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

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Western

Esso Imperial Oil

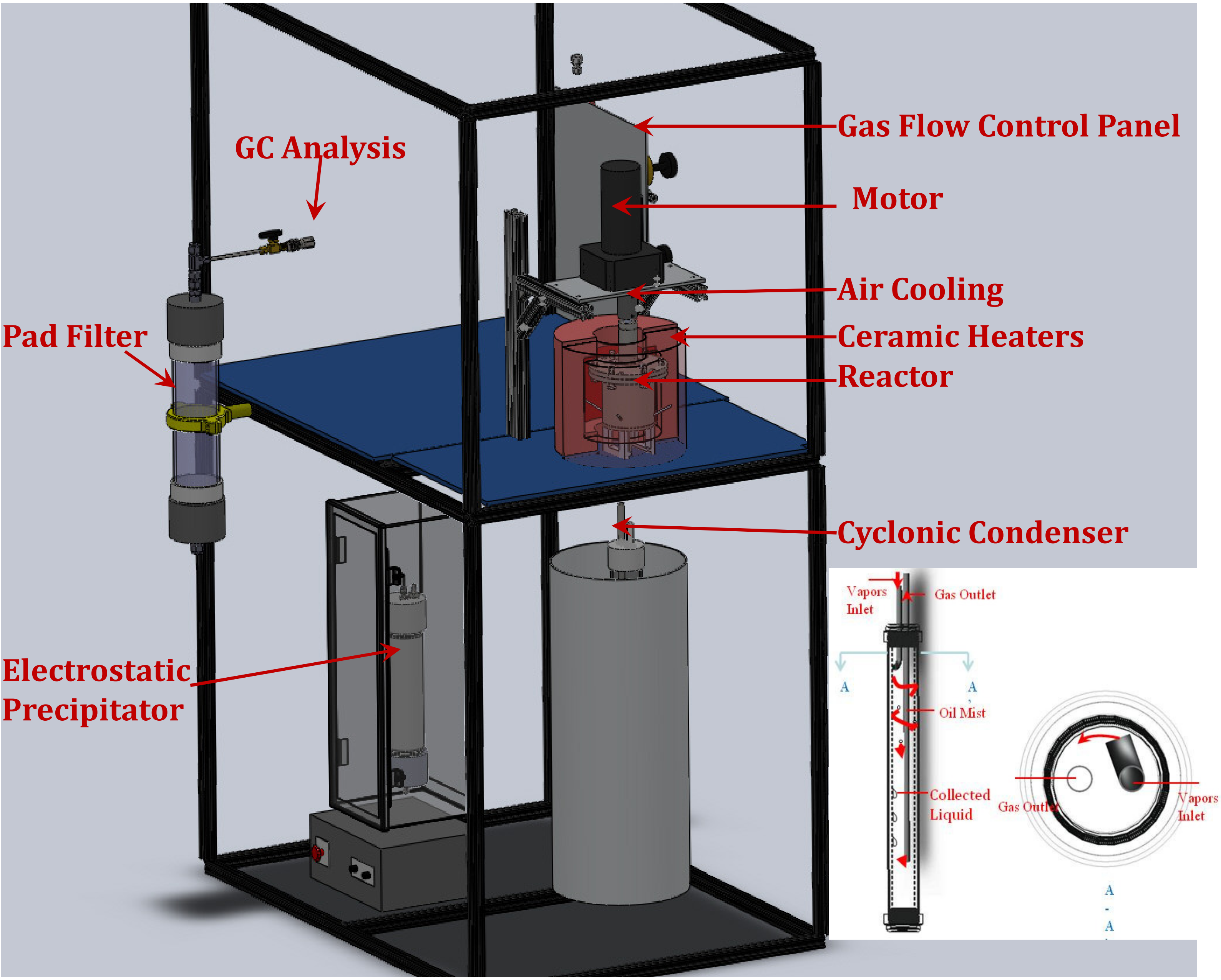
Objectives

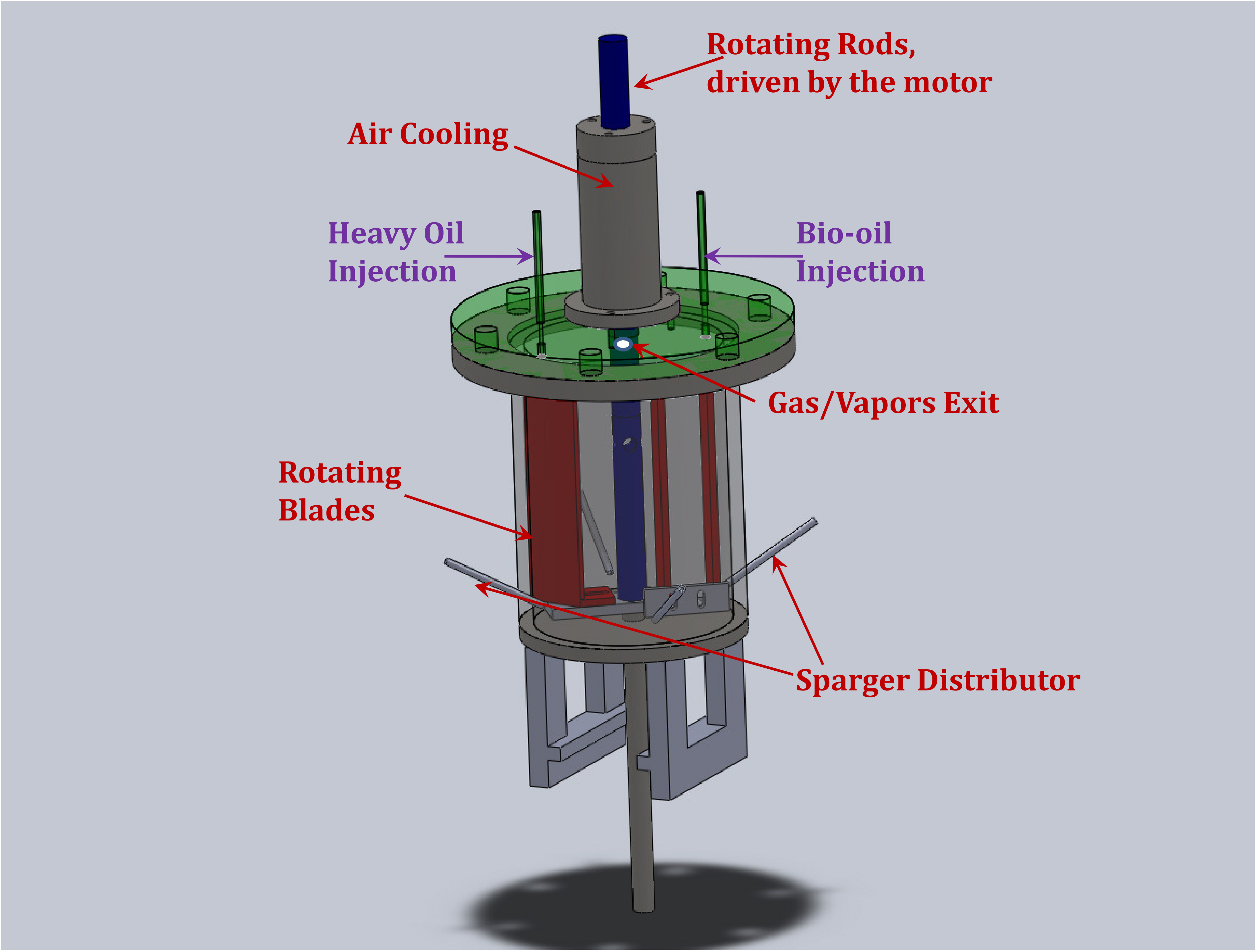
- Co-pyrolysis of bio-oil or biomass and heavy oil

