

Co-processing of Heavy Oil and Bio-oil in a Continuous Mechanically Fluidized Reactor

**Institute for Chemicals and Fuels
from Alternative Resources**
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Programme**



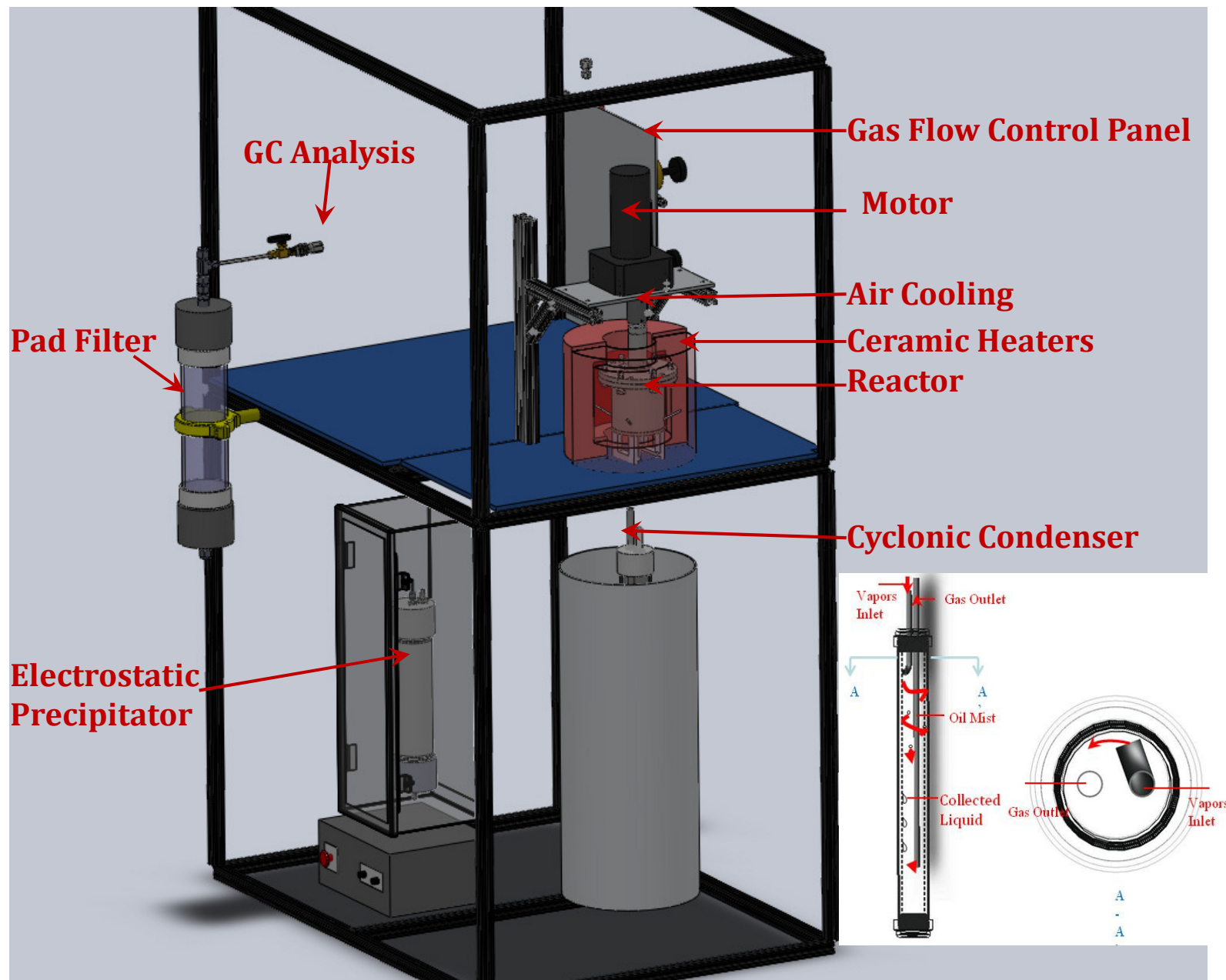
Imperial Oil

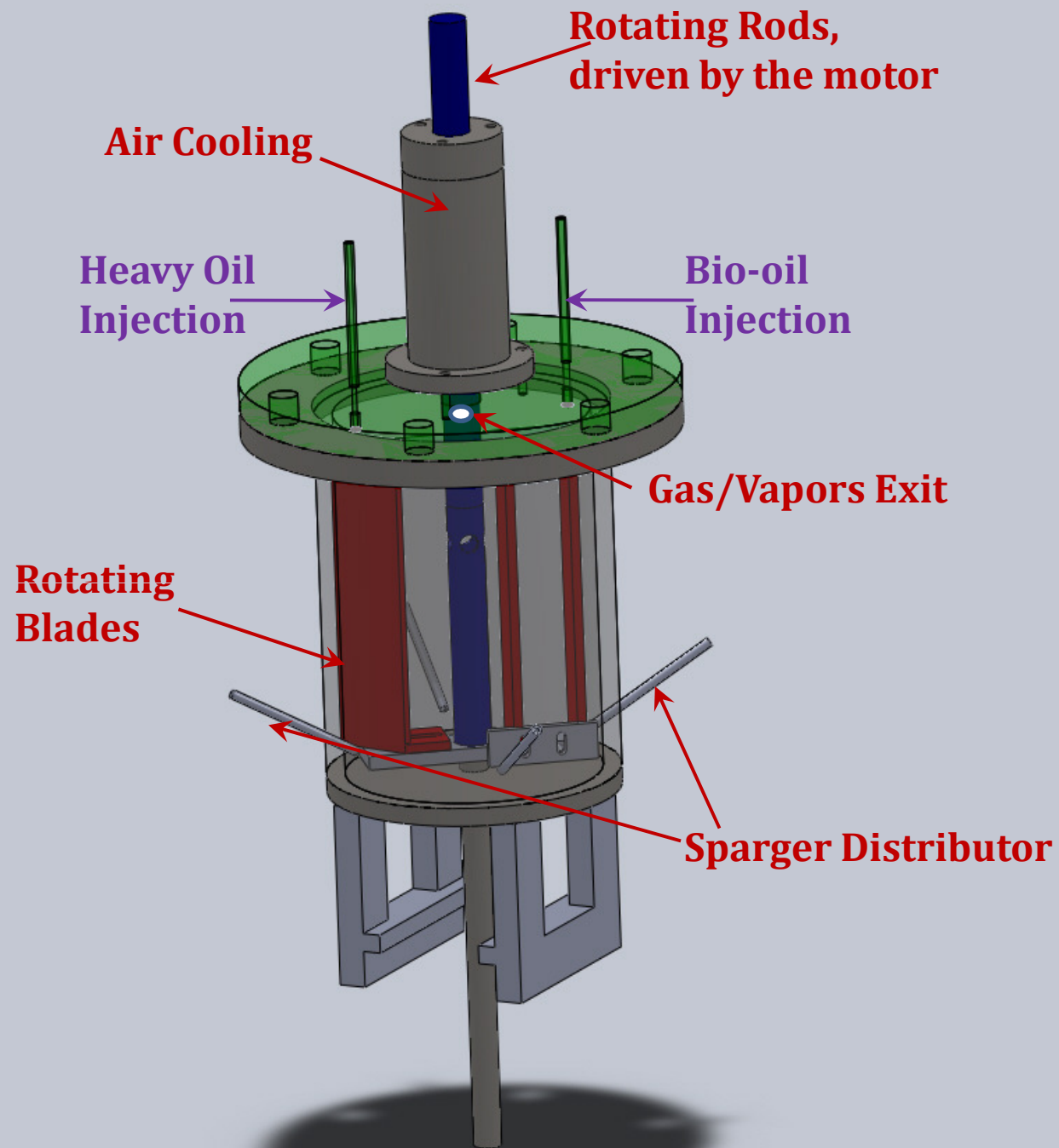


Objectives

- **Co-pyrolysis of bio-oil or biomass and heavy oil**
- **Can we get interesting chemicals and fuels from the combination of radicals from bio-oil/biomass and heavy oil?**
- **Operate at conditions relevant to industrial fluid cokers, which are currently used to convert heavy oil into synthetic crude**
 - **350 000 B/d in Fort Mc Murray, Alberta**
 - **100 000 B/d in Sarnia, Ontario**

Experimental Setup





Feeding System

2 Syringe Pumps

Combined Feeding Rate- 5 mL/min
Initial Reactor Temperature: 550°C

Viscosities:

Heavy Oil - 700cp @ 500°C

Sawdust Bio-Oil - 27.7 cp @ 25°C

High Heating Values:

