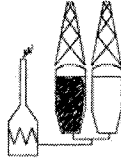


Delayed Coker Furnace Pigging Setup, Operation & Breakdown Safety Perspective



Presented by Mitch Moloney of ExxonMobil
@ coking.com May-2006

Delayed Coker Furnace Pigging Setup, Operation & Breakdown

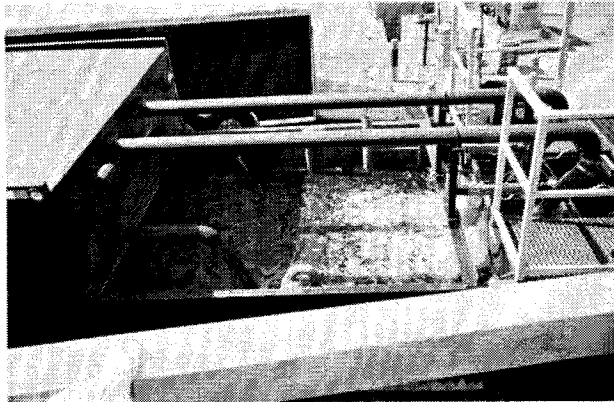


Three Aspects to be Addressed

Setup

Operations

Breakdown



Delayed Coker Furnace Pigging Setup, Operation & Breakdown



Setup of Pigging Equipment

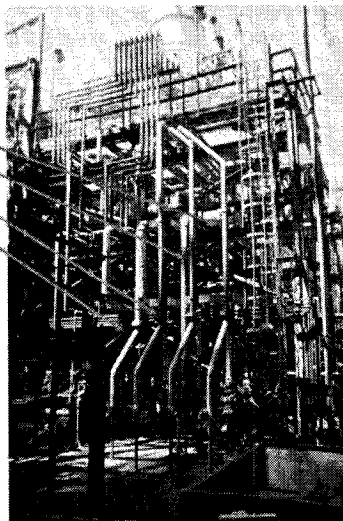
- => Work with Pigging Contractor to Locate the Trucks & Water Handling Equipment
 - Minimize Distance from tie-in spools to Truck
 - => Reduce tripping hazard & facilitate the pigger's work
- => Provide access to the inlet and outlet of the heater near grade
 - Normally the inlet to the heater convection section is located at an elevated position with only ladder access
 - Two options exist:
 - (1) Install the pigging piping at the outlet of the pass control valve
 - (2) Provide piping from the elevated swing elbows down to grade
 - Option (2) is recommended if access to the control valves is restricted by other piping (e.g. steam, water, emergency steam, fuel gas, etc.)

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Bringing Convection Inlet to Grade

- => Here is piping provided at the Jose Upgrader in Venezuela



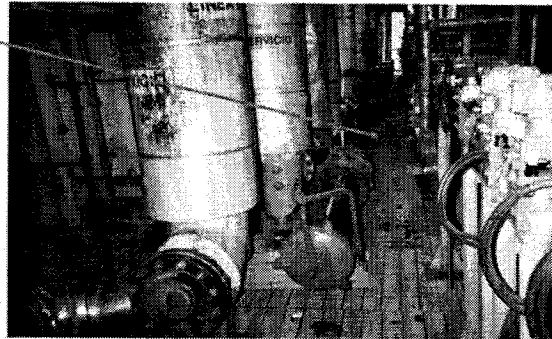
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Pig Launchers/Catchers on the Outlet Platform

=> Restricted space
can be an issue

These launchers
can jump off their
blocks due to
hydraulic surge.
Worker access
should be
controlled to this
area during pigging



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Delayed Coker Furnace Pigging Setup, Operation & Breakdown



Working Inside the Furnace Box while Pigging

=> Basic position: Avoid working in the box during pigging, unless internal furnace work is critical path & safety risks have been mitigated to a level required by the site

=> What are the Risks?

- A tube fails causing piping or water to hit the worker
- Falling refractory and/or tube hangers
- Refractory dust and scale in the eyes
- Noise
- Vibration of tubes against scaffolding or temporary supports

=> Perform a risk-based safety review

- Include pigging contractor, operations, mechanical rep & technical

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Delayed Coker Furnace Pigging Setup, Operation & Breakdown



Tube Failure

=> This does not happen very often, of course. Probability is about one in 200

=> What are the Risk Factors?

- Amount of coke in the tubes
- Amount of remnant resid in the tubes
- Temperature history & age of tubes
- Diameter of tubes (3.5" ID good, 2.5" is higher risk)
- Type of return bends
 - Contoured plugs are best
 - U-bends are good, but need sufficient thickness to avoid erosion

Delayed Coker Furnace Pigging Setup, Operation & Breakdown



Normally pigs self-destruct before damaging the piping



Fractured pigs,
scale, and coke

Delayed Coker Furnace Pigging Setup, Operation & Breakdown



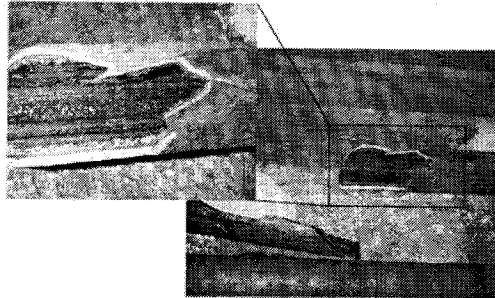
What if a pig is stuck?

