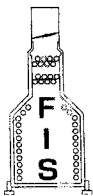


## Improving Reliability of Coker Heaters

- Ashutosh Garg,  
Furnace Improvements

## Why coker heaters?

- Important
- Heavier Crudes
- More products
- Over firing



## Typical problems in coker heaters

- Run length
- Tube metal temperatures
- Flame
- Arch pressure
- FD/ID fans
- Oxygen in flue gas
- Stack temperature

## Our Objective

- Improving run length of coker heaters

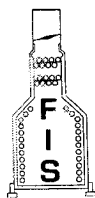


## Coker heater

- Heavy residues for the Coker unit
- Charge heated to the desired ( app. 900-935 °F)
- Coke formation in drums

## Coker Heaters

- Endothermic reaction

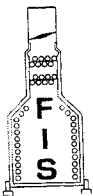


## Coker heaters- Design features

- ❑ Residence time
- ❑ Down flow
- ❑ Tube Material
- ❑ Tube size
- ❑ Number of passes

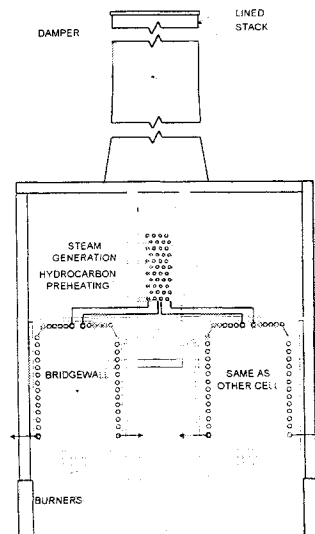
## Coker heaters

- Coking
- Removable plug headers
- Header boxes
- Steam snuffing



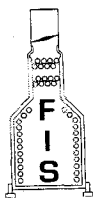
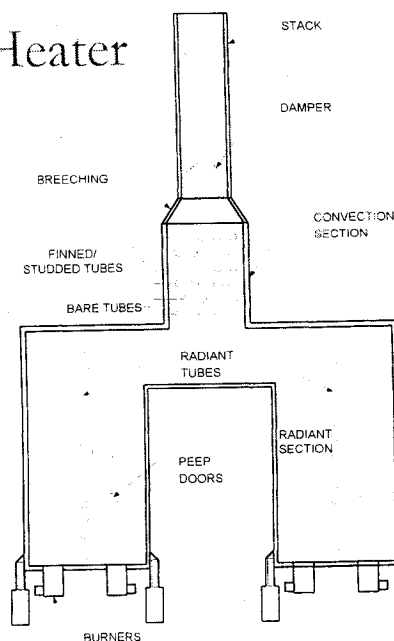
## Typical coker heater design

- Box heaters
- Horizontal tubes
- Burners
- Bridge wall
- Convection Section
- Stack



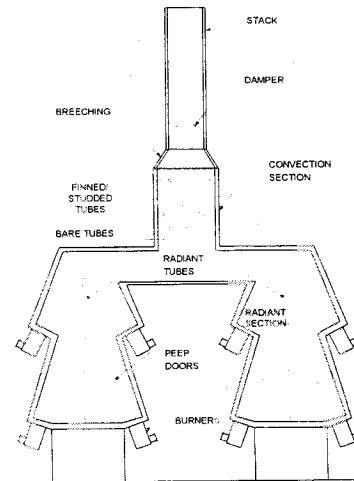
## Double fired Coker Heater

- Tubes
- Burners
- Number of fire boxes
- Convection section



## Terrace Wall Coker Heater

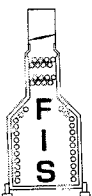
- Foster Wheeler
- Firebox shape
- Firing arrangement
- Number of terraces
- Heat flux