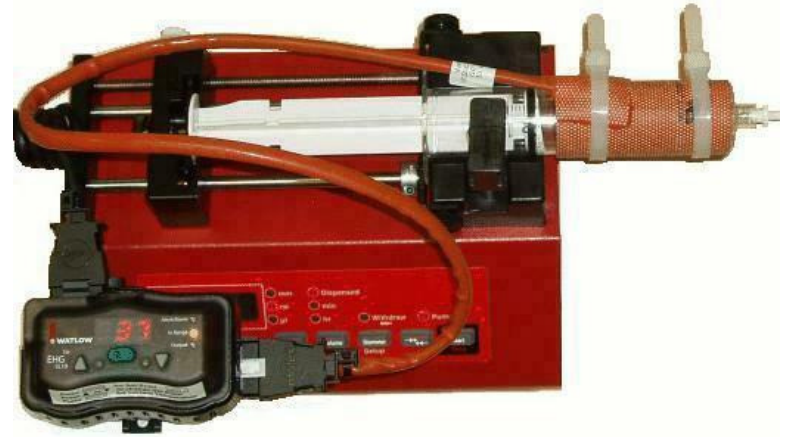
Heavy Oil - 43.63 kJ/g

Sawdust Bio-Oil - 16.50 kJ/g

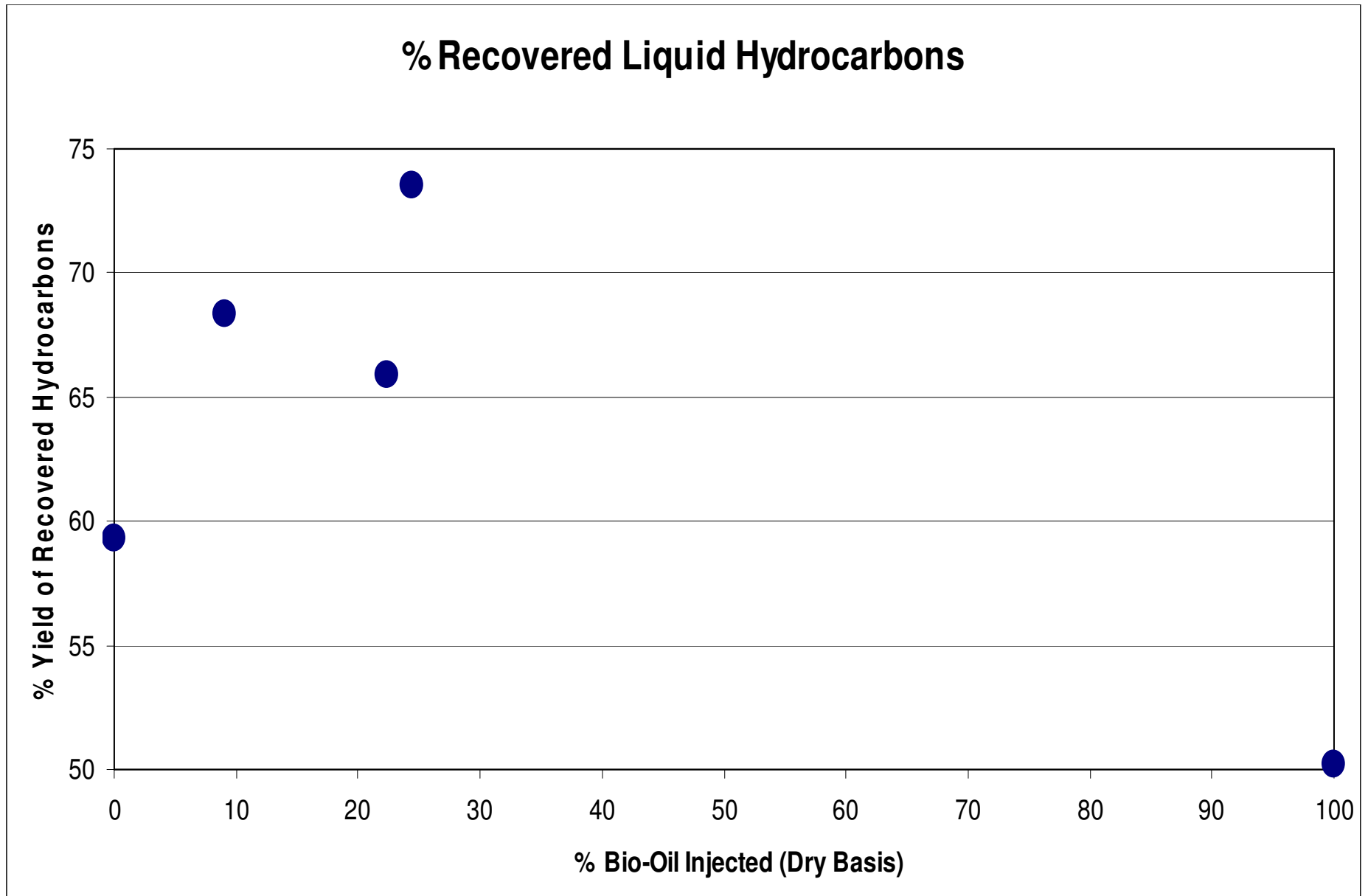
Moisture Content

Heavy Oil - 0%

