VAPOR FLOW IN A FLUID COKER
- FLUID COKING REACTOR (FCR)

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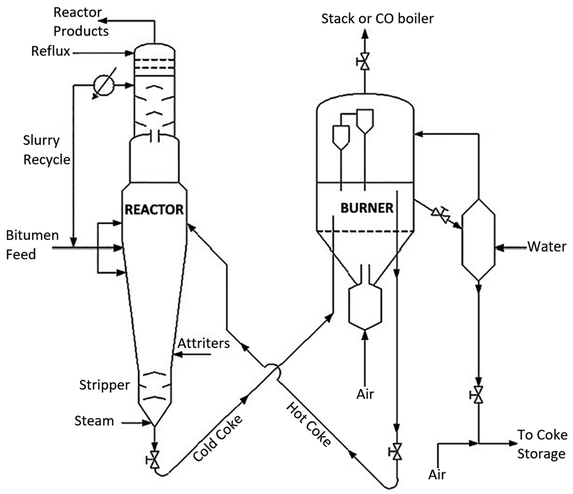
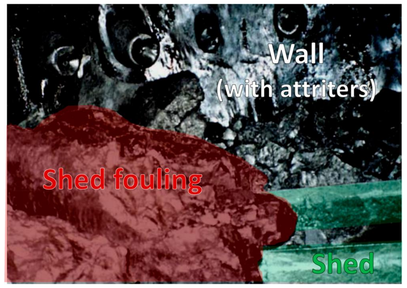
Motivation & Background

Fluid Coking: a thermal cracking process using hot fluidized coke to convert heavy, low-grade petroleum oils into lighter hydrocarbons.

Could local vapor saturation increase detrimental liquid carry-under to stripper?



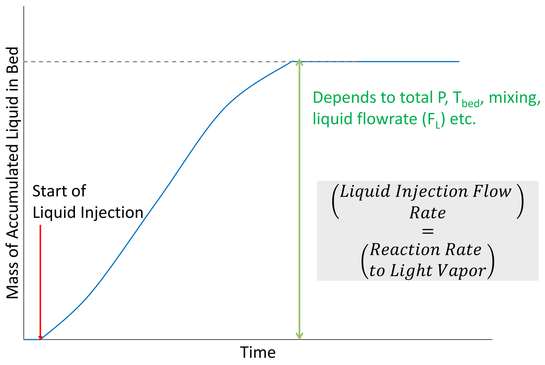


Research Objectives

1. Quantify liquid accumulation due to vapor saturation with a pilot plant Fluid Coker

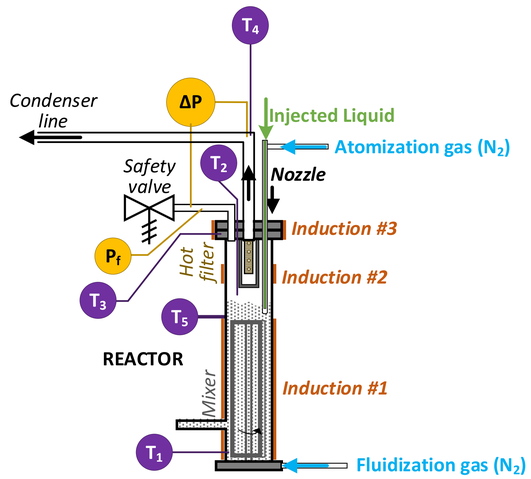
Assumption:

Mass of Accumulated Liquid in Bed vs. Time



2. Determine impact of vapor saturation on liquid yield and composition

Equipment: Fluid Coking Reactor (FCR)

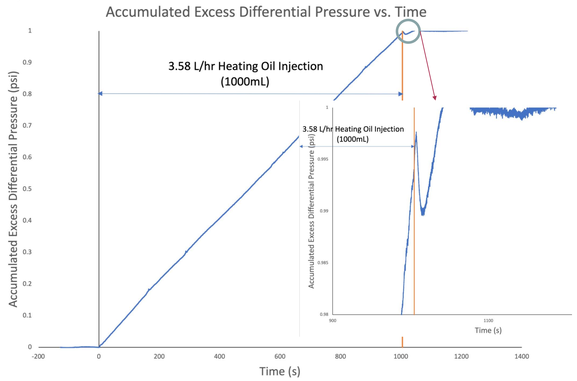


Research Methodology

Very good mixing:
- No agglomerates
- Very good heat transfer

→ liquid accumulation from vapor saturation

Measure amount of accumulated liquid vs. injection time:
- At end of injection, increase bed temperature by 30°C to vaporize all in-bed accumulated liquid
- Use ΔP to measure the amount of vapor out of the bed after the end of injection



