

The Catalysis of Delayed Petroleum Coking

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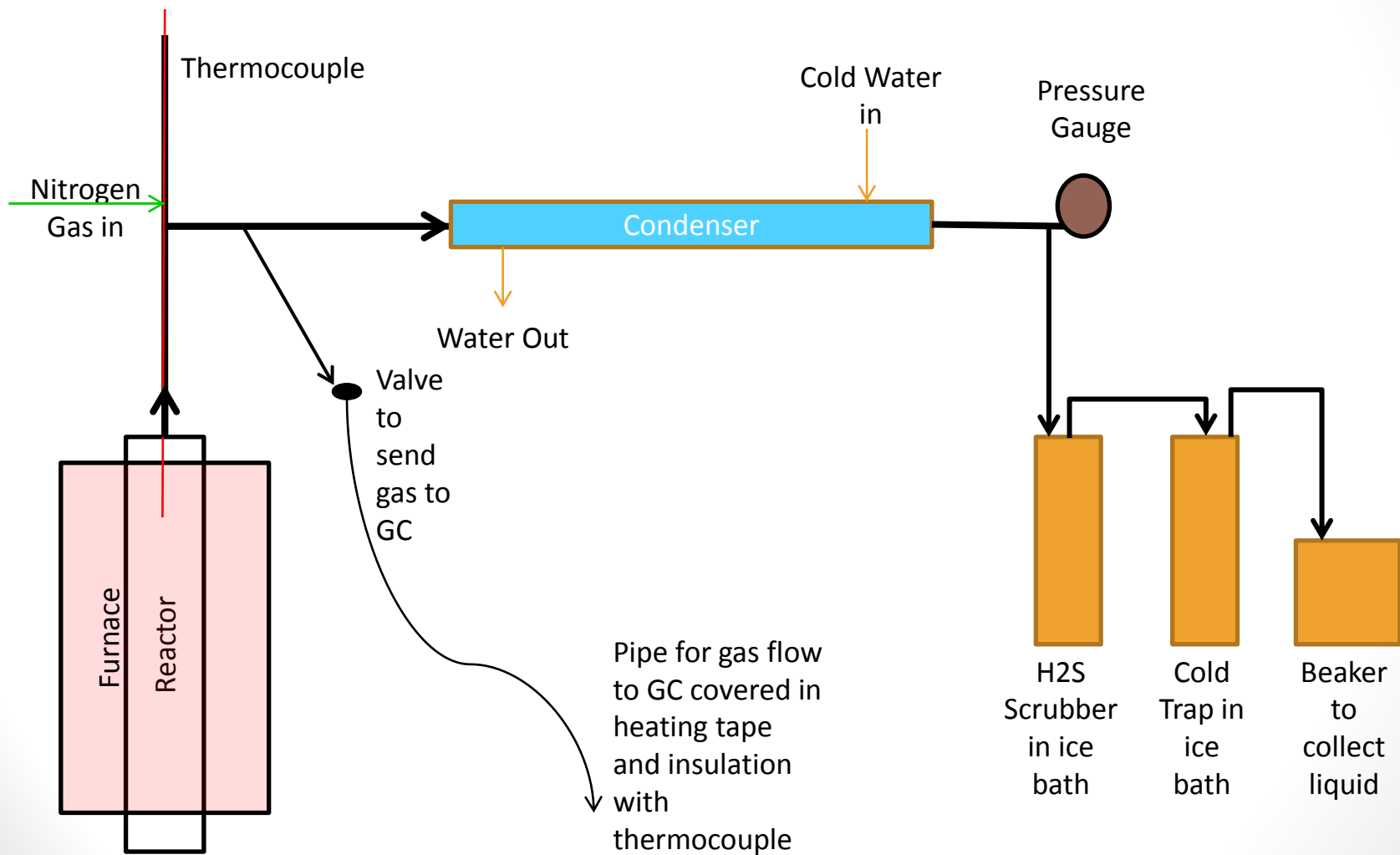
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Background

- In 2007 the world petroleum refining capacity had reached 4100 million metric tons per year (Sawarkar, Pandit et al. 2007)
- Petroleum crudes are getting heavier and have increasing amounts of contaminants such as heavy metals and sulfur (Sawarkar, Pandit et al. 2007)
- Coking is a process via which the molecules are thermally cracked to produce lighter molecules (Fahim, Al-Sahhaf et al. 2009)
- The coking process produces solid coke and various lighter liquids which can all be sold as fuel (Fahim, Al-Sahhaf et al. 2009)
- Main Goal: How do catalysts effect the production of liquids from the delayed coking process