When pigs get stuck, the tubes can jump when the pig starts moving again (some have seen tubes jump 1 ft)

=> If the pigger is going to free the tube, the workers must be removed from the box since higher pressures will be used to get it out and tubes can break

At our Torrance Ref a pig jammed in the tube and the tube failed due to hydraulic shock

Pressure reached ~800 psig, but hydraulic shock can yield still higher forces



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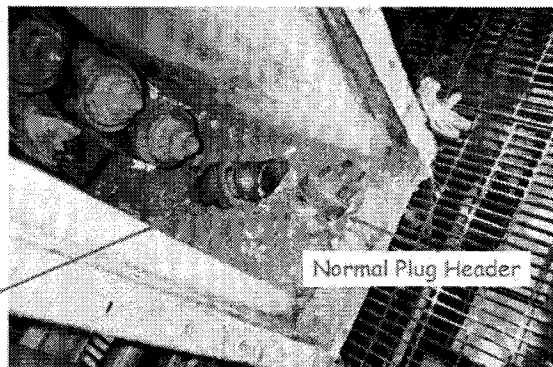
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Minimize Stuck Pigs



Utilize Contoured Elbow Plug Headers

Normal Plug Header

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Delayed Coker Furnace Pigging Setup, Operation & Breakdown



Working Inside the Furnace Box while Pigging

=> Mitigation of the Risks?

- (1) A tube fails causing piping or water to hit the worker
 - => Hydrotest, max pigging pressure review (400 - 800 psig), & monitoring
 - => Use actual metal thickness to calculate max allowable pressure
- (2) Falling refractory and/or tube hangers
 - => Inspection prior to start of pigging (Observe piping during 1st run)
- (3) Refractory dust and scale in the eyes
 - => Proper PPE - goggles
- (4) Noise
 - => Proper PPE - Single ear protection usually sufficient
- (5) Vibration of tubes against scaffolding or temporary supports
 - => Proper Scaffold Set-up, cushion pads may be needed to avoid cracking a vibrating tube against scaffolding

Delayed Coker Furnace Pigging Setup, Operation & Breakdown

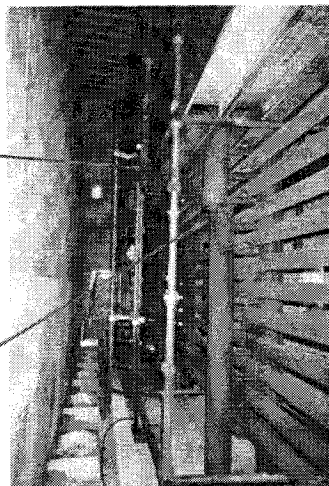


Scaffolding during Pigging

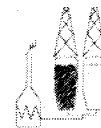
Scaffolding in the
firebox

Provide adequate
spacing or cushions to
avoid tube damage,
cracking or
shattering

Cracked tube support
stanchion caused by
snuffing steam
condensate



Delayed Coker Furnace Pigging Setup, Operation & Breakdown



Working Inside the Furnace Box while Pigging
=> Safe Entry Procedure

- (1) After washing with light oil & steaming coil to remove all hydrocarbon, blind and hydrotest the coil with raw water prior to pigging
 - => Testing at 150% of design pressure to verify piping integrity
 - => Be careful for brittle fracture, avoiding striking of the tubes during or after the testing
- (2) Set pigging pump safety valve (if needed) for the tubes being pigged
- (3) Alert all persons entering the box that tubes are pressurized and no work can be done to the tubes during the pigging operation (such as cleaning or grinding)

Communication between pigging lead & workers supervisor is key

Delayed Coker Furnace Pigging Setup, Operation & Breakdown



Working Inside the Furnace Box while Pigging
=> Safe Entry Procedure (cont'd)

- (4) Set a high pressure alarm during pigging in the DCS
 - The Singapore Refinery Visbreaker set an alarm point of 250 psig that required evacuation of the heater
 - Normal pigging inlet pressure was 150 psig & pump max was 600 psig
 - They recorded & trended tube pressure in the control room also
- (5) Require appropriate breathing requirements (dust mask or respirator depending on conditions)
- (6) Treat furnace firing cell as a "Confined Space"

Delayed Coker Furnace Pigging Setup, Operation & Breakdown



Other Operation Considerations

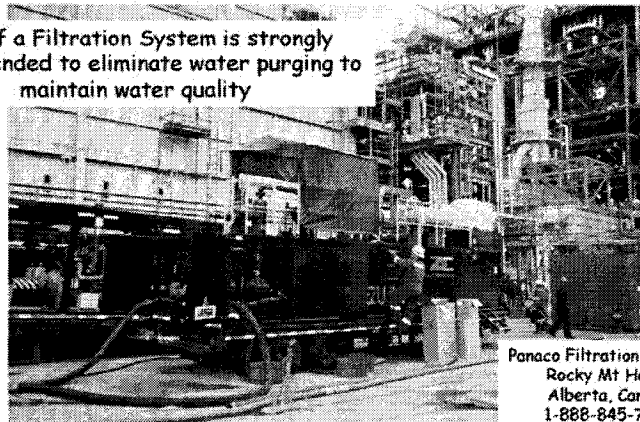
- Control Access to the Furnace Area
 - => Slipping and water hazards exist during the pigging
- Ensure that the studs or screws used in the pigs have Brinell hardness less than the tubes to minimize gouging / erosion
- Consider pigging in one cell or side, while allowing work in the other

Delayed Coker Furnace Pigging Setup, Operation & Breakdown



Operations - Minimizing Waste Water

Use of a Filtration System is strongly recommended to eliminate water purging to maintain water quality



Panaco Filtration Systems
Rocky Mt House
Alberta, Canada
1-888-845-7386

Delayed Coker Furnace Pigging Setup, Operation & Breakdown

Breakdown of Pigging Equipment



- Facilitated by bringing access to the launchers to grade level
- Largely in the hands of the Pigging Contractor
- Coke recovery to storage barrels
- Hose roll-up into truck storage
- Hose down area, if needed