- Can we get interesting chemicals and fuels from the combination of radicals from bio-oil/biomass and heavy oil?

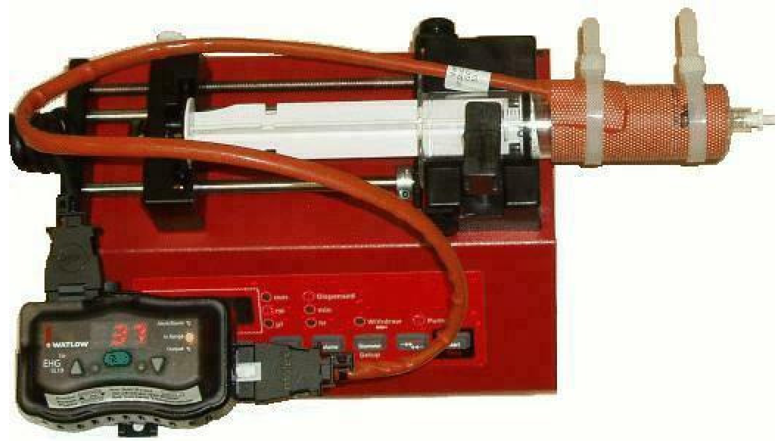
- Operate at conditions relevant to industrial fluid cokers, which are currently used to convert heavy oil into synthetic crude
  - 350 000 B/d in Fort Mc Murray, Alberta
  - 100 000 B/d in Sarnia, Ontario

Experimental Setup




Rotating Rods,
driven by the motor
Air Cooling
Heavy Oil
Injection
Bio-oil
Injection
Gas/Vapors Exit
Rotating
Blades
Sparger Distributor

Feeding System



2 Syringe Pumps

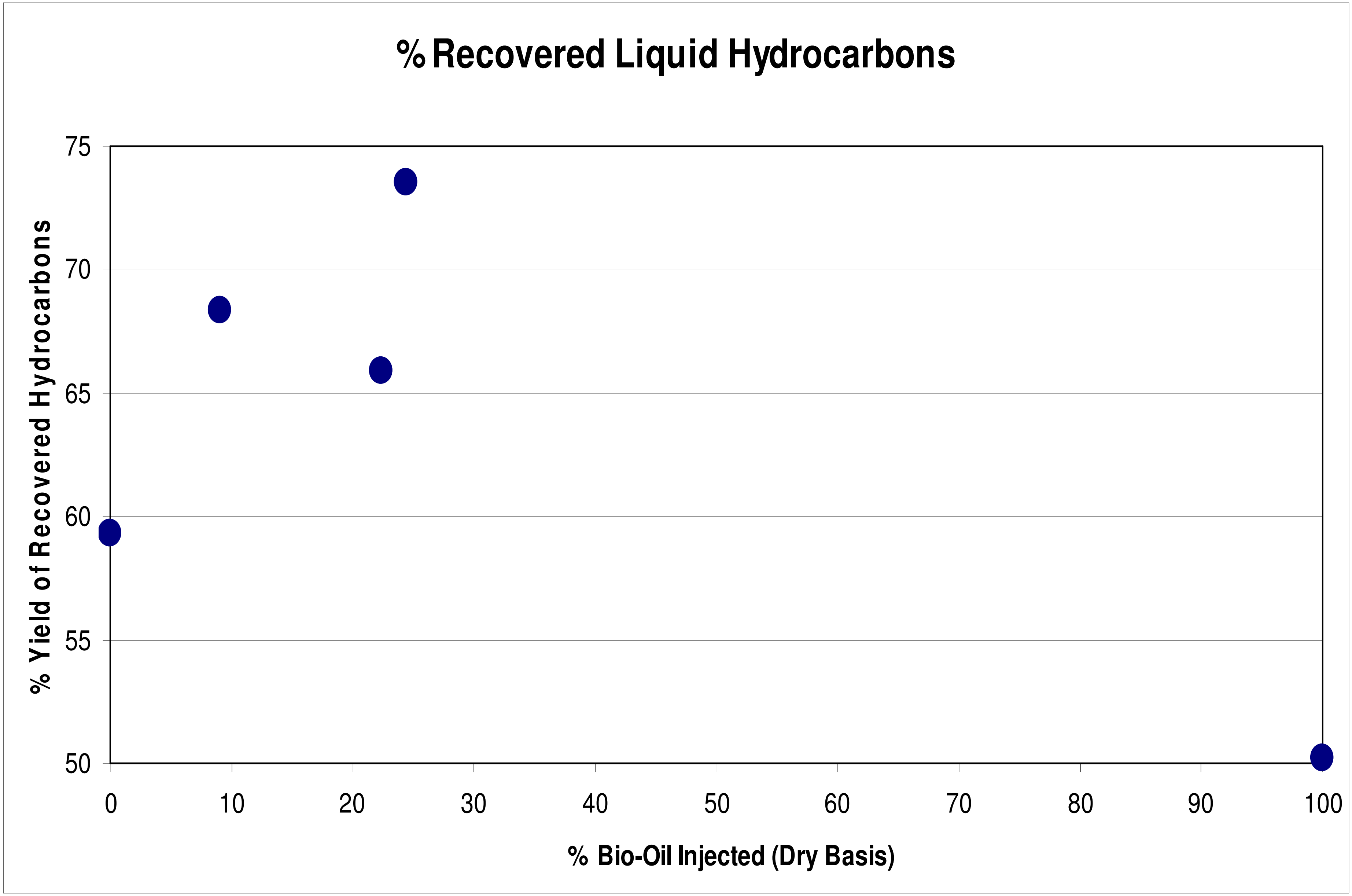
Combined Feeding Rate- 5 mL/min
Initial Reactor Temperature: 550°C

