School of Chemical and Process Engineering
FACULTY OF ENGINEERING

NOVEL CATALYTIC THREE STAGE REACTOR SYSTEM FOR HYDROGEN PRODUCTION FROM BIOMASS

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OUTLINE

- Background
- Aims and Objectives
- Experimental Rig
- Experiment Results
- Conclusion
- Future Works
- Questions

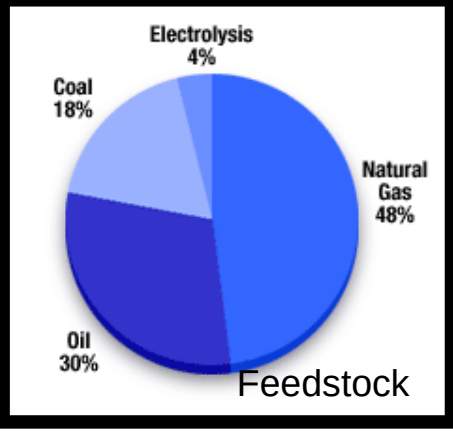
BACKGROUND

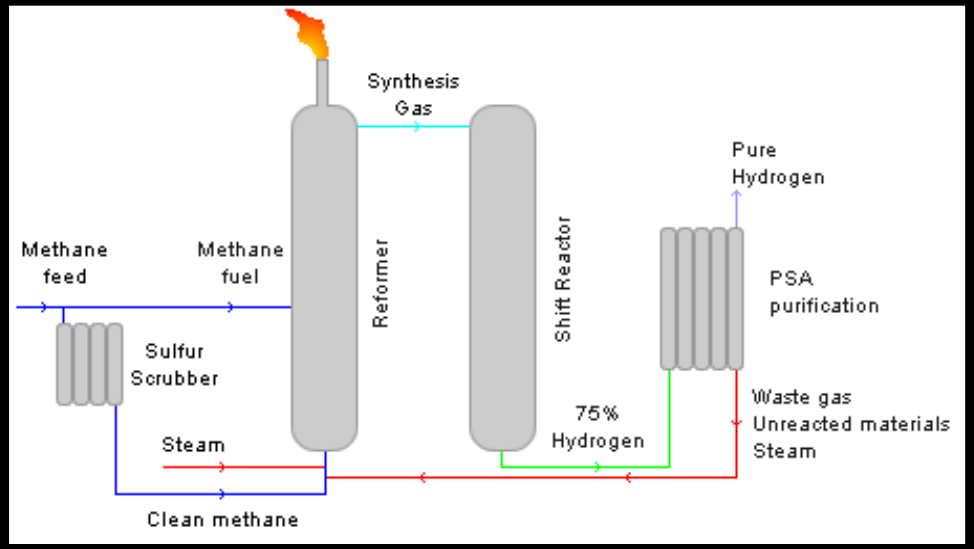
There is a growing need for hydrogen due to its environmentally friendly properties such as

- Clean fuel source
- The only by product on combustion is water
- Highest energy per unit mass (143.31 kj/g)
- Potential to be a future fuel

HYDROGEN PRODUCTION: CATALYTIC METHANE STEAM REFORMING

World H_2 production ~50 Mt/yr





Steam-methane reforming reaction

e.g. ~800 °C; Ni-catalyst

$$CH_4 + H_2O \rightarrow CO + 3H_2$$

Water-gas shift reaction

e.g. 350 °C: Fe-catalyst

$$CO + H_2O \rightarrow CO_2 + H_2$$

Commercial catalytic methane steam reforming

Source: http://www.digipac.ca/chemical/; http://www.airproducts.com

AIMS AND OBJECTIVES

Aim: To develop a novel, three stage catalytic process for hydrogen production from the gasification of biomass waste.