Methodology



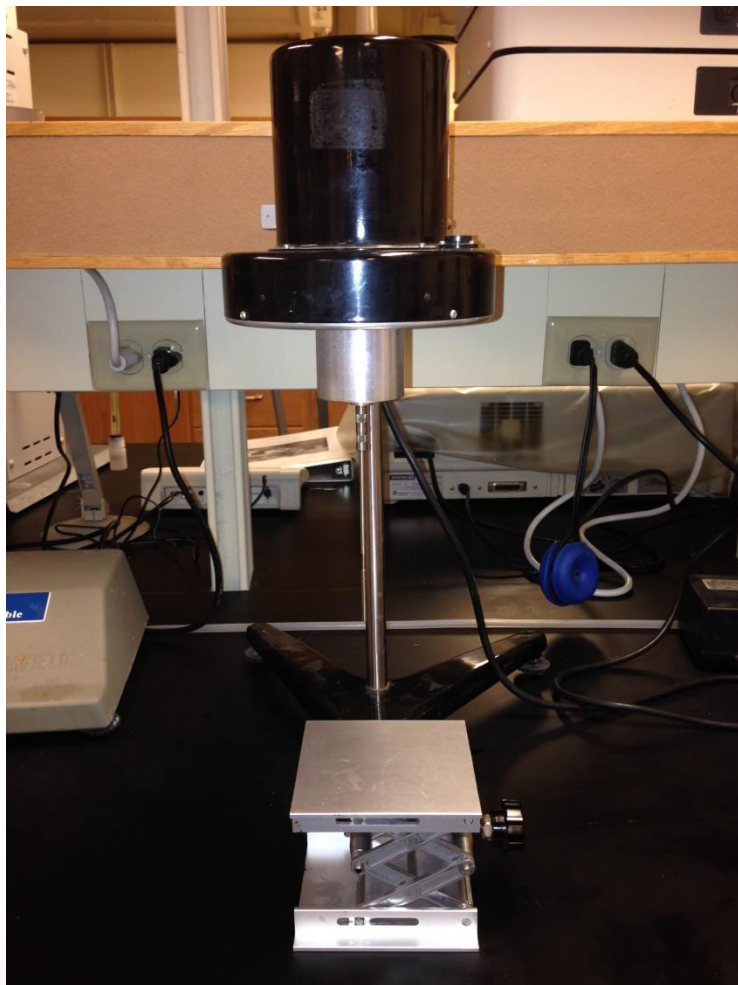
Methodology

- Testing Conditions
 - 15 psi pressure
 - Nitrogen environment
 - Each condition run at 450°C, 475°C, and 500°C
 - 0, 50ppm, or 100ppm of each catalyst (platinum 0.5% on alumina and nickel or molybdenum promoted 1wt%)
 - 0, 10%, 20%, or 30% by weight of LGO or HGO with remainder being VR
- Every 15 minutes during run gasses are tested via GC
- Final liquid product tested via GC
- All GC analysis done via an accelerated version of ASTM D2887: Standard Test Method for Boiling Range Distribution of Petroleum Fractions by Gas Chromatography
- New Problem: raw materials are very viscous so will be difficult to fill the reactor
 - New Goal: understand how heating affects the viscosity of the raw materials