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



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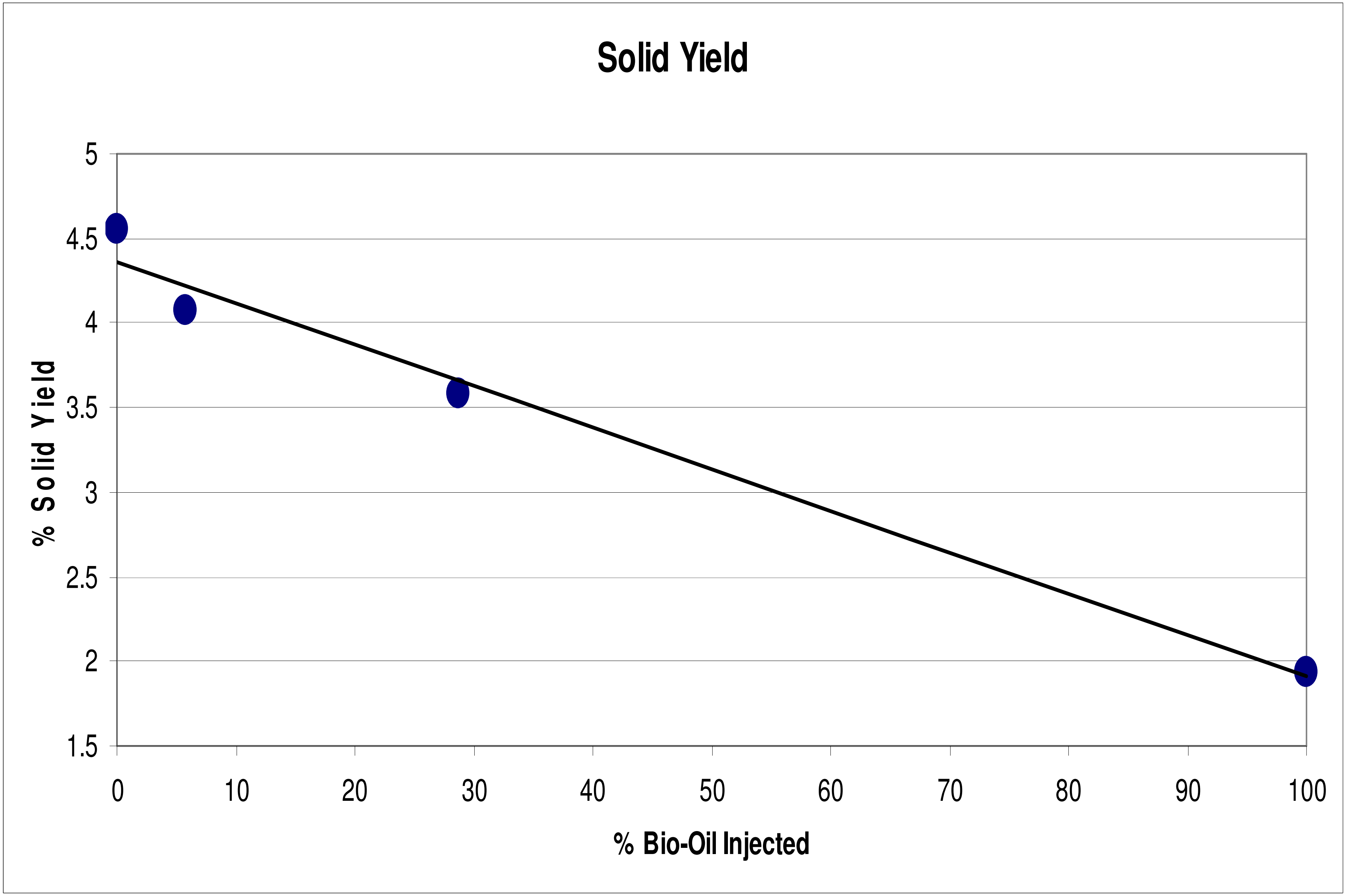

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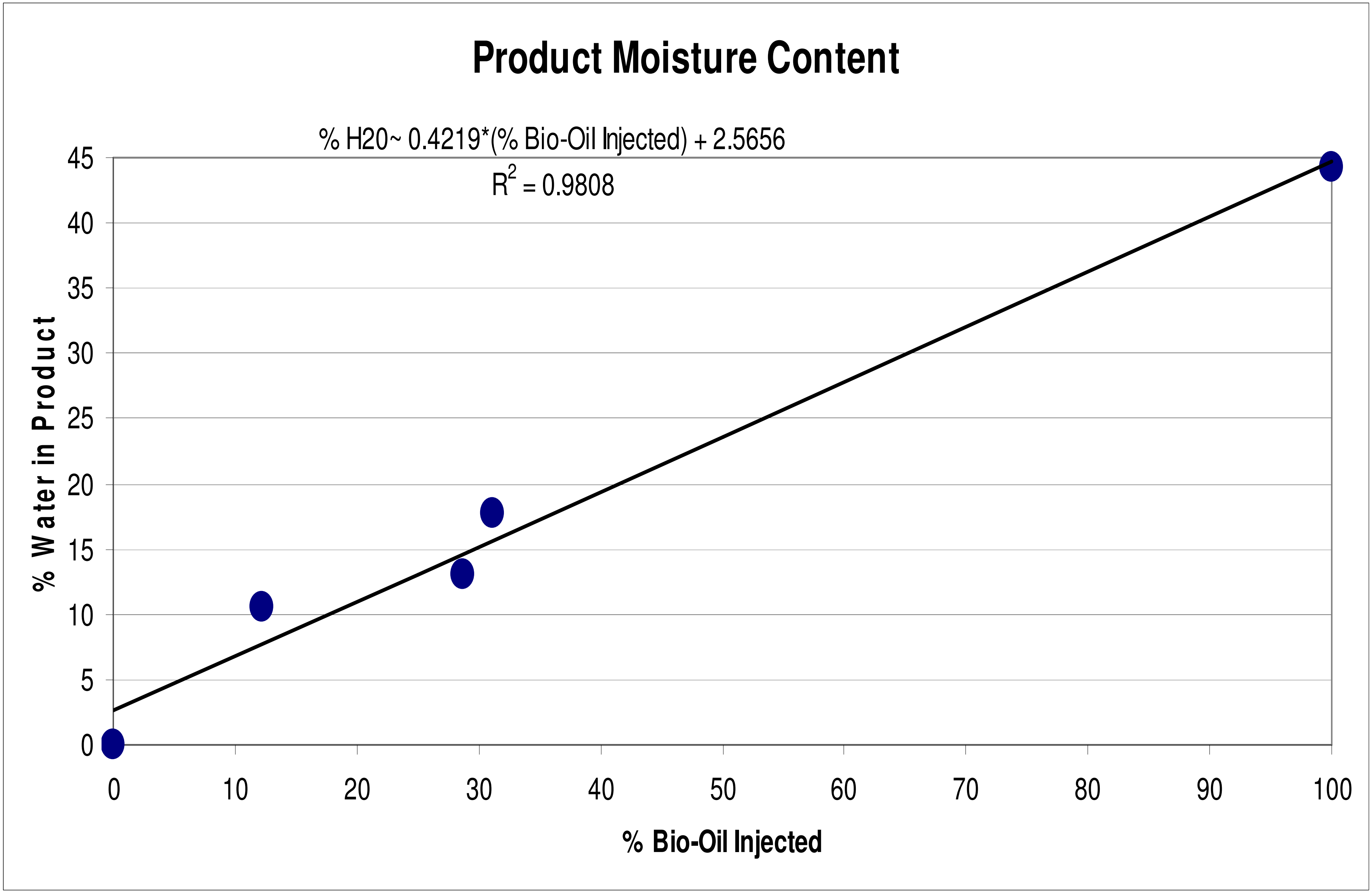