Objectives:

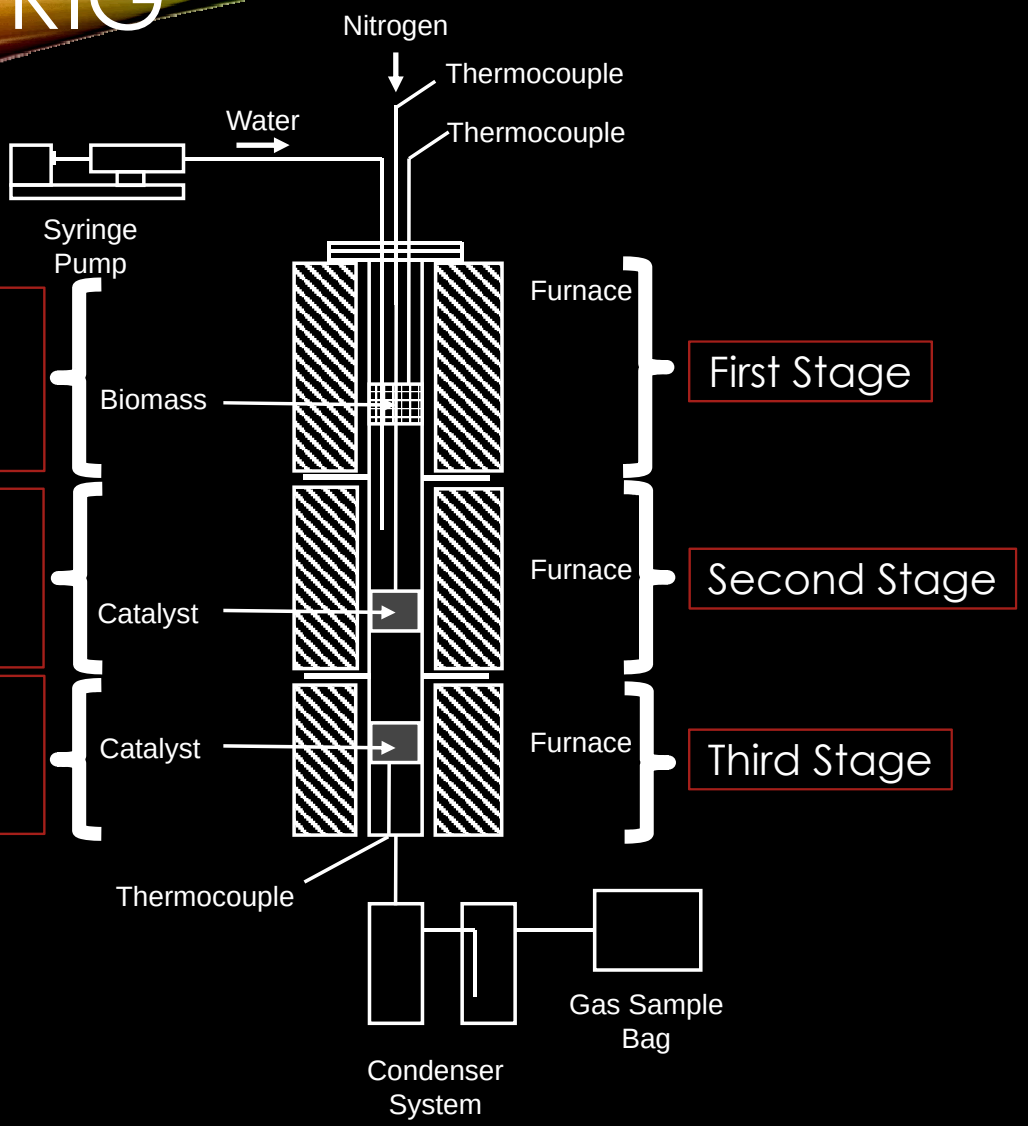
- To produce different novel catalyst for hydrogen production from the gasification of biomass
- To develop the best operating conditions to produce the optimum hydrogen yield using a novel three stage reactor system

