gasification of WPC using Red Mud, according to the ER value





➢ Product distribution and gas composition according to temperature





Conclusions

When a catalyst containing 10wt% Ni was used and C/F ratio=0.1, the selectivity of H2 and CO and the gas yield increased. Also, Using RM as the catalyst, the gasification results showed the highest gas yield and selectivity of H2 and CO. Based on these results, the experiment was conducted using only Red mud. The selectivity of H2 and CO was better with lower ER values, 0.2. When different temperatures were used, the highest gas yield and selectivity of H2 were observed at a temperature of 800°C. At the results, it appears that gasification processes using low-cost catalysts could provide a new technology for converting WPC into useful and high-energy density materials, such as H2

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