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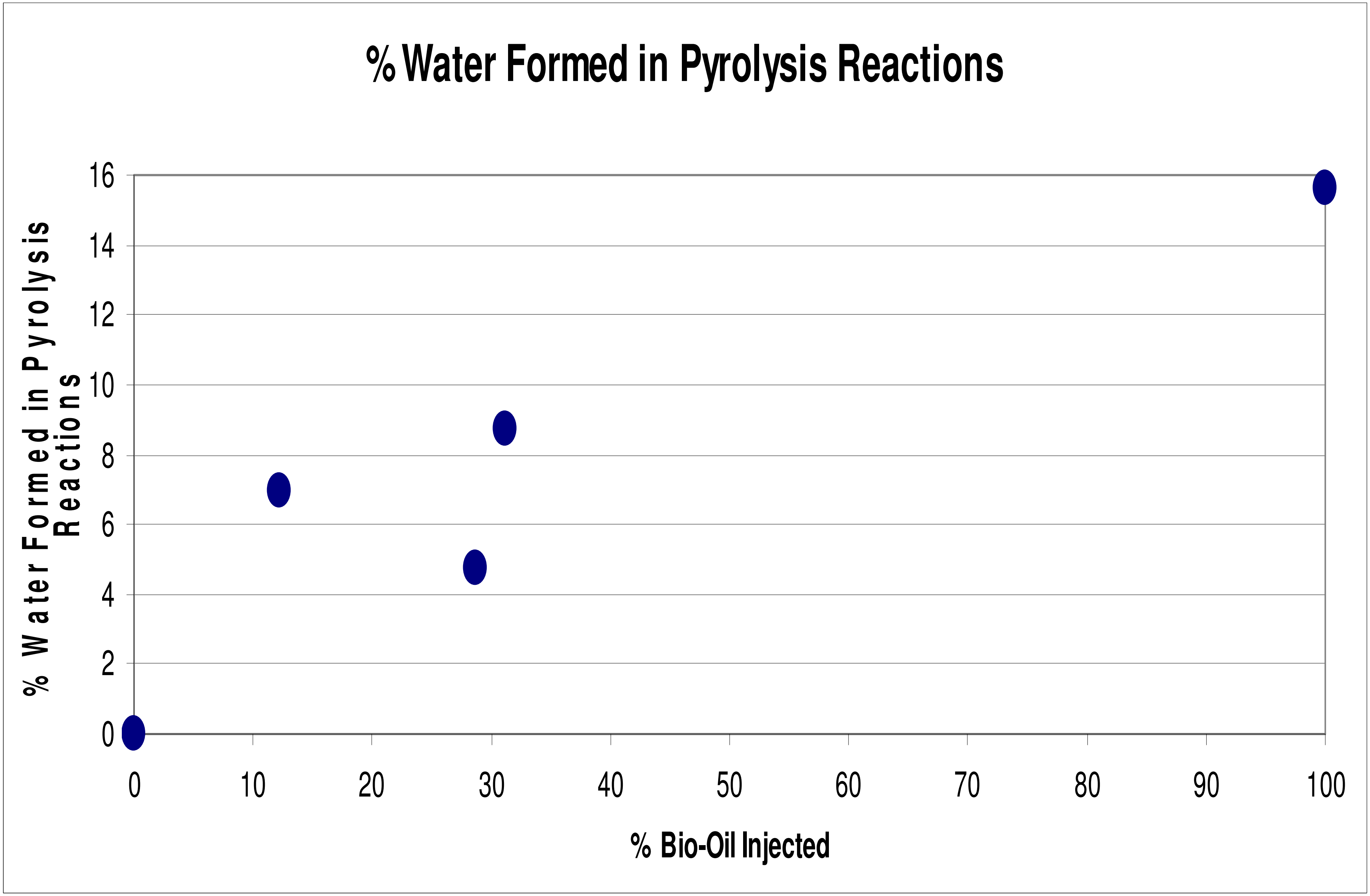