EXPERIMENTAL RIG

First Stage
Temp 550°C
Biomass

Second Stage
Temp 750°C
Nickel Based Catalyst

Third Stage
Temp 350°C
Iron Based Catalyst



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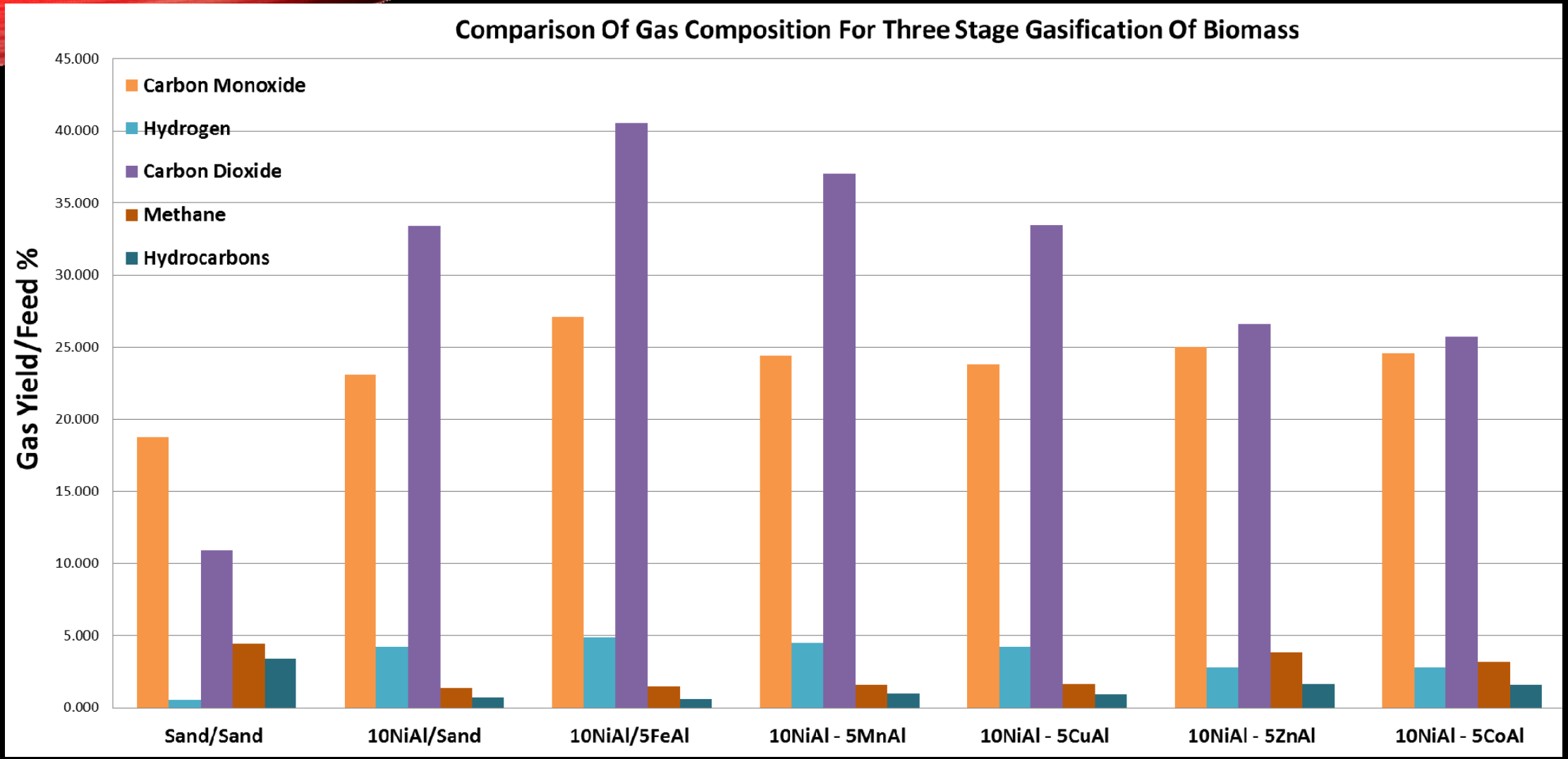