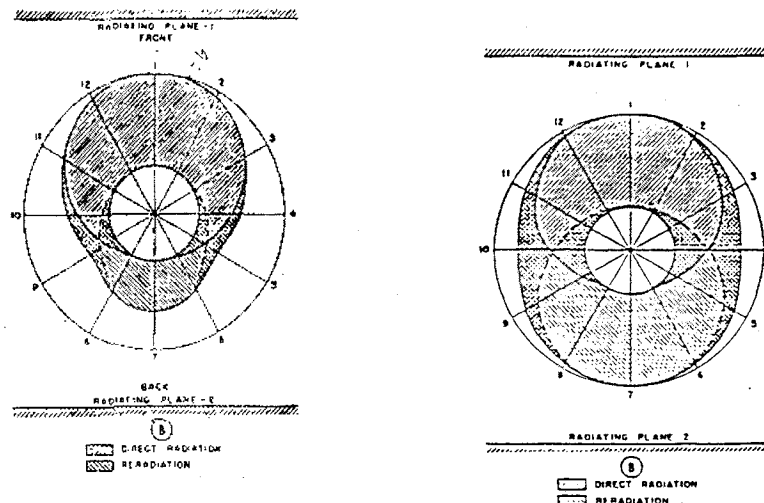
## Single fired vs. Double fired

- Single fired
- Double fired
- Differences
  - Coil length
  - Residence time
  - Pressure drop
  - Firing arrangement

Good heater design required

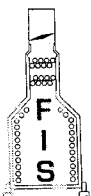


## Single fired vs. Double fired



## Heat flux

- Average heat flux
- Heat absorbed per unit area
  - = Radiant heat duty/ Radiant surface area
  - units are Btu/hr ft<sup>2</sup>
- Peak heat flux
- Front of the tubes receive the maximum heat

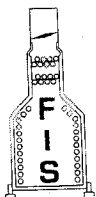
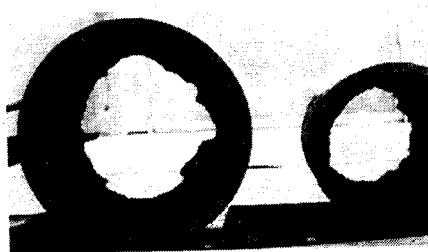


## Limitations on run lengths

- Limiting parameters
- Tube metal temperature
- Pressure drop
- Coke formation

## Coke formation

- Two reasons
  - Heater design
  - Heater operation

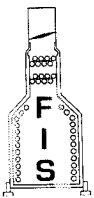
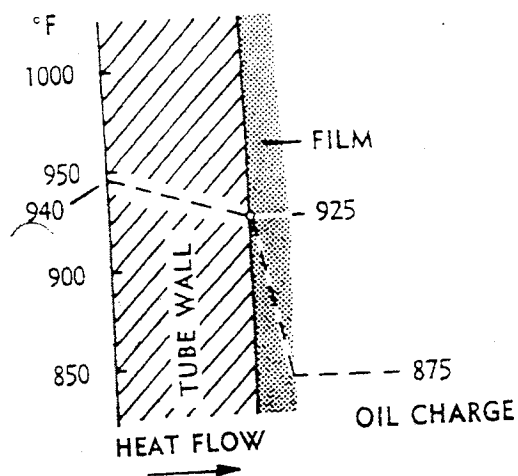


## Coke formation

- Metal thermal conductivity
  - 200 -300 Btu/hr ft<sup>2</sup> F /inch
- Coke thermal conductivity
  - 1-30 Btu/hr ft<sup>2</sup> F /inch
- Typically 1/8 inch of coke adds up to 100 F of tube metal temperature rise

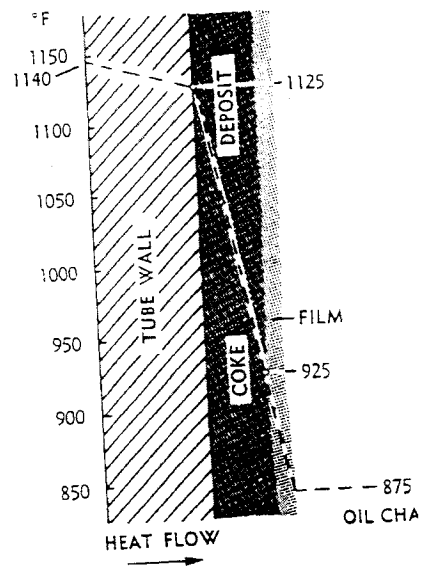
## Clean tube

- Oil temperature
  - 875 F
- Film temperature
  - 925 F
- Metal temperature
  - 940 F



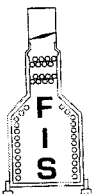
## Coked tube

- Oil temperature
  - 875 F
- Film temperature
  - 925 F
- Coke temperature
  - 1125 F
- Metal temperature
  - 1140 F



## Coke formation

- High film temperatures
- Cracking of Hydrocarbons
- Laying down of coke
- Coking rate vs. tube metal temperature increases