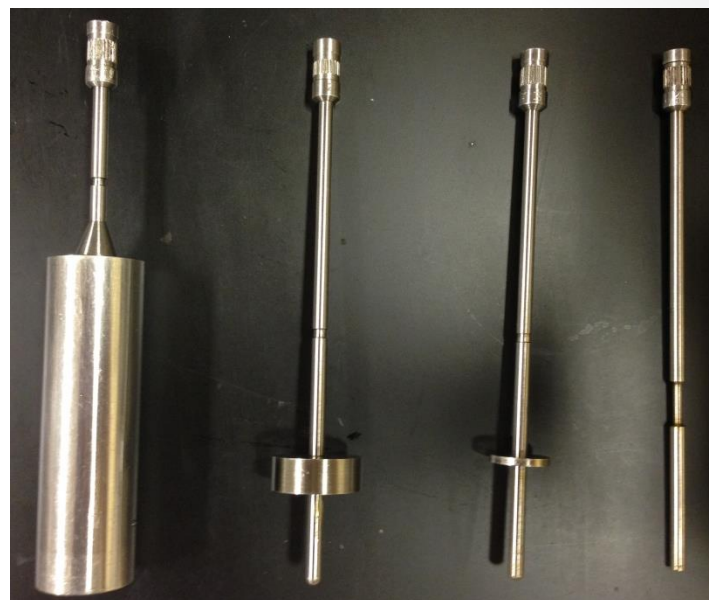
Methodology

- Samples: Vacuum residue, light gas oil, and heavy gas oil in 600ml bottles
- Tested using dial viscometer
 - 4 spindles numbered 1-4 (higher number means larger viscosity range)
 - 4 rpm settings (6,12,30,60rpms)
- Heated in a 75°C water bath
- Testing Procedure:
 - Attach correct spindle
 - Record sample temperature
 - Submerge spindle
 - Set rpms
 - Wait for reading to stabilize then record
 - Change rpms and repeat