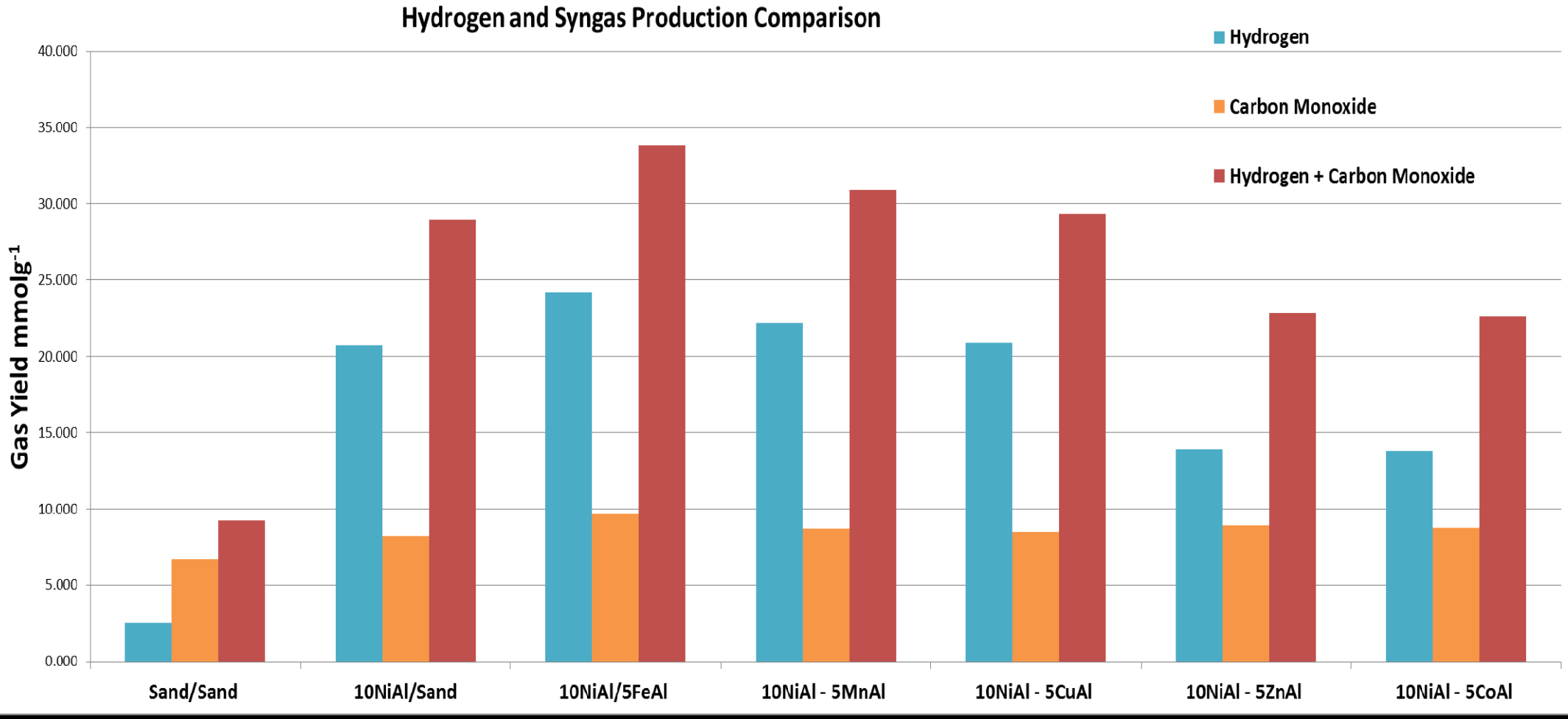
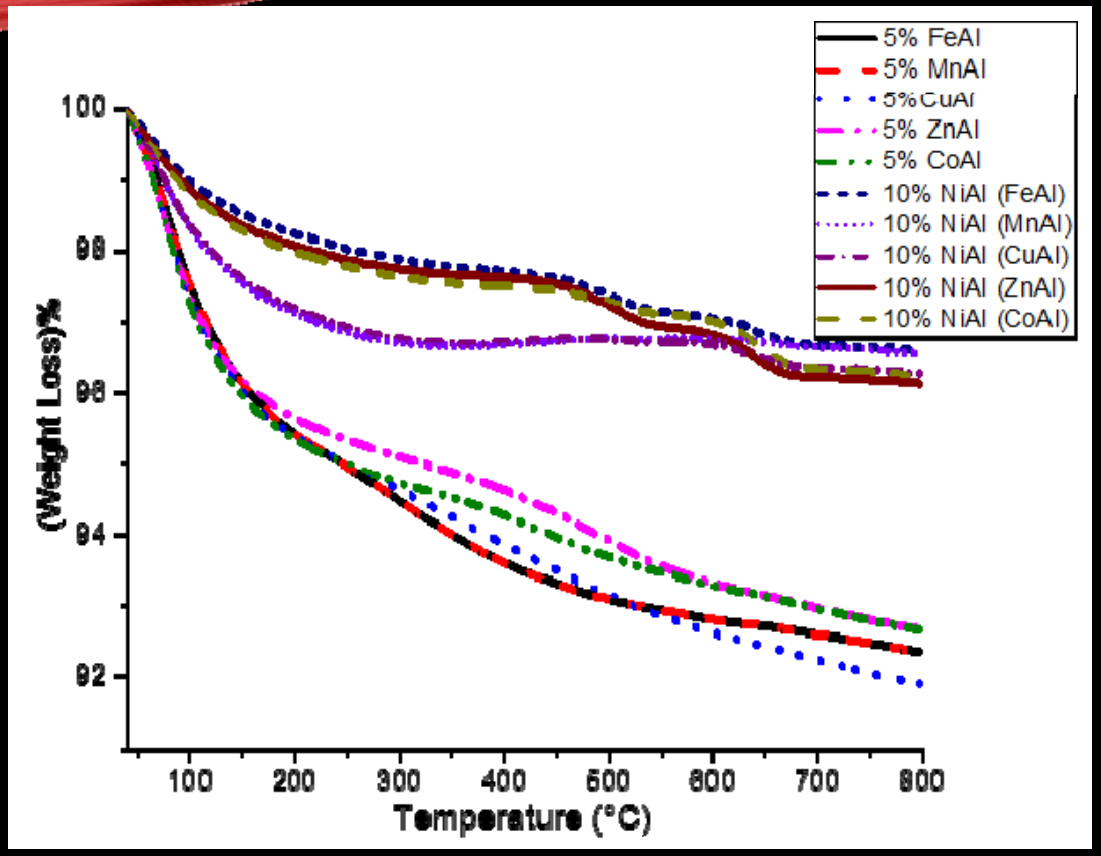
EXPERIMENTAL RESULTS GAS COMPOSITION