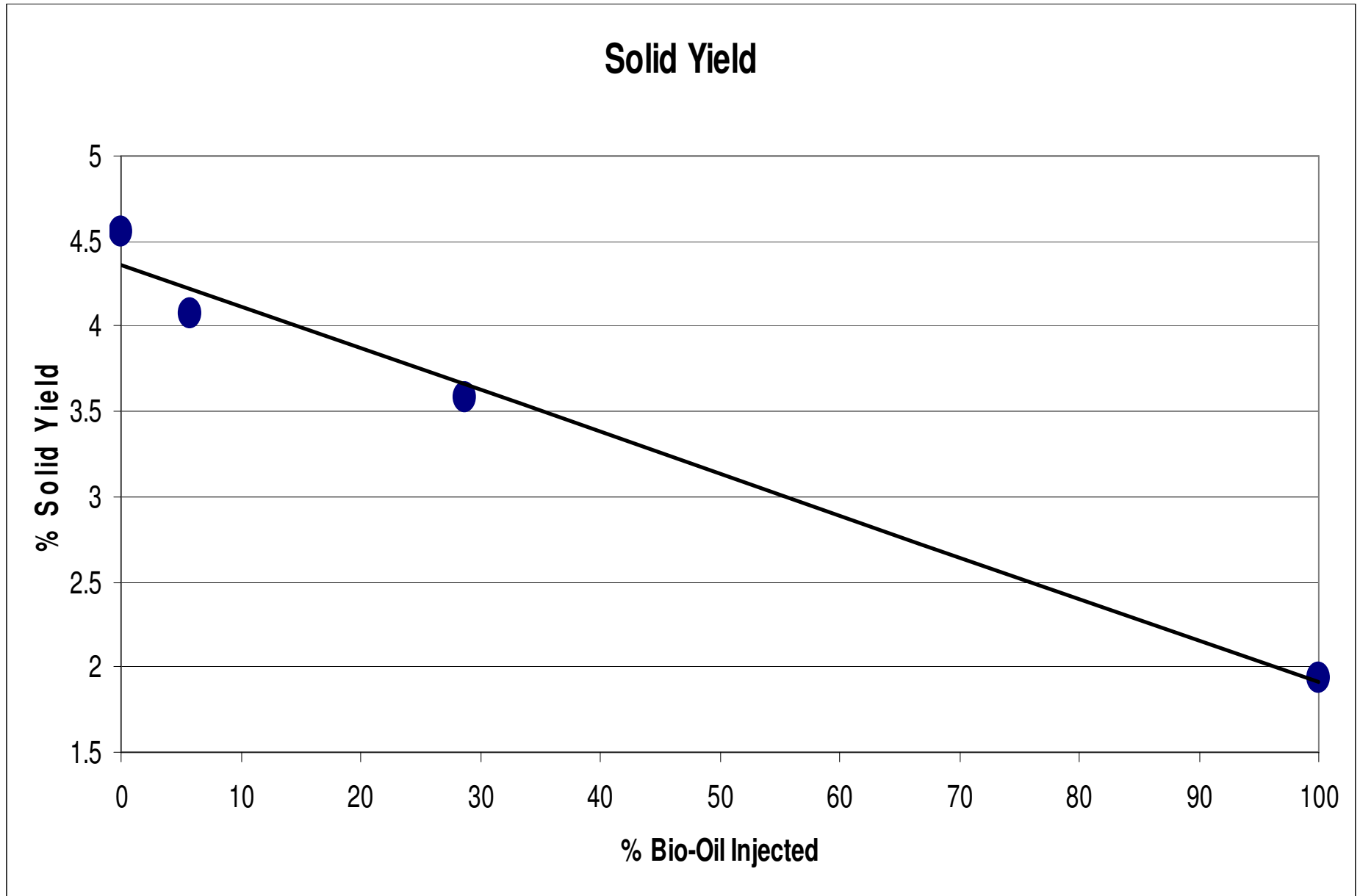
Sawdust Bio-Oil - 28.68%



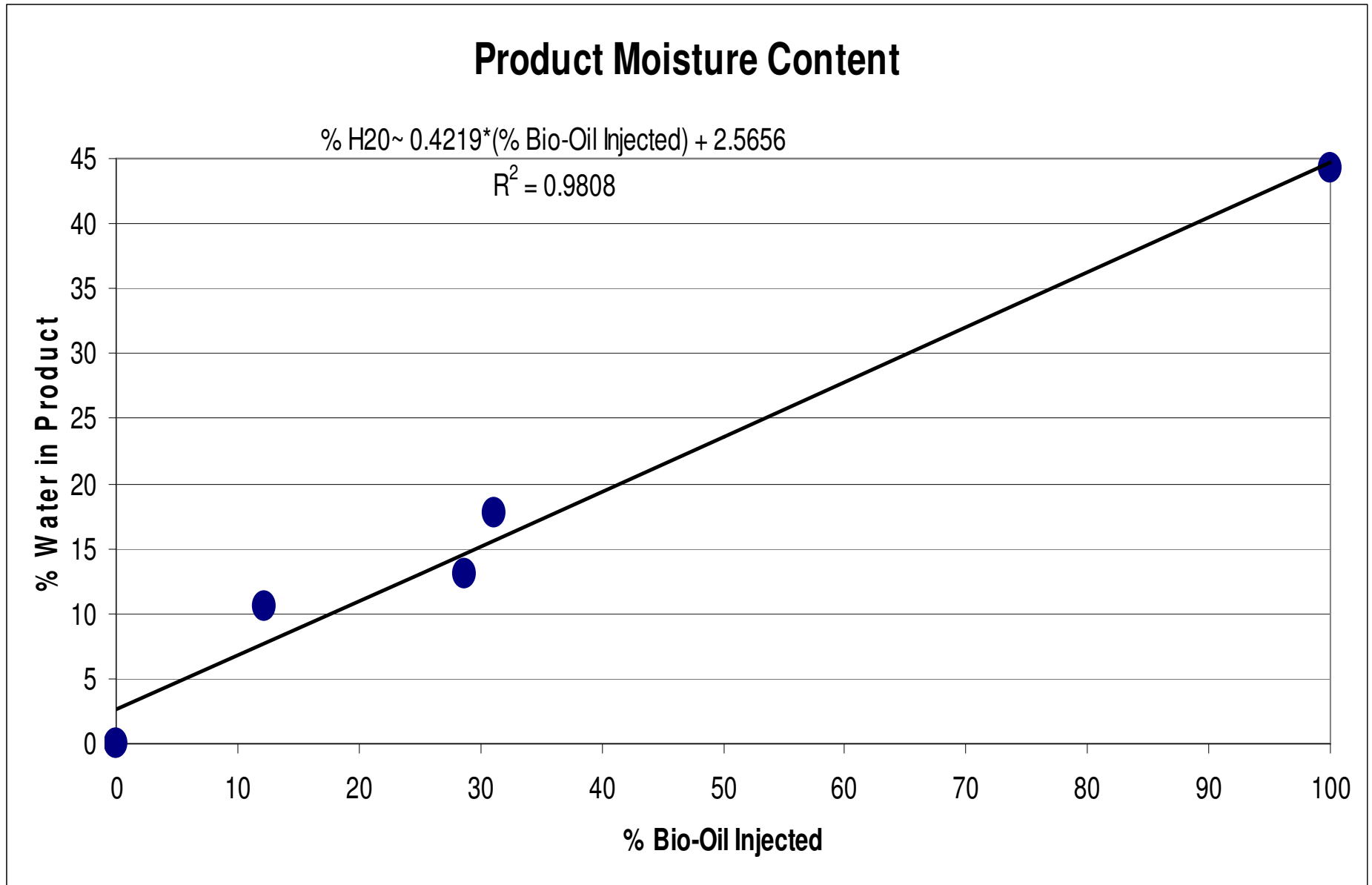
Experimental Results



Experimental Results