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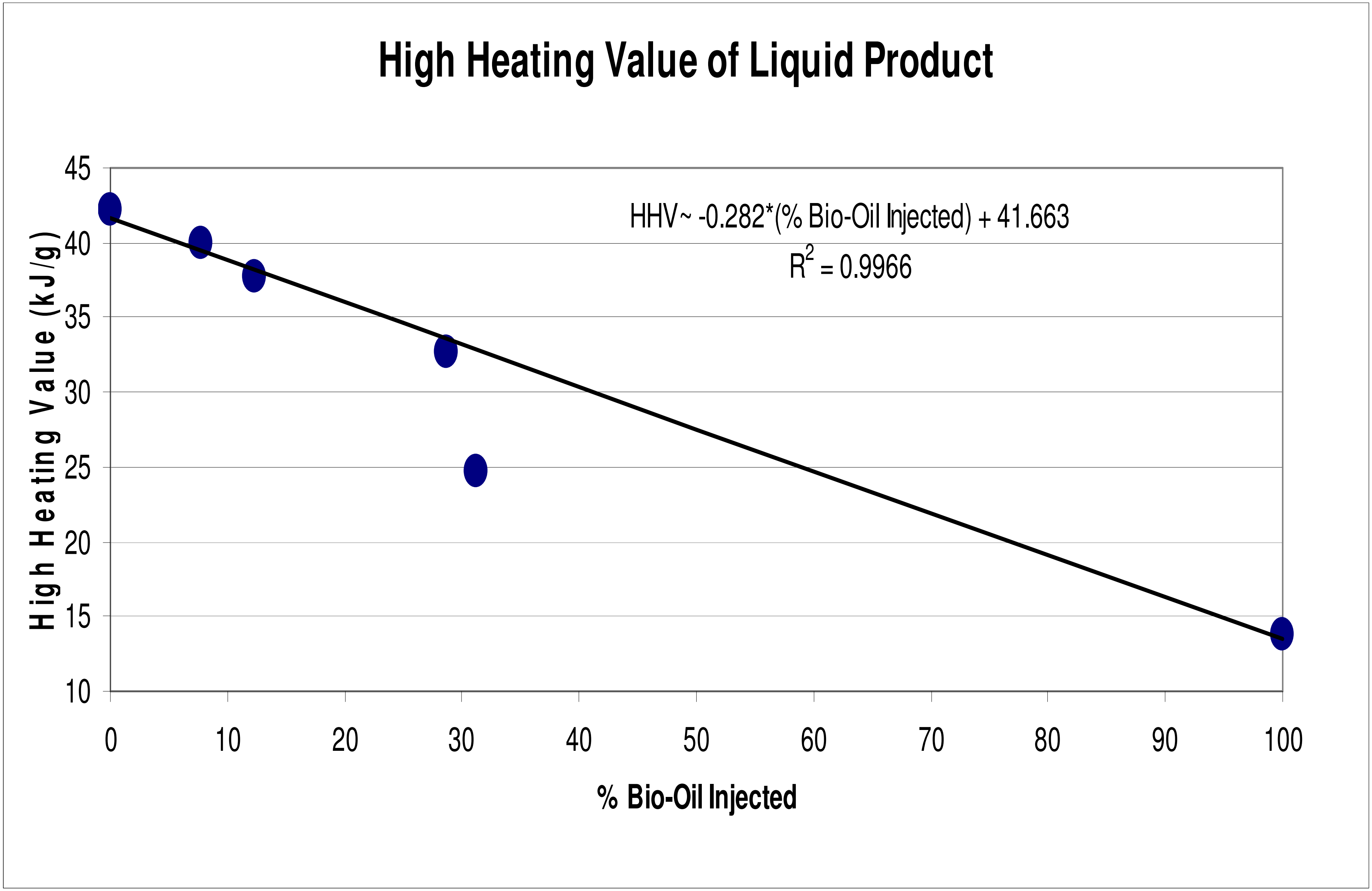

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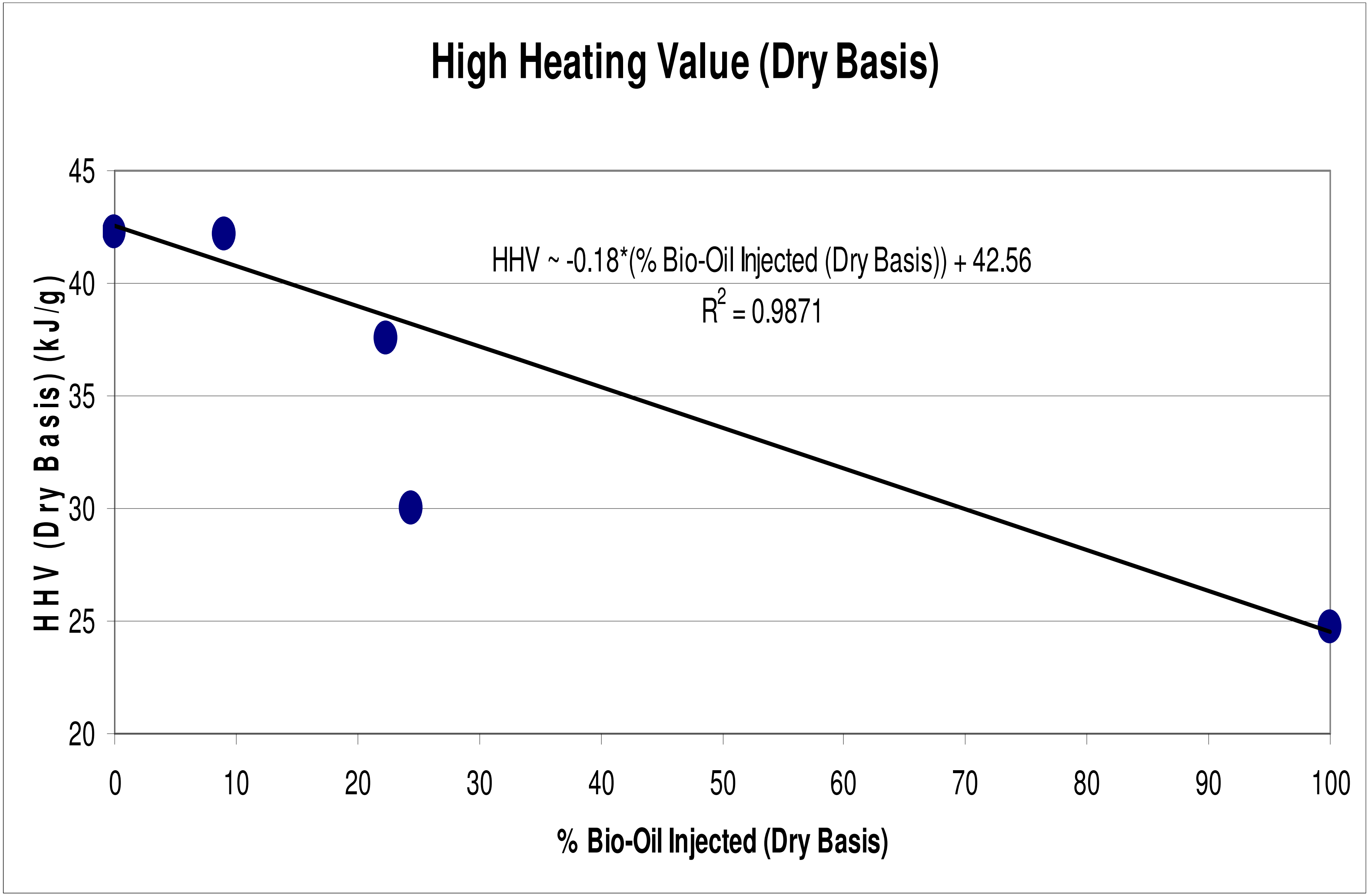