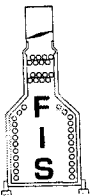


### Coke formation

- Tube metal temperature
- Pressure drop across heater
- Tube rupture
- Tube sagging, bowing

### Coking in tubes

- Tube metal temperature
- Pressure drop across the coil
- Firebox temperature
- Firing rate
- Efficiency
- Charge rate
- Shut down the heater and clean the tubes

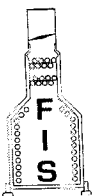


## Monitoring Coking

- Tube skin thermocouples
- Infra-red surveys
- Monitor operation

## Good operation vs. run length

- Good Combustion
- Equal flow distribution

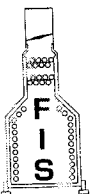


### Typical operating philosophy

- Firing rates
- Limiting metal temperatures
- coke formation
- Flames

### Uniform firing

- Excess air control
- Provide required draft

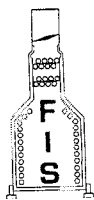


### Typical Operating Parameters

Heater Number	Flowrate, BPD	Inlet temperature, °F	Outlet temperature, ° F
B-1	14,800	756	885
B-2	15,385	765	894
B-3	15,200	769	883

### Typical Operating Parameters

Heater Number	Inlet pressure, psig	Outlet pressure, psig	Pressure drop, psi
B-1	300	67	233
B-2	300	59	241
B-3	350	72	278

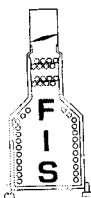


## Typical Combustion Control

- Oxygen set point- 3%
- Draft set point -?
- Measured O2 in stack-6-7%
- Draft in the heater-?
- Using stack O2 to control the excess O2
- Using stack damper to control O2.
- Where is the excess O2 coming in the stack?
- How to control the excess O2?

## Dampers

- Poor dampers
- Stuck
- Do not operate
- Operators
- Furnace Improvements can supply you with very good and reliable dampers which can control draft and excess air

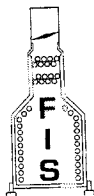


## Good operation

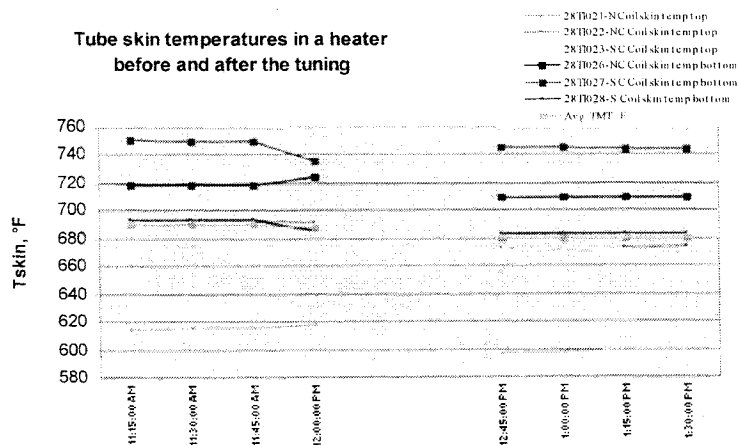
- Control draft
- Control excess O<sub>2</sub>
- Burner register
- Stack damper

## Burners

- Burner sizing
- Flame lengths
- Operation
- FIS can help you select proper burners and ensure that you get the required flame pattern and correct excess oxygen.

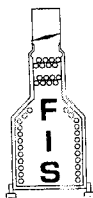
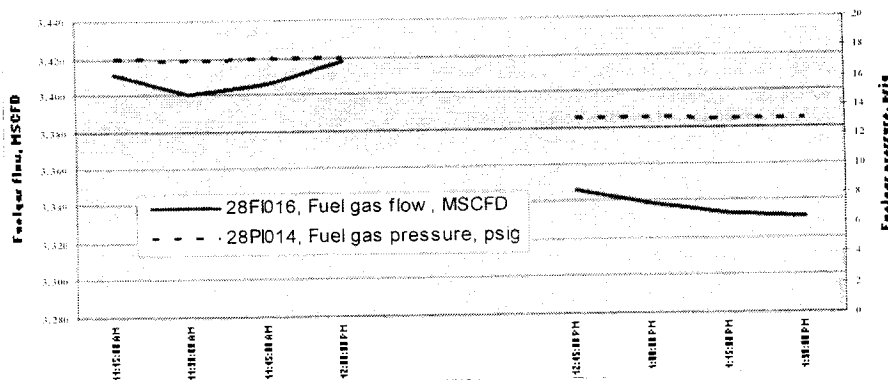