Methodology



Brookfield Dial Viscometer



1

2

3

4



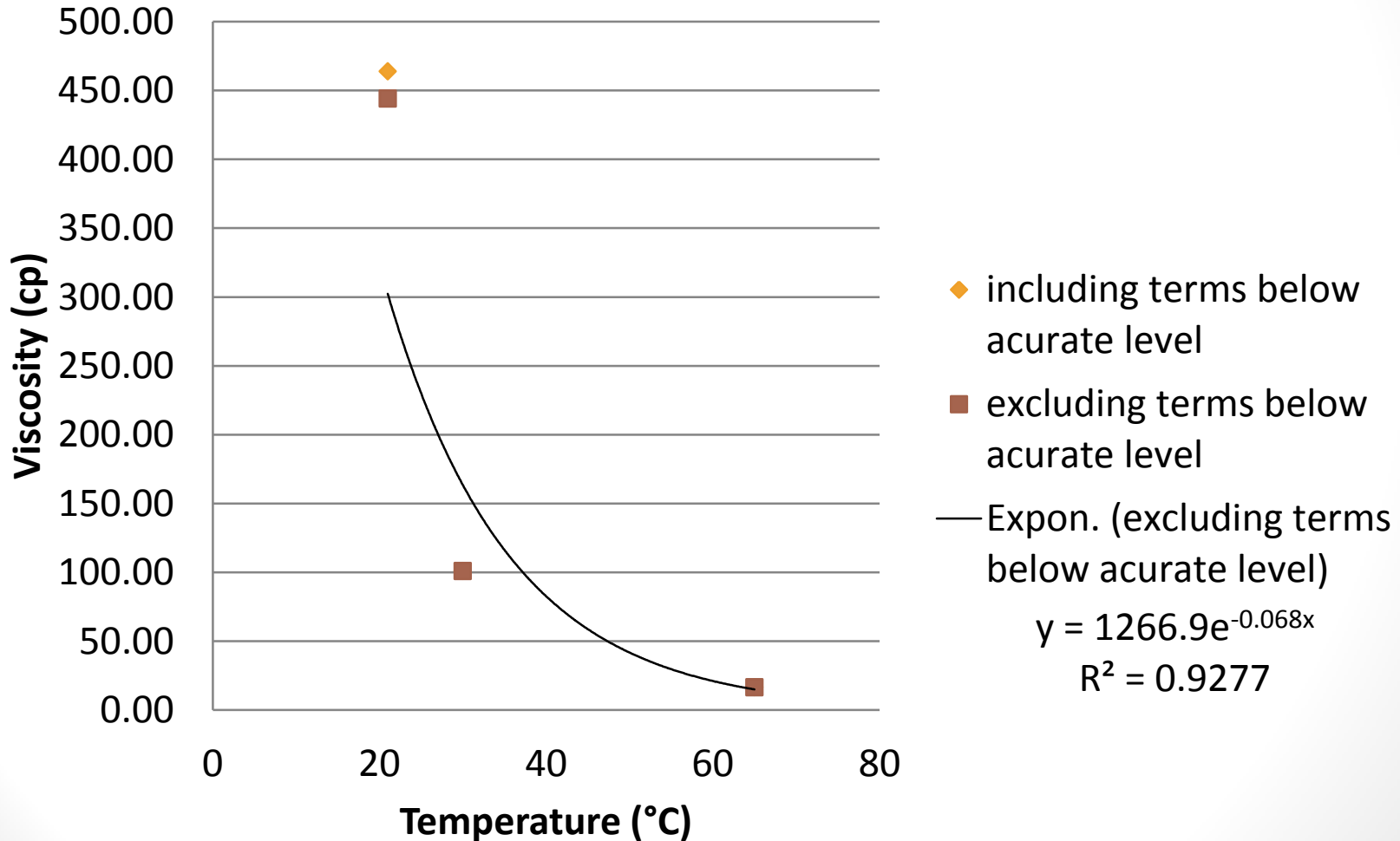
VR

HGO

LGO

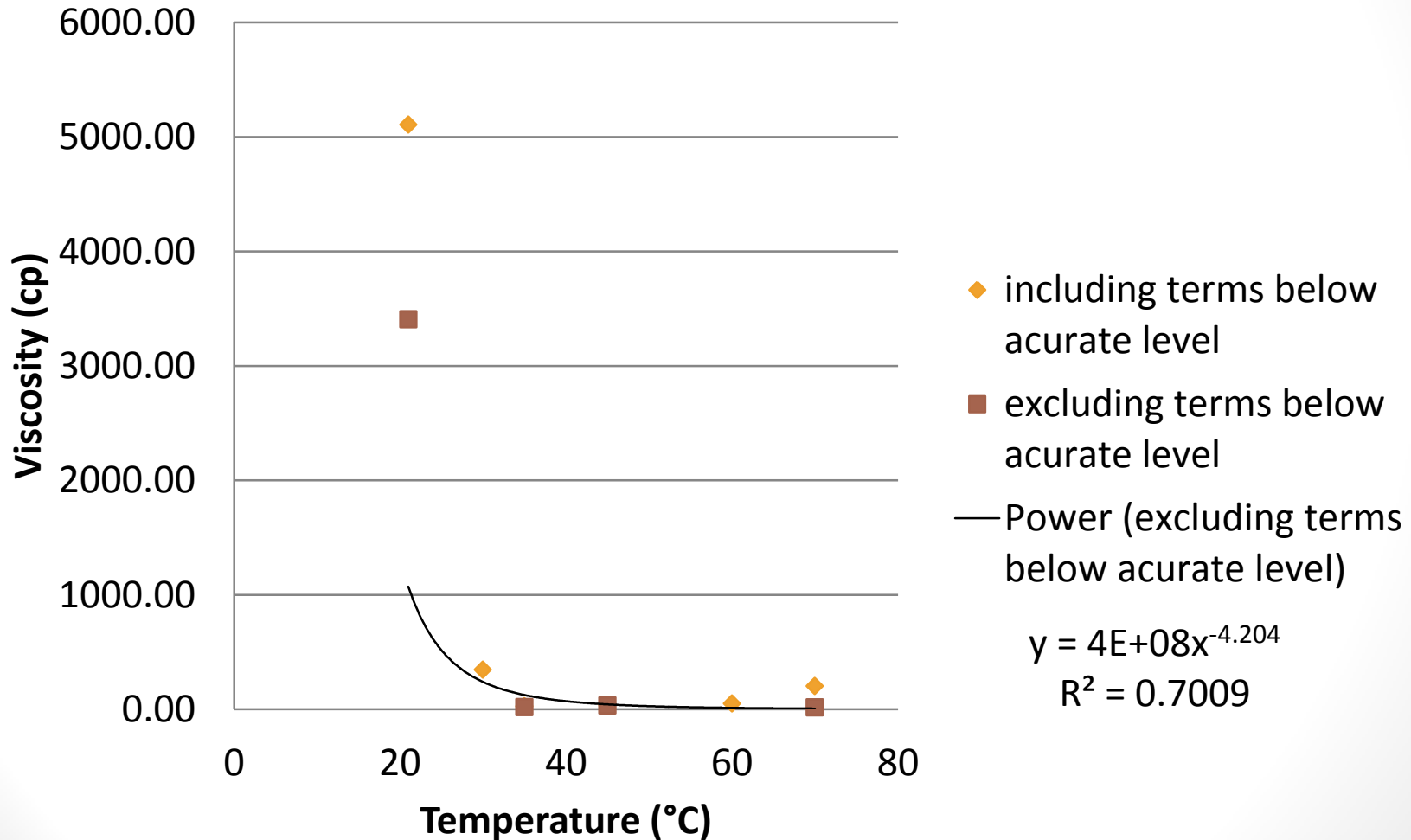
Results-Light Gas Oil

Light Gas Oil Viscosity vs Temperature



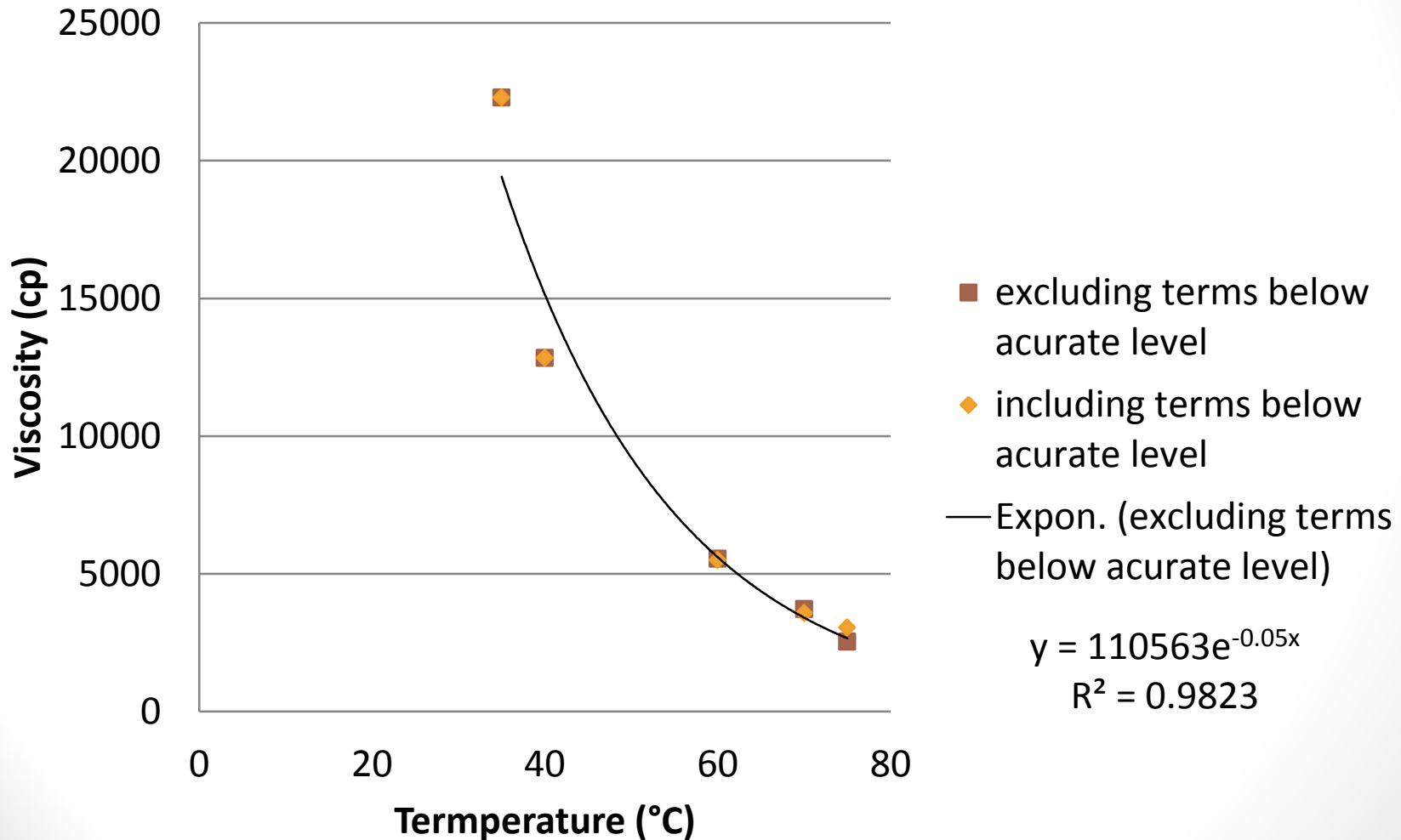
Results-Heavy Gas Oil

Heavy Gas Oil Visocosity vs Temperature



Results-Vacuum Residue

Vacuum Residue Viscosity vs Temperature



Conclusions

- For ease of loading the reactor:
 - LGO can be loaded at room temperature
 - HGO should be heated to around 40°C
 - VR should be heated to at least 75°C
- Next Steps
 - Investigate loading hot water bath with a non-volatile liquid which can safely be heated past 75°C
 - Further raw material characterization work
 - Once apparatus in lab is operational begin running original experimental plan

Acknowledgement

- Dr. Enrico Martinez
- Rick Mcglothlin
- Robert Khakimov
- Dr. Hyun-Tae Hwang
- Yury Zvinevich

Works Cited

Fahim, M. A., T. A. Al-Sahhaf, et al. (2009). *Fundamentals of Petroleum Refining*, Elsevier Science.