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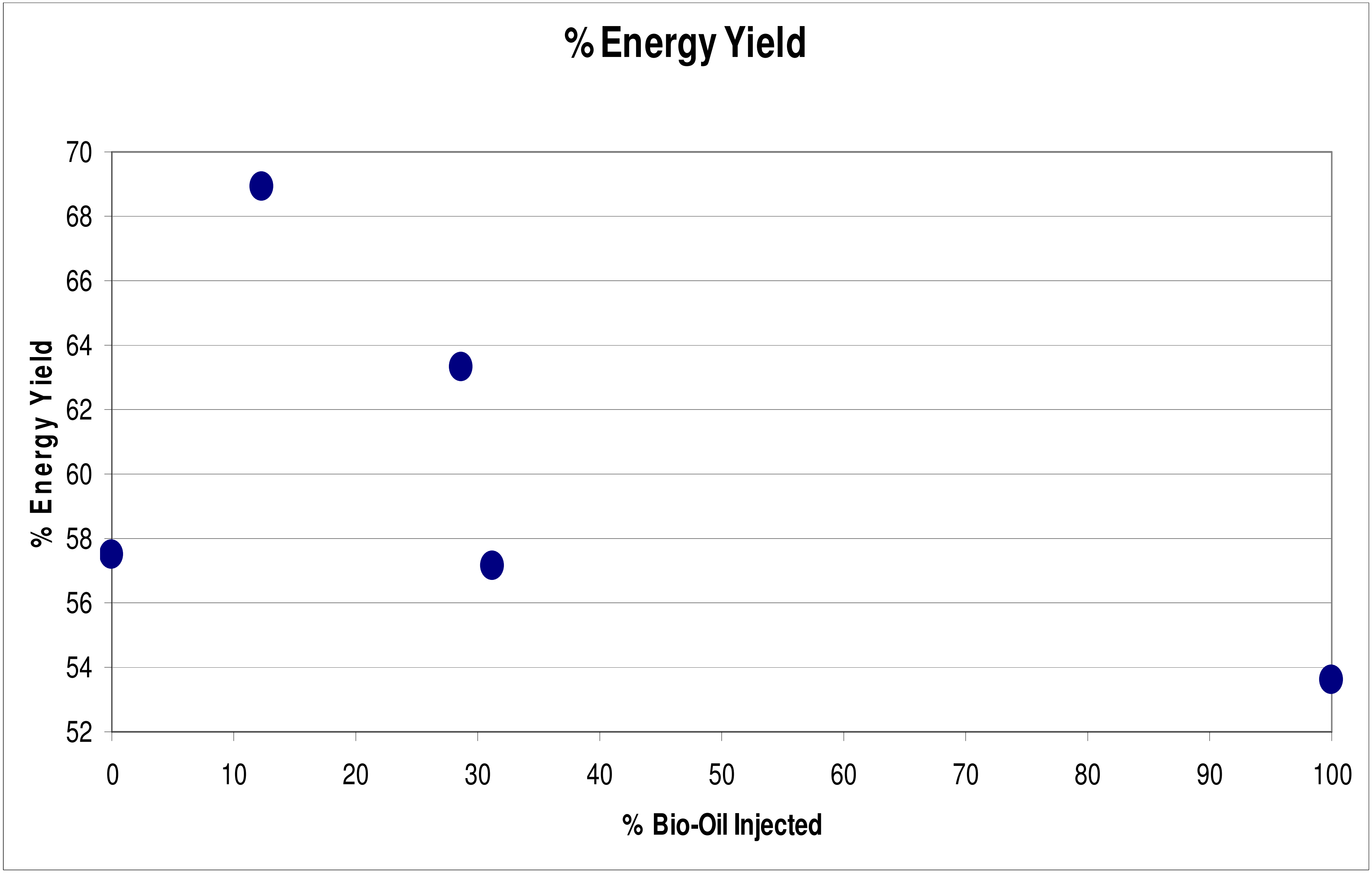

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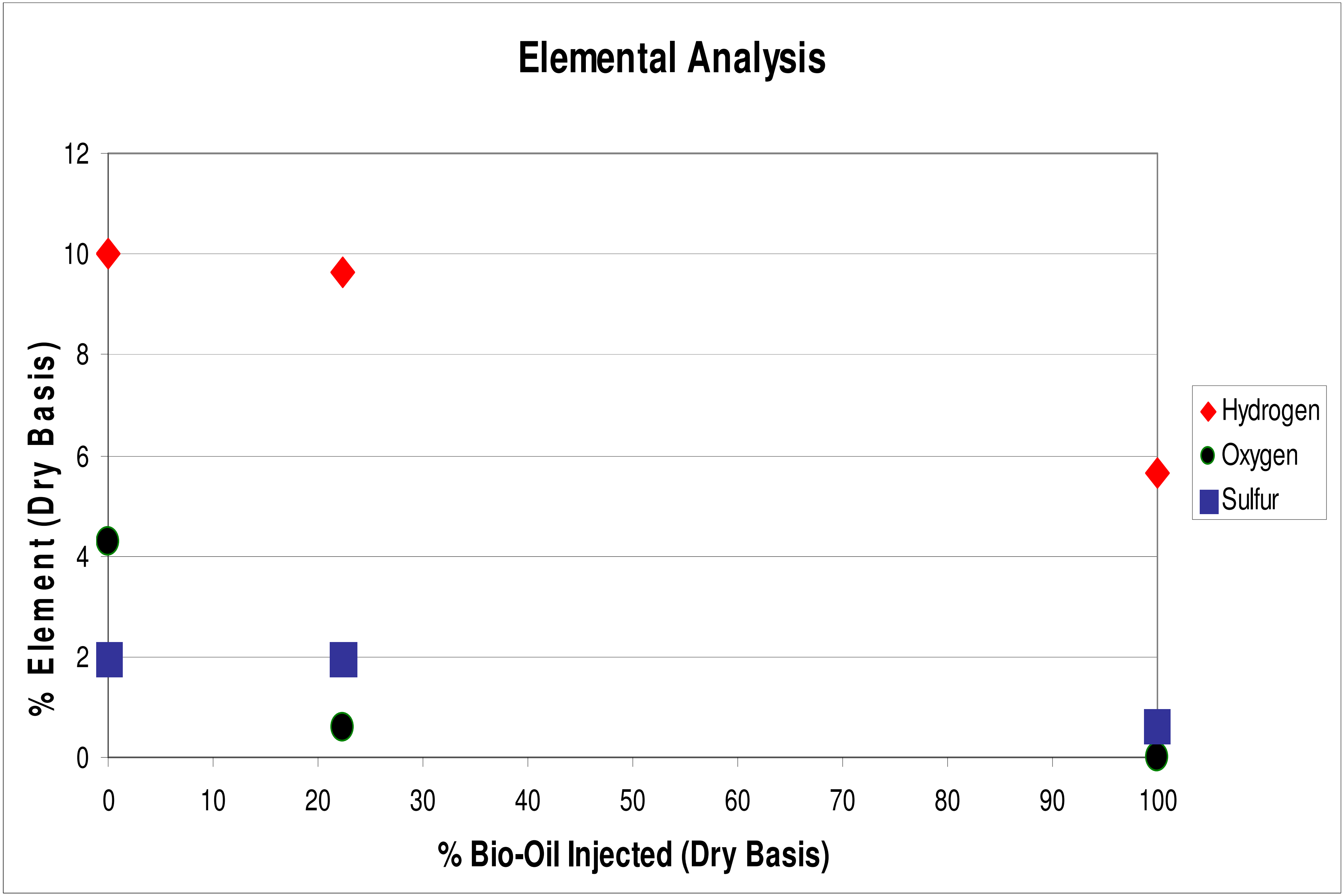