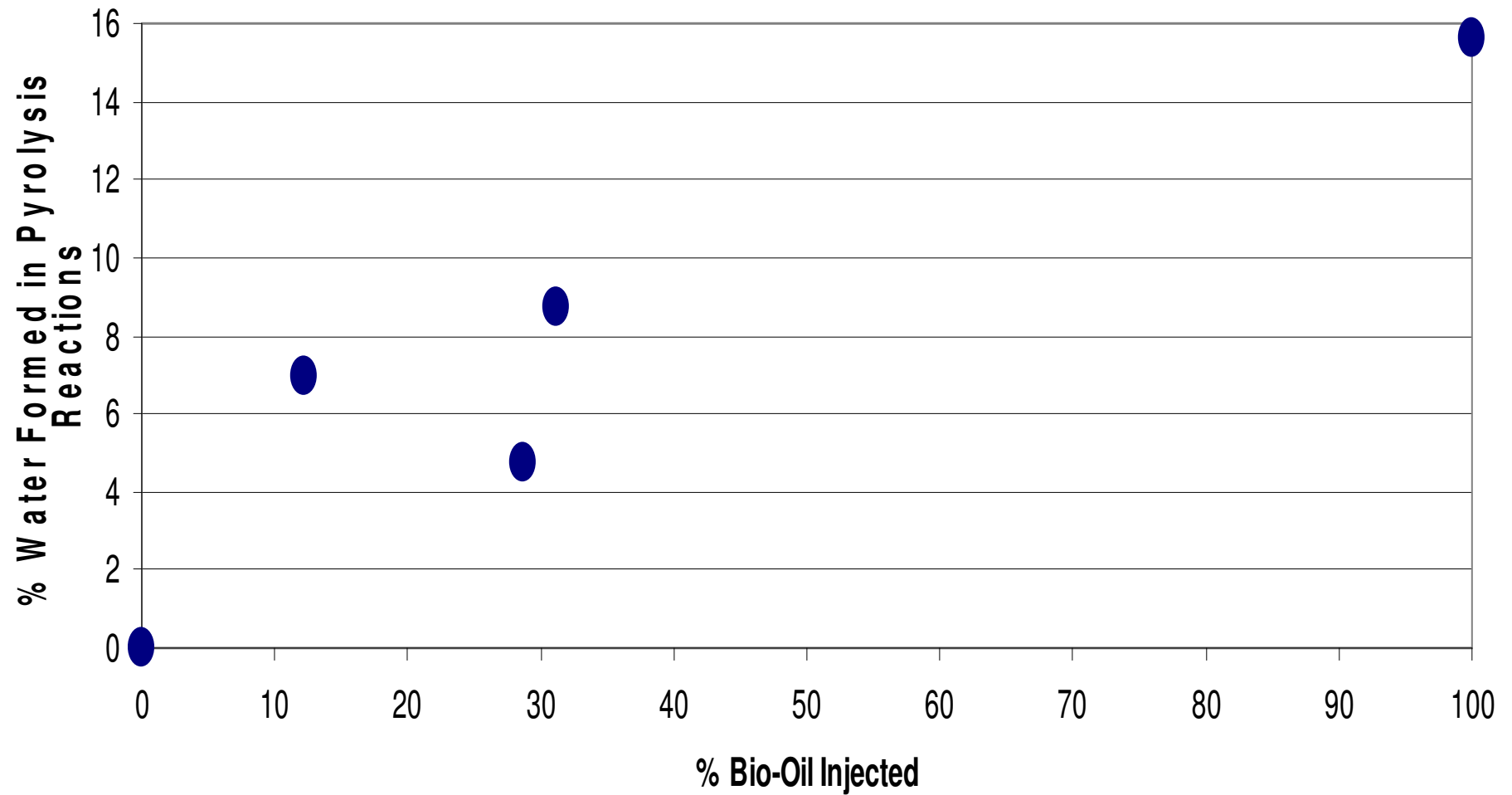


Experimental Results



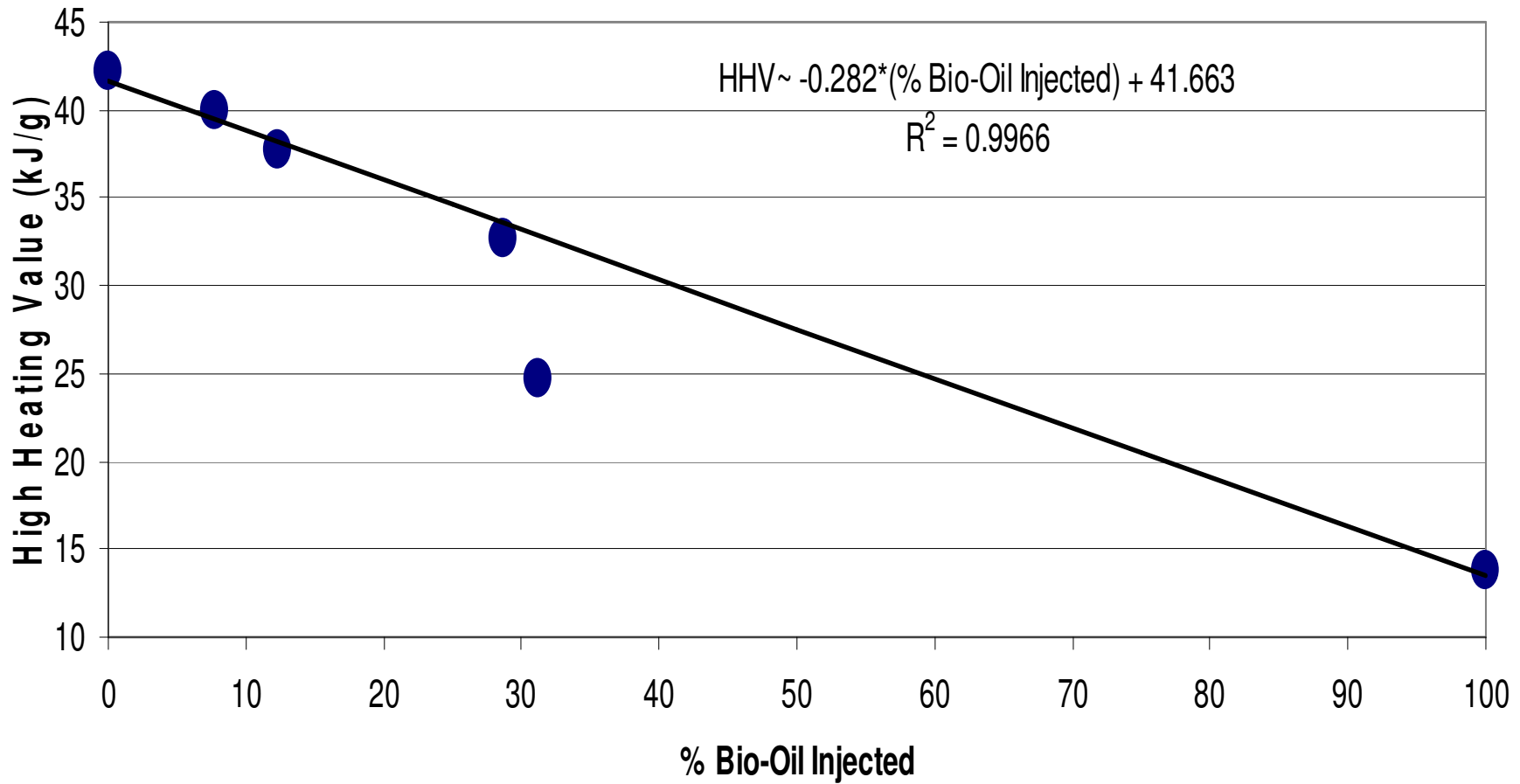
Experimental Results

% Water Formed in Pyrolysis Reactions



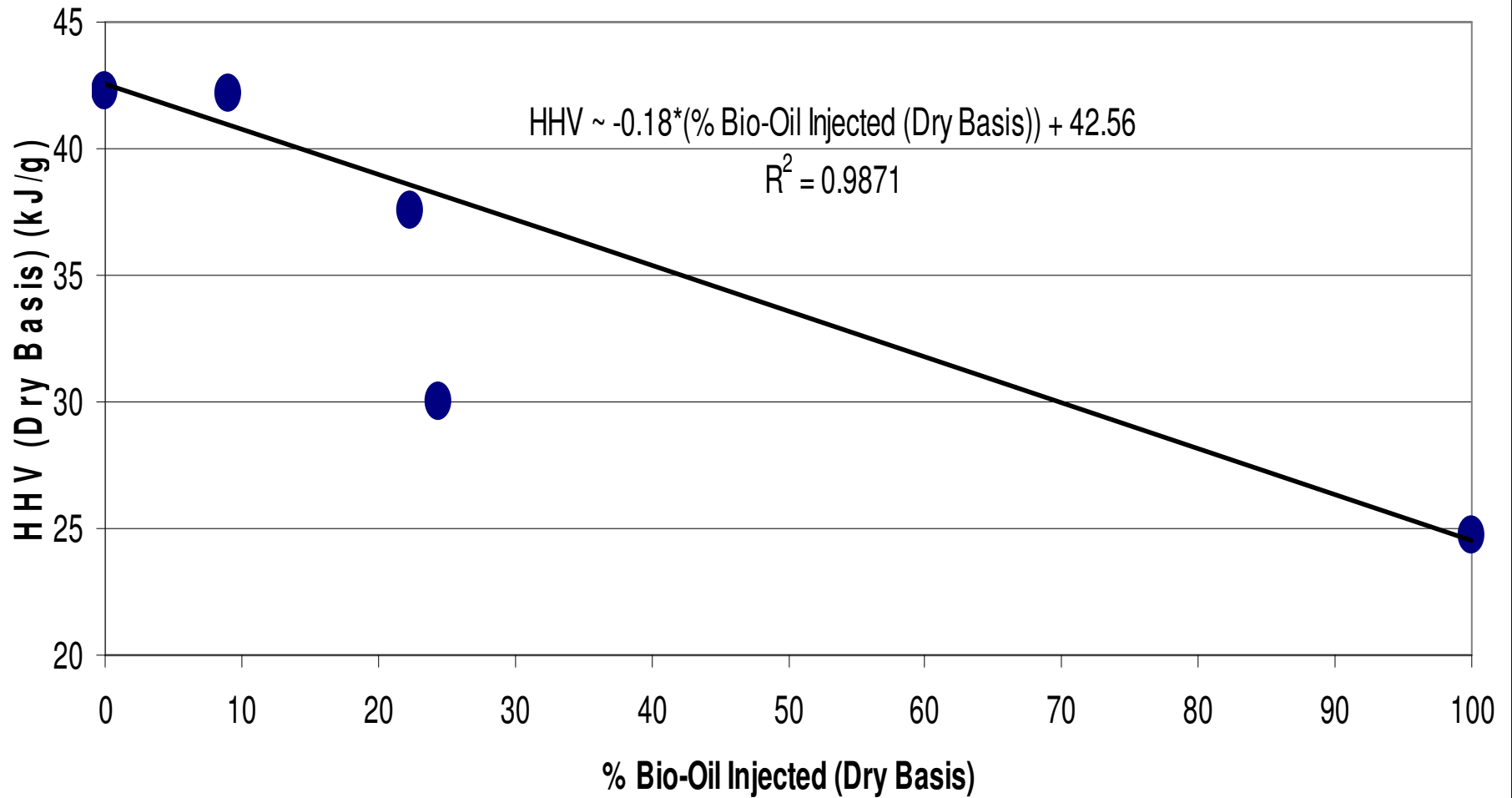