$$\textit{Fraction of injected liquid that is vaporized after the end of injection} = \frac{\int_{end\ of\ injection}^{\infty} \Delta P_e(t)\,dt}{\int_{\infty}^{0} \Delta P_e(t)\,dt}$$

$$(\Delta P_e = \Delta P - \Delta P_{no\ vapor})$$

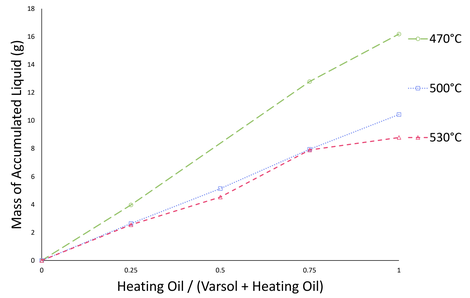
- Feed compositions:
  - i. Mixture of heating oil and Varsol
  - ii. Varsol: very light → no accumulation

Liquid product characterization:
- Density
- Viscosity
- Simulated distillation
- Gas yield (measure of over cracking)

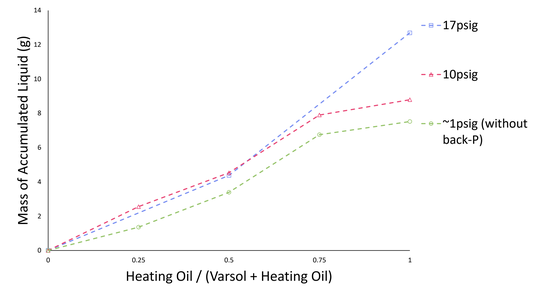
Results

Impact of Experimental Conditions:

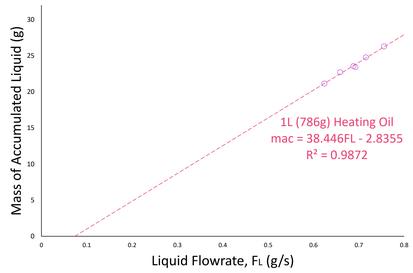
A. Change of Bed Temperature (T)



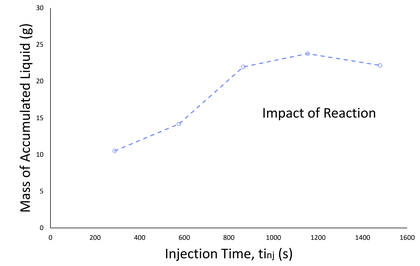
B. Change of Bed Pressure (P_f)



C. Change of Liquid Flowrates (F_L)



D. Change of Injection Time (t_{inj})



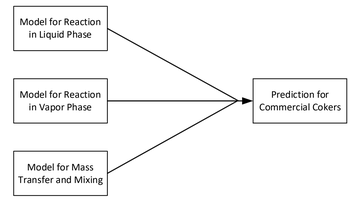
$$F_V = M_V \times \frac{P_{sat}}{P} \times \left(\frac{F_{N_2}}{M_{N_2}} + \frac{F_V}{M_V}\right)$$

If NO reaction:
when $F_L = F_V$ → $m_{ac} = 0$

	Heating Oil (cSt)	Varsol (cSt)
Injected Liquid (before)	1.67	1.3735
Collected Liquid (after, 10psig, 470C-lowest T)	1.3252	1.2719

Conclusion

1. New method to characterize liquid accumulation
2. Liquid accumulation mitigated by reaction to lighter compounds
3. Liquid composition



Future Work

1. Simulated distillation of liquid product
2. Test different feedstocks from Syncrude
3. Incorporate vapor saturation in Fluid Coker model:
   - I. Vapor-liquid equilibrium: HYSIS
   - II. Gas mixing and transfer: measurements in large cold model of Fluid Coker

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Syncrude