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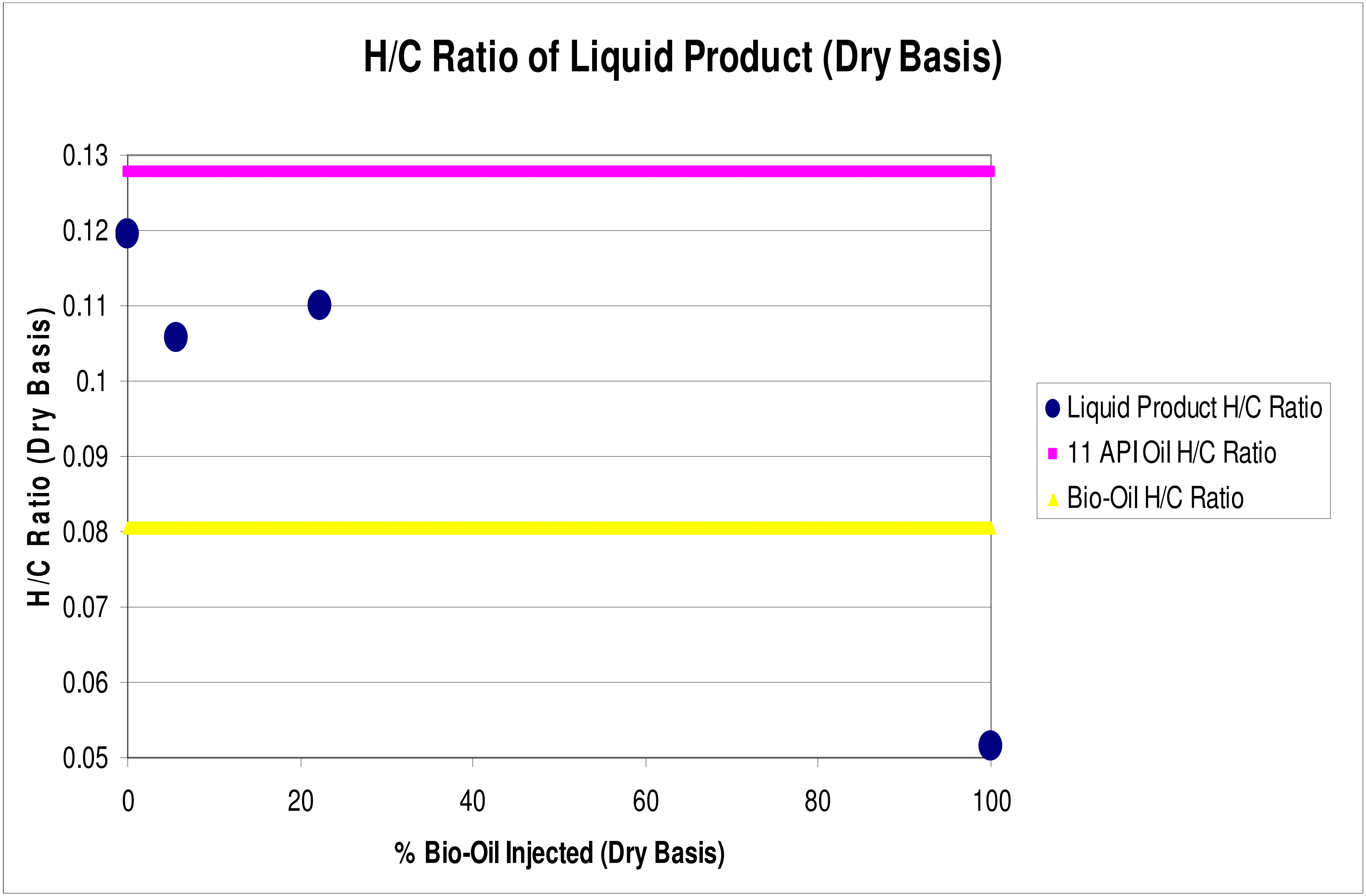


Conclusions

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]