Sawarkar, A. N., A. B. Pandit, et al. (2007). "Petroleum Residue Upgrading Via Delayed Coking: A Review." The Canadian Journal of Chemical Engineering **85**(1): 1-24.

Appendix:

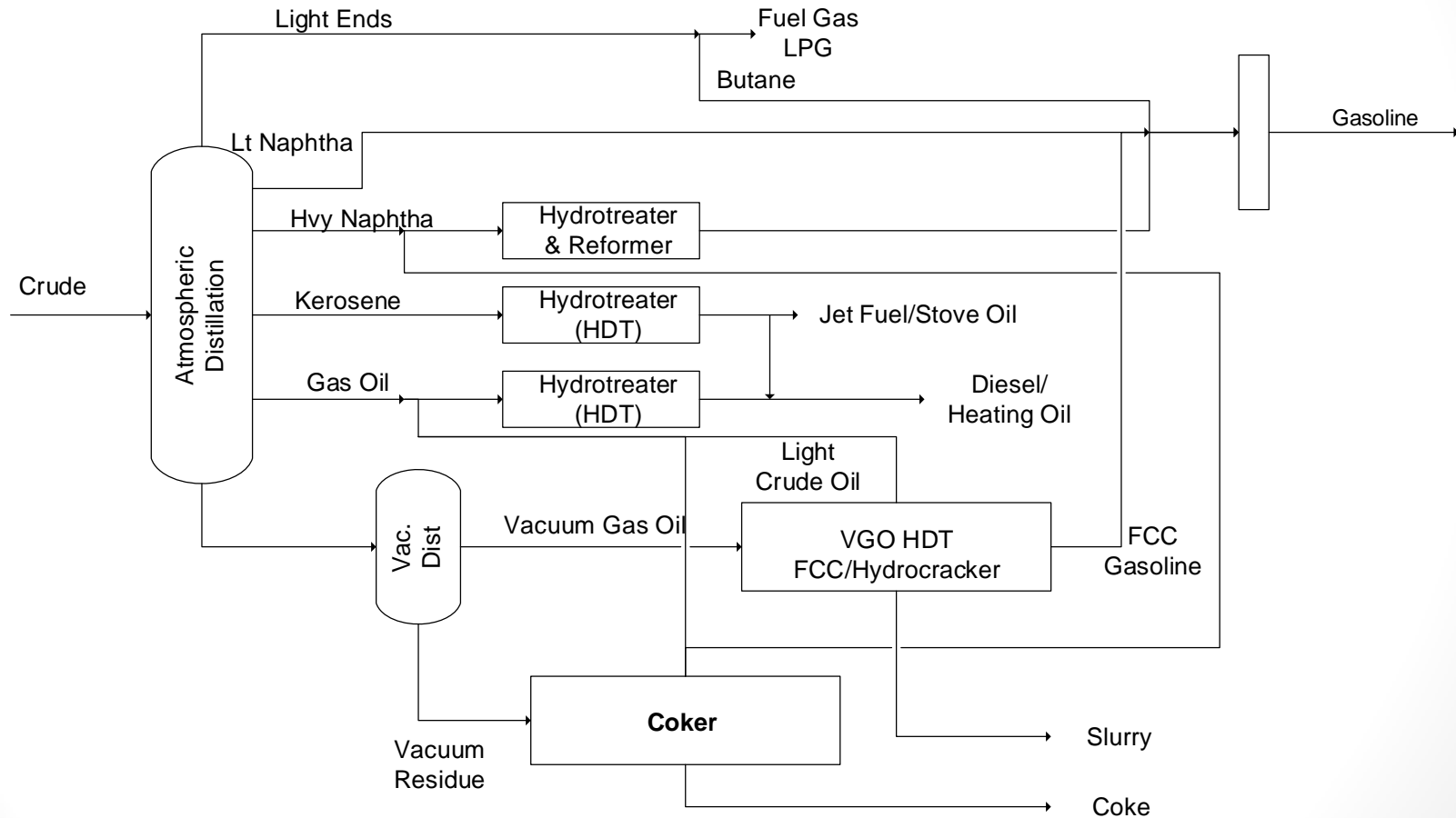


Diagram of Commercial Petroleum Processing

Source: Thermal Cracking and Coking by Mohamed A. Fahim, Taher A. Al-Sahhaf, Amal Elkilani, C