Experimental Results

High Heating Value of Liquid Product

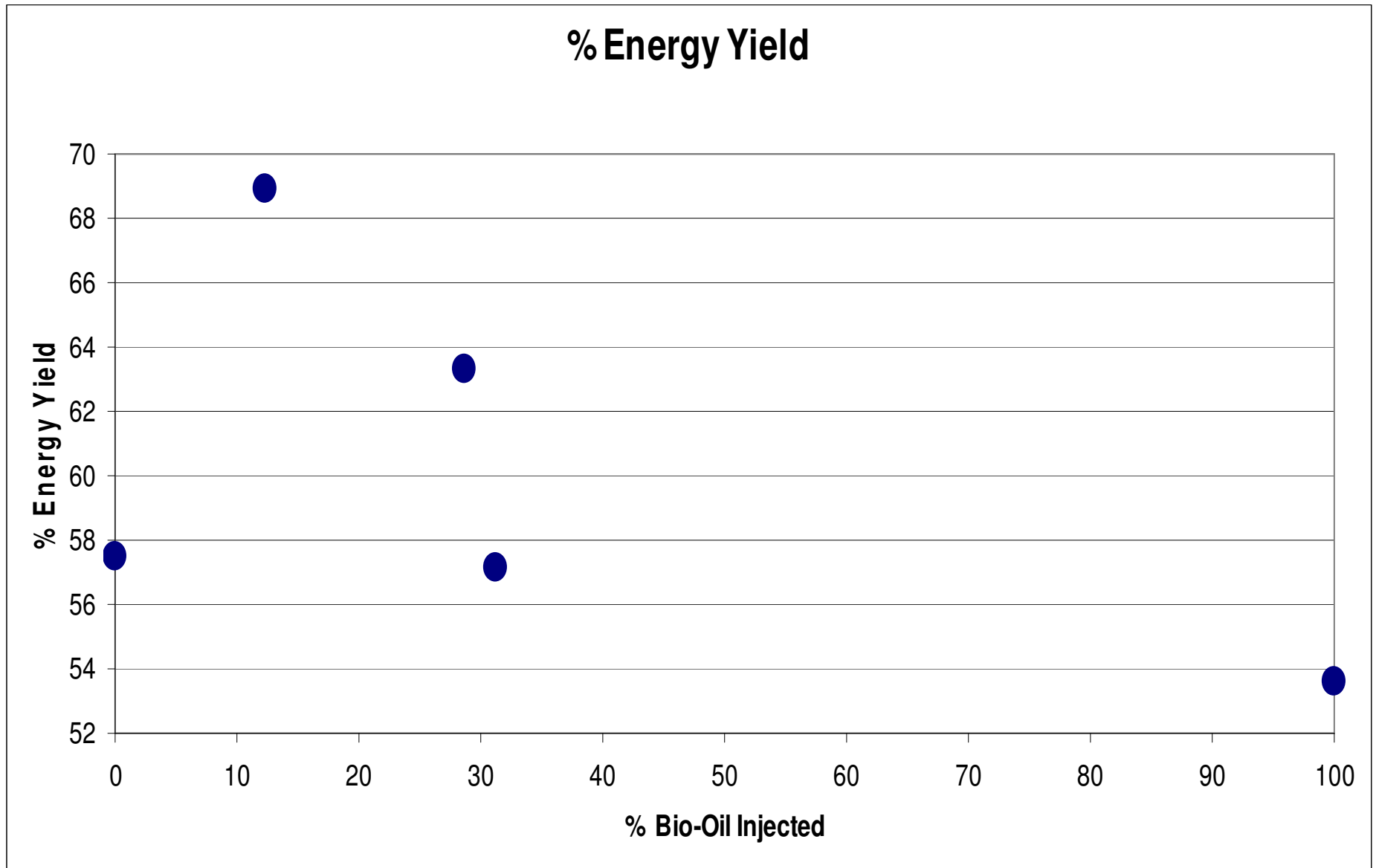


Experimental Results

High Heating Value (Dry Basis)