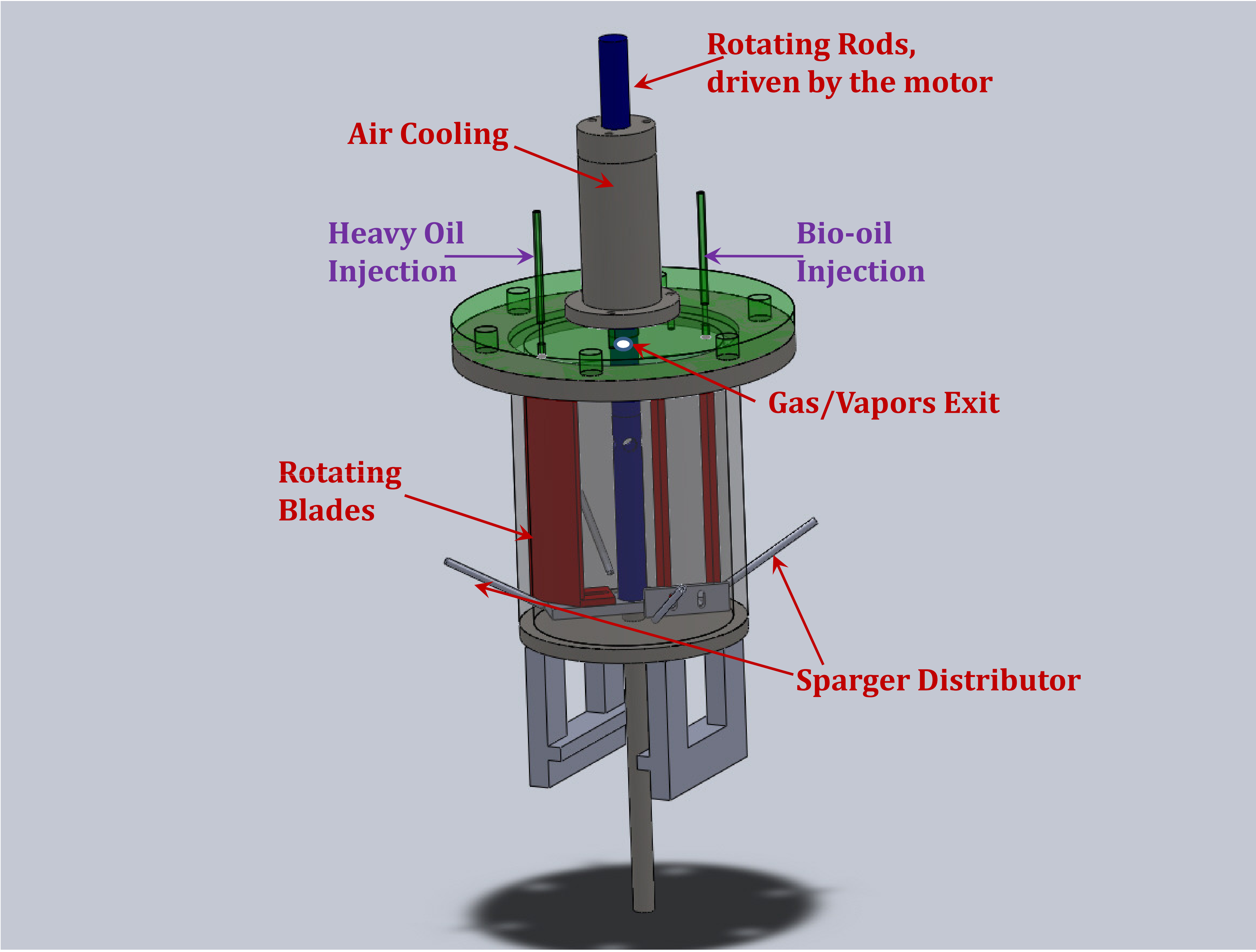
Total Liquid Feed: 10 mL/min

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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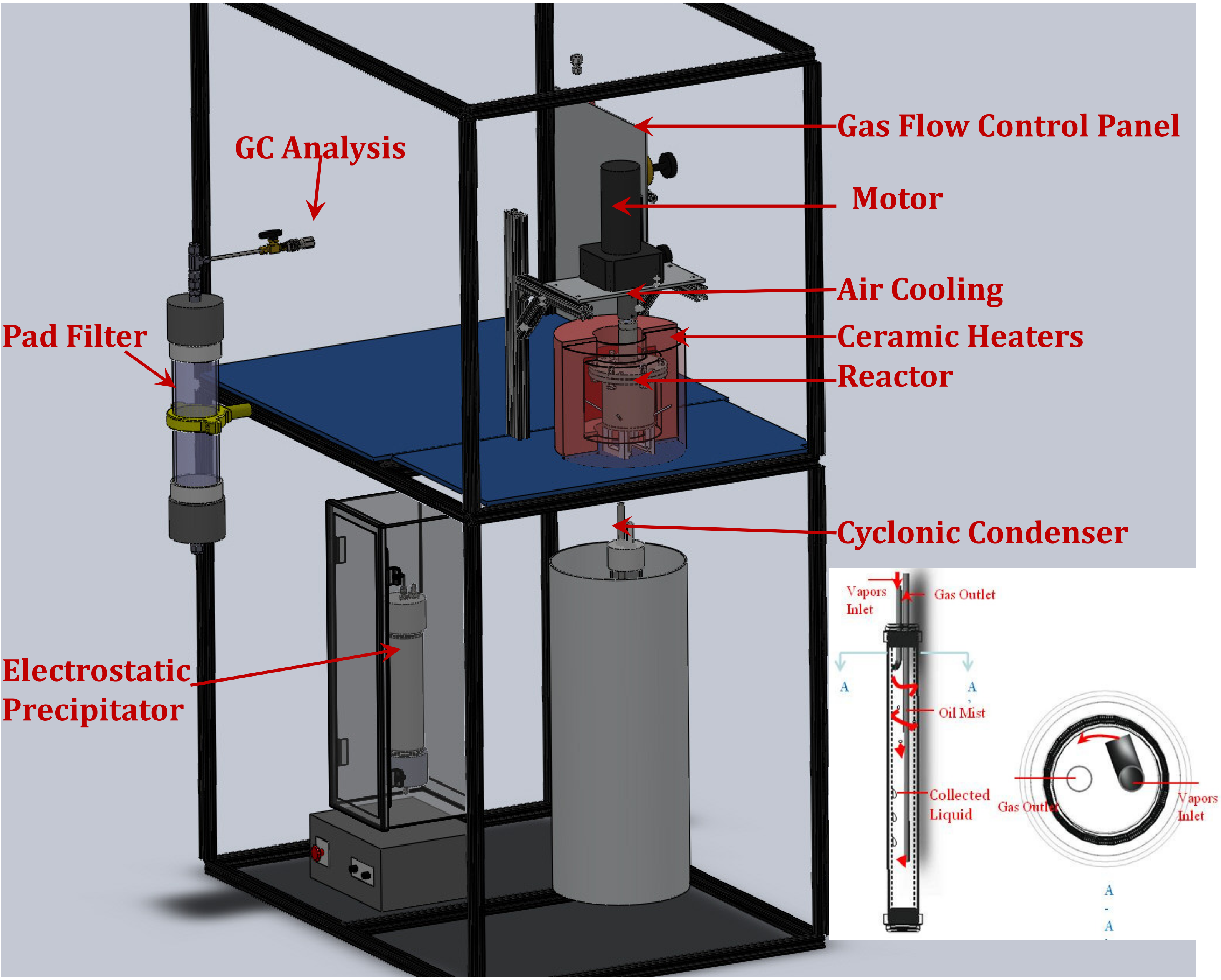
Current Batch Problems



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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