Appendix

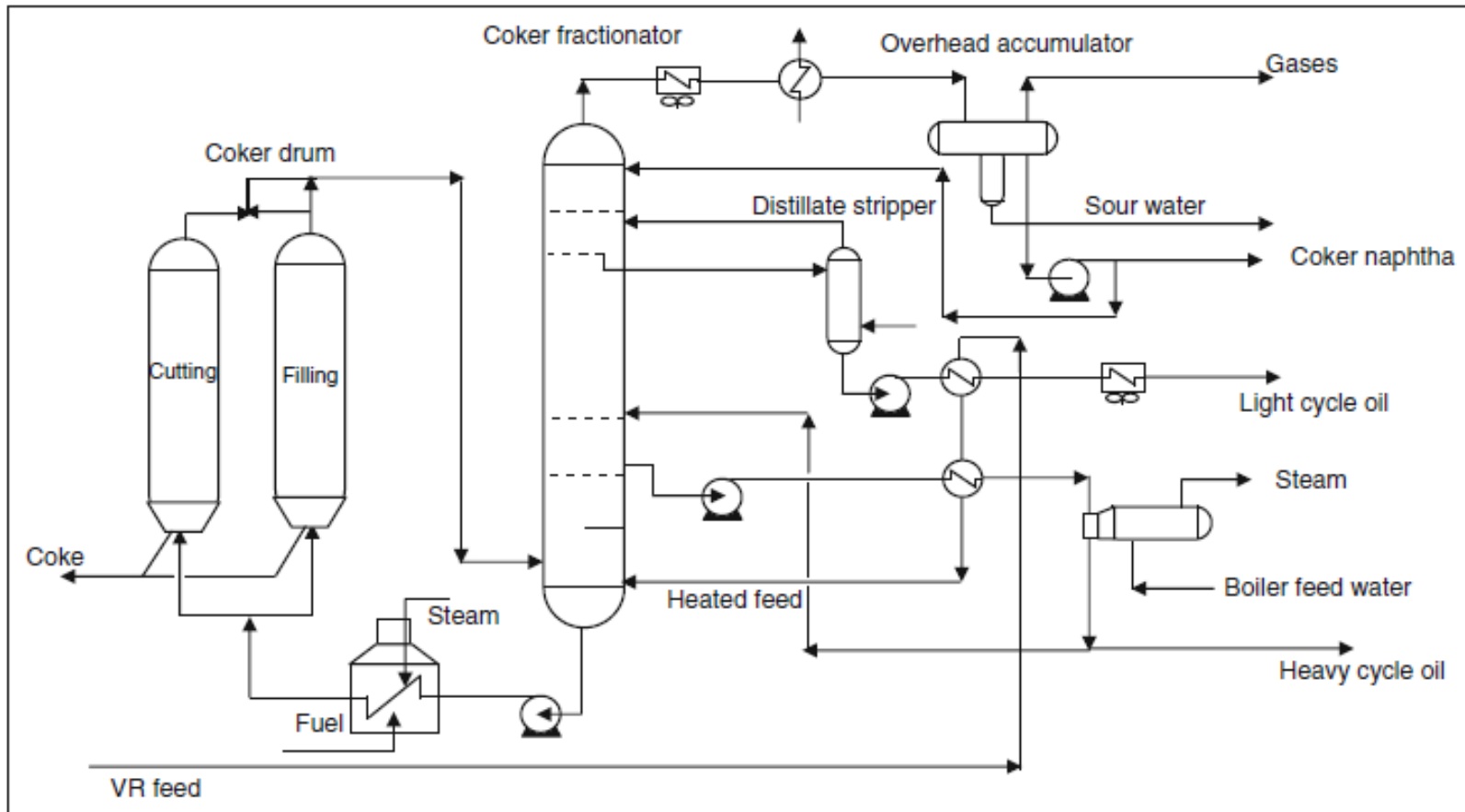


Diagram of Commercial Delayed Coking Process
Source: Fundamentals of Petroleum Refining