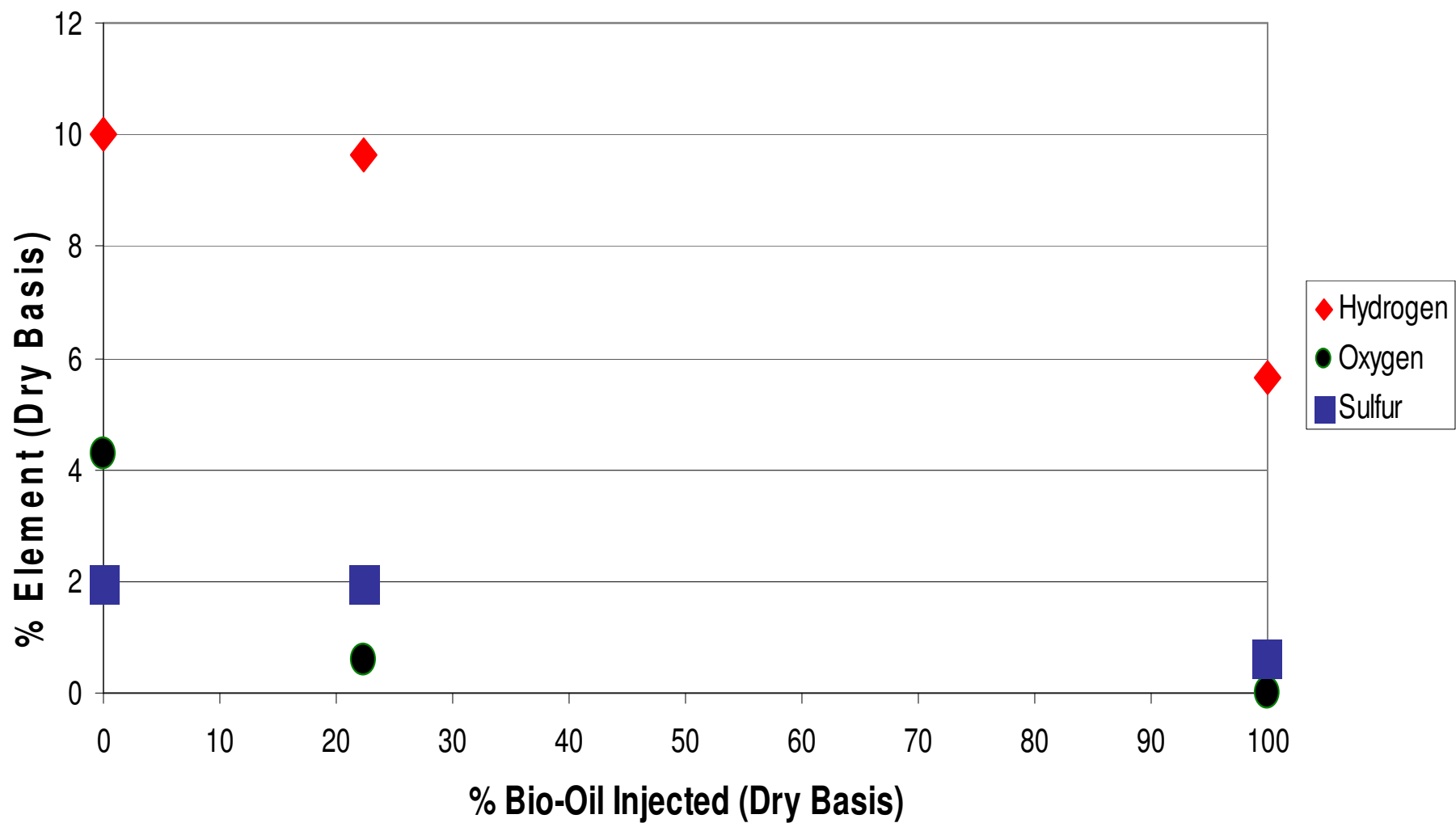


Experimental Results



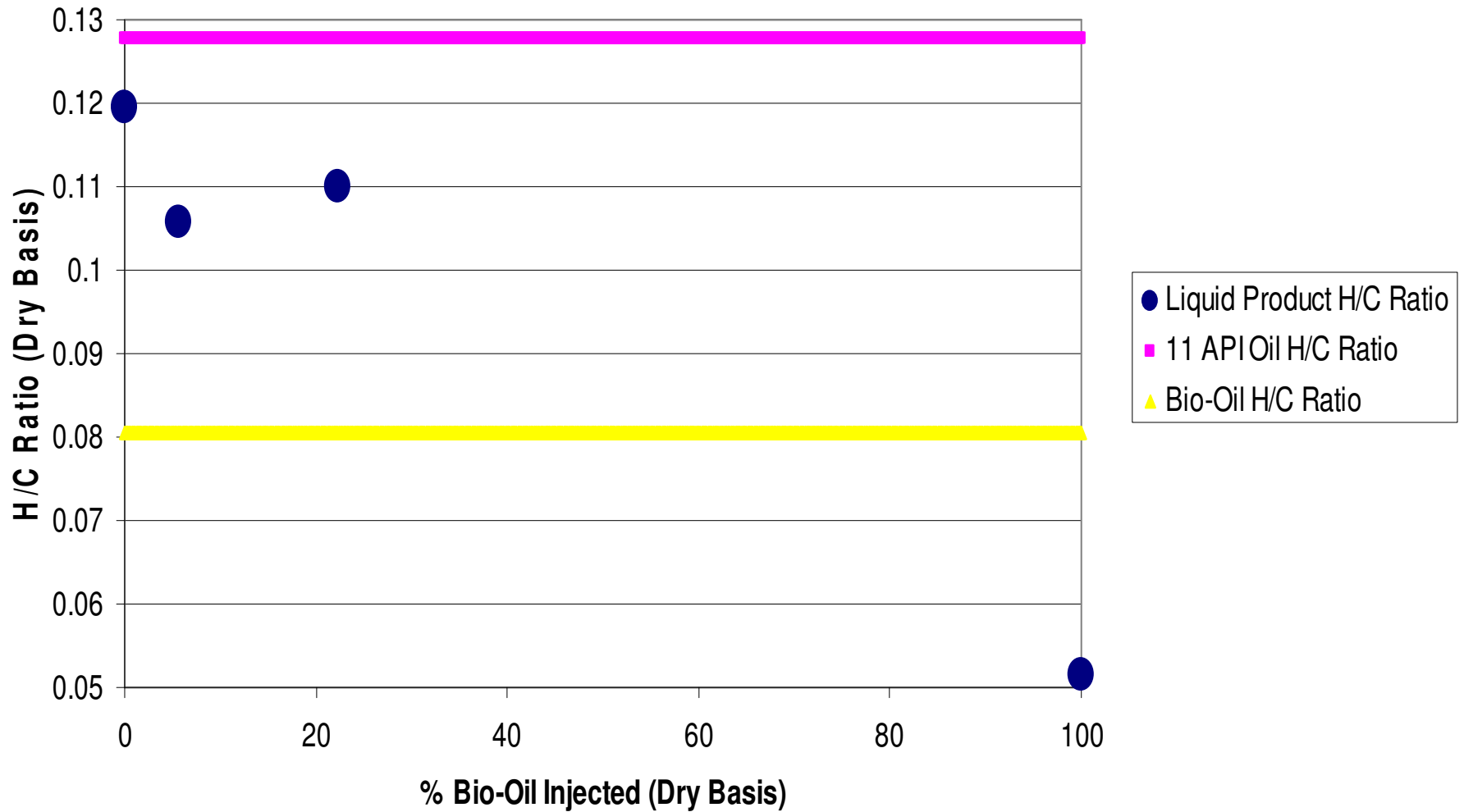
Experimental Results

Elemental Analysis



Experimental Results

H/C Ratio of Liquid Product (Dry Basis)



Conclusions

The mechanically fluidized reactor has been successfully modified to operate using with heavy oil and sawdust bio-oil

Pyrolysis of bio-oil with or without heavy oil removes oxygenated compounds from the bio-oil and forms water

Co-processing heavy oil with bio-oil reduces the yield of coke

Co-processing heavy oil with bio-oil may increase the yield of recovered liquid hydrocarbons. Further investigations must be done to confirm this.

Continuous Plan

Operating Temperatures: 520, 540, 560°C

Nitrogen Flowrate: [0.75-5 SLM]