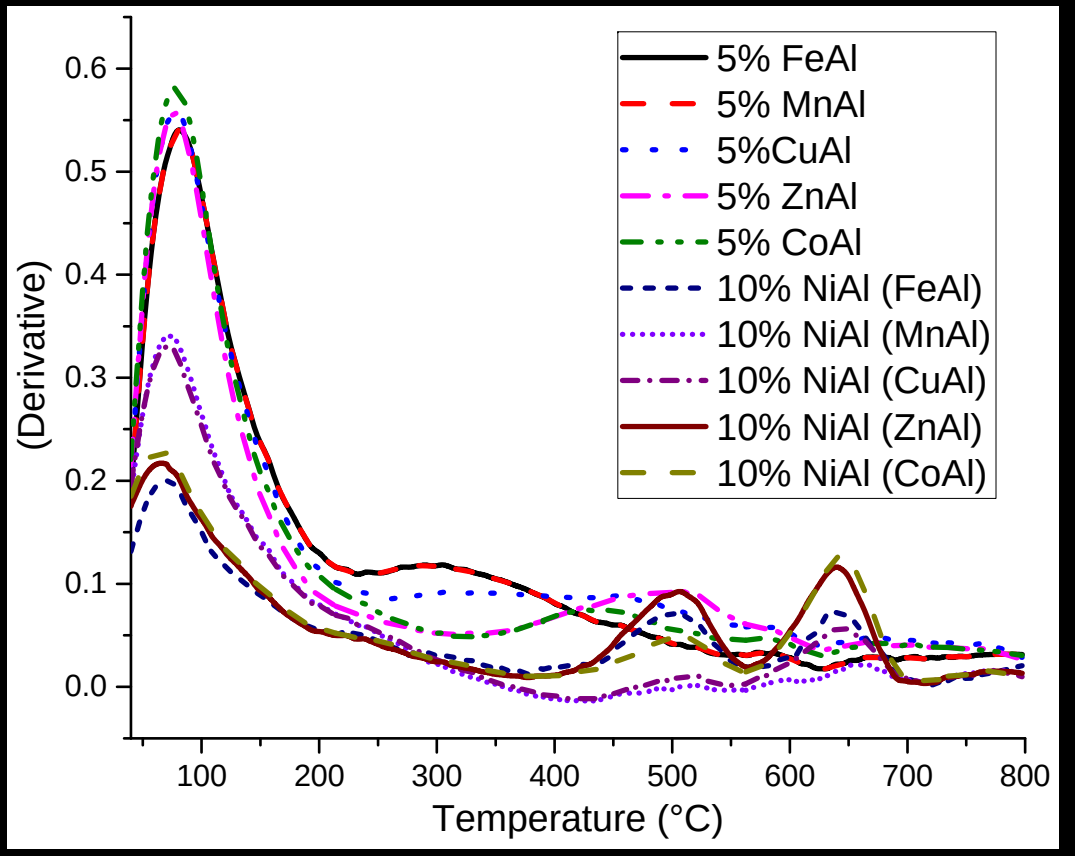


EXPERIMENTAL RESULTS
HYDROGEN AND CARBON MONOXIDE COMPARISON



EXPERIMENTAL RESULTS
TEMPERATURE PROGRAMMED OXIDATION(TPO)





CONCLUSION

- 10%NiAl/5%FeAl produced the highest amount of Hydrogen and Carbon monoxide approximately 34mmol/g in comparison to the other 4 catalyst studied
- 10%NiAl/5%FeAl produced approximately 75% biomass to gas conversion, which was the highest biomass to gas conversion for all the catalyst studied
- 10%NiAl/5%CoAl produced approximately 60% biomass to gas conversion, which was the lowest biomass to gas conversion for all the catalyst studied
- Temperature Programmed Oxidation (TPO) showed carbon deposition between 1-3% for the 10% NiAl catalyst used in the second stage and 5-7% for the metal based catalyst used in the third stage
- The derivative of the TPO showed that metal based catalyst used in the third stage seems to show peaks corresponding to amorphous carbon while the nickel based catalyst used in the second stage seems to show peaks corresponding to filamentous carbon

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FUTURE WORKS

- Currently investigating the effects of heating rate, steam flow rate and furnace temperature on the yield and composition of Hydrogen in the third stage reactor

- Investigate the effect of metal loading and a mixture of metals in the third stage reactor for hydrogen production

ANY QUESTIONS ?

- Thank you for listening

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