## Tube skins before and after tuning



## Fuel gas flow and pressure Before and after tuning

Fuelgas Flow and Pressure  
before and after tuning of the heater

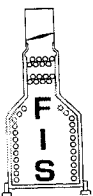


## Training

- Training of operators
- It pays off big time
- Operating cases
- Furnace Improvements  
can provide class room  
and hands on training  
for your coker heaters

## Coking of heater

- Coker heater will be coking
- Design basis
- Extend run length
  - On line spalling

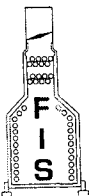


## On line spalling

- Alternate heating and cooling with steam to spall of the coke from the tube wall.
  - Extends the heater run lengths
  - Does not require a shutdown
  - Passes are decoked one at a time
  - Feed cut off
  - Steam introduced
  - Coke is thermally stressed until it breaks
  - Goes to coke drums

## Tube cleaning during turnaround

- Steam air decoking
- Pigging

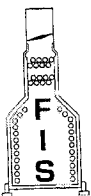


## Steam air decoking

- Two step process
- Coke spalling
  - Shrinking and cracking the coke loose by heating the outside and blowing steam inside
- Coke burning
  - In this process, air is injected with steam and coke burning takes place inside the tube

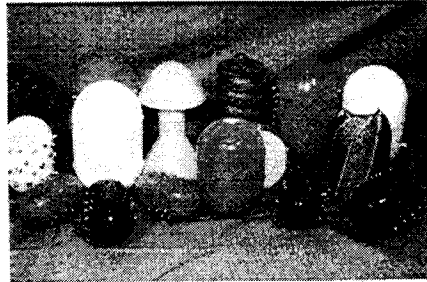
## Steam air decoking

- Use steam, air and heat to burn out the coke in the tubes.
- Experienced operators are required to perform the decoking.
- Infra-red thermography can help monitor steam air decoking very closely
- Improper procedure can result in overheating of tubes.
- Inexpensive

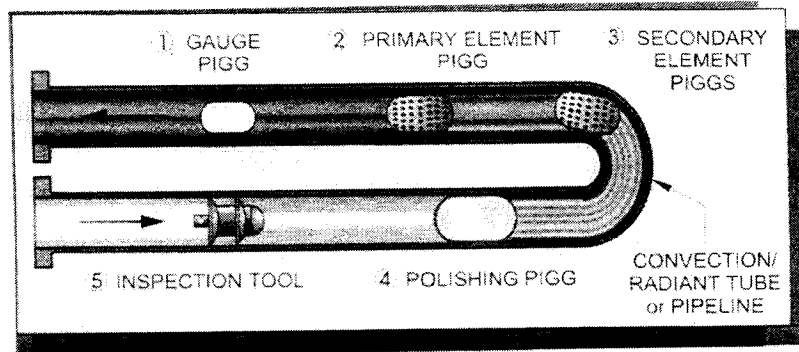


## Pigging

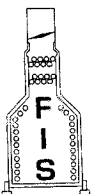
- Abrasive pigs can be used to clean tubes mechanically.
- Propelling a pig with equipped with steel wires through tubes with water.
- The pig is sent back and forth through the tubes and deposits are removed like brushing to clean a surface.



## Pigging Process

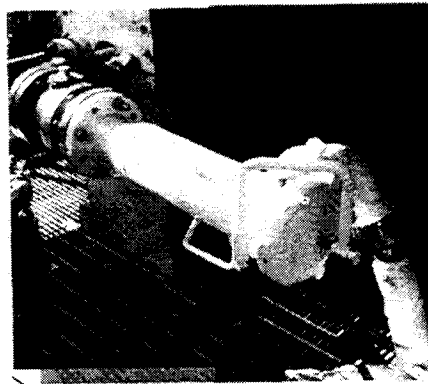


Courtesy- Eliminator Pigging Co.



## Pigging

- Requires modification in the heater piping to create a location to launch and receive pigs.
- Gaining popularity
- Need to be careful if the tubes are not round



We Hoped You Enjoyed our  
Presentation

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heater needs