Total Liquid Feed: 10 mL/min

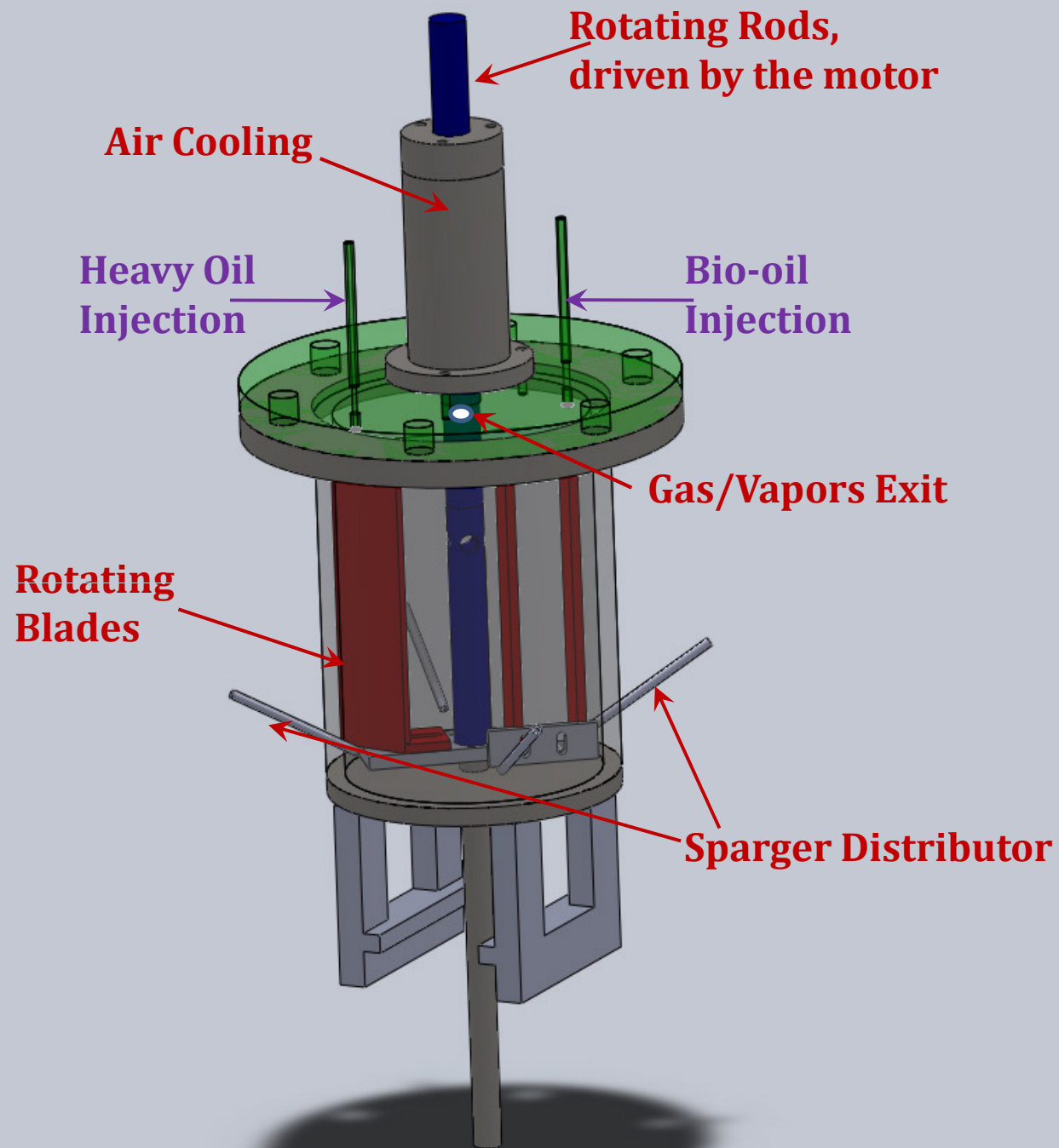
Heater Types

- Band
- Ceramic
- Induction Heater.

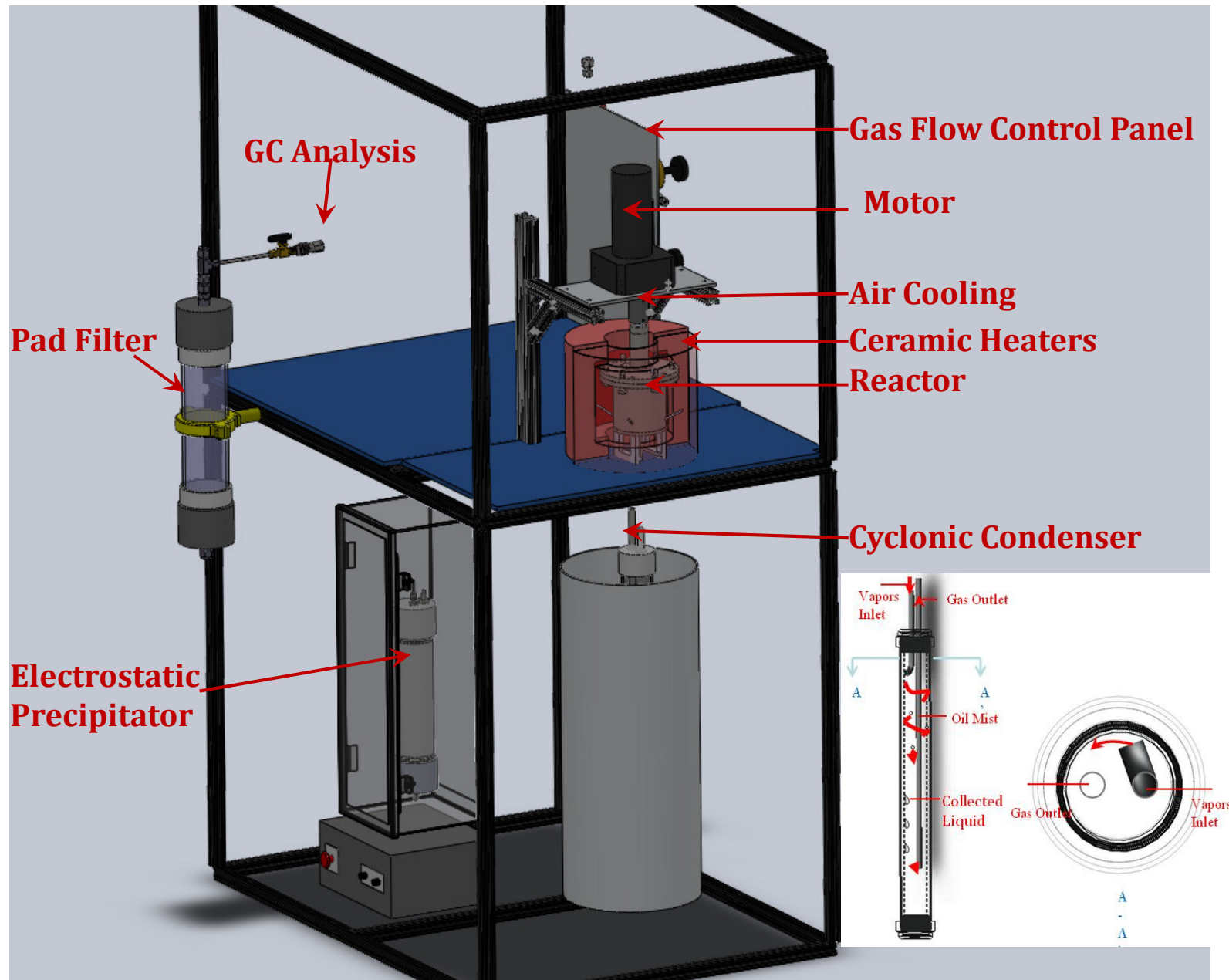
Mixing Ratios: 0%, 5%, 10%, 15%, 20% Bio-oil

Water Removal Using CaO

Co-processing with Lignin Injected Using Solvents



Current Batch Problems



Batch Plan

Nitrogen Flowrate: [0.75-5 SLM]

Batch Mass: 200 g

Heater Types

- Band
- Ceramic
- Induction Heater.

Mixing Ratios: 0%, 5%, 10%, 15%, 20% Bio-oil

Temperature Cuts:

25-110°C

110-200°C

200-300°C

300-350°C

350-400°C

400-450°C

450-500°C

500-550°C

550-600°C

Acknowledgements

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