Ethylene Unit Pyrolysis Furnace Opportunity & Strategic Improvements

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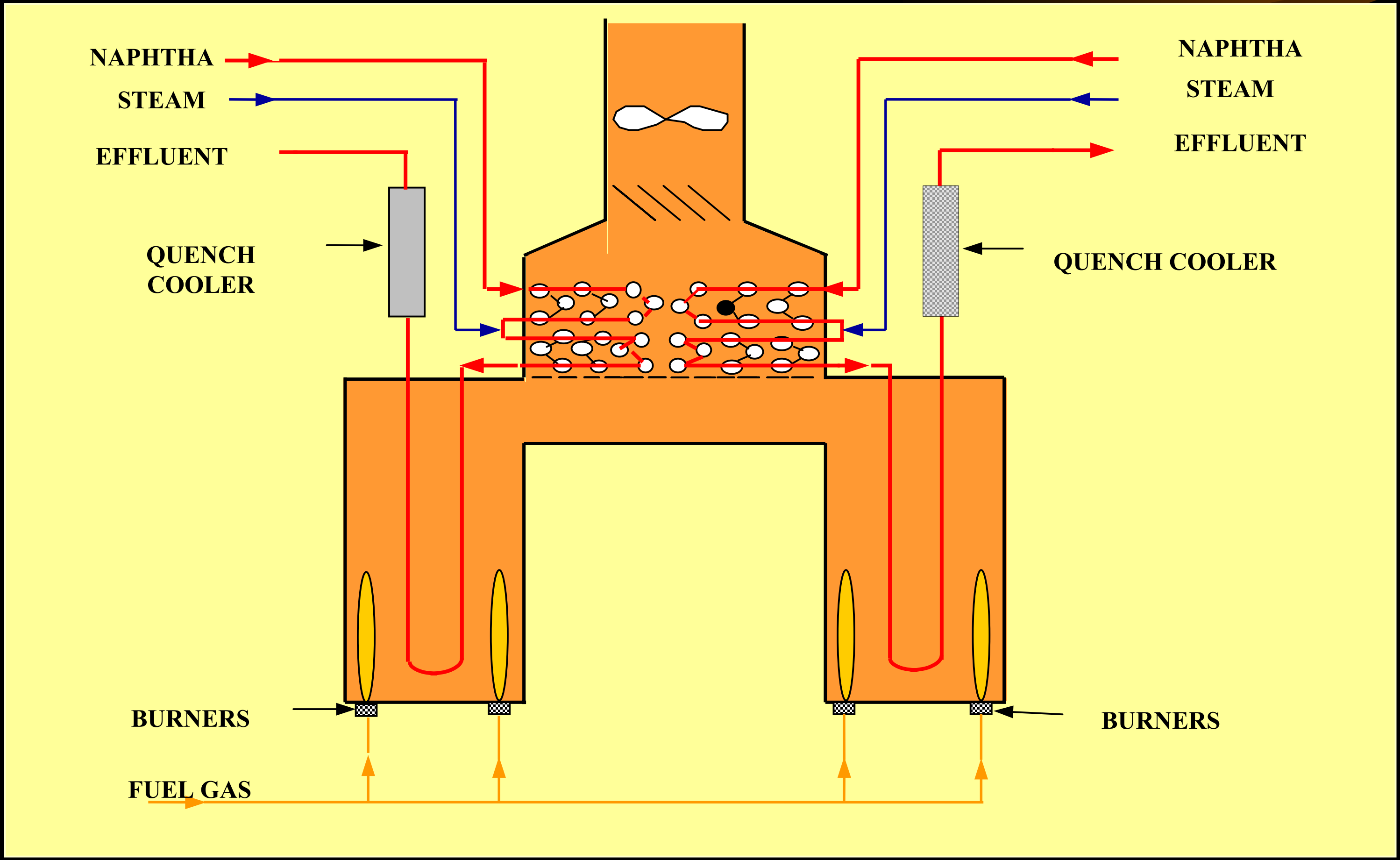
Pyrolysis Furnace Opportunity & Strategic Improvements

- Furnace layout
- Radiant Coil Elongation
- Convection tube bowing
- Shadow box hot-spots
- U-bend erosion
- Radiant Coil Thermal shock
- Conclusion

Unit 2 Furnace Layout

- 6 furnaces (12 Zones)
- 10 Naphtha Zones & 2 Recycle Zones
- Common Convection Heat Recovery Bank for two zones with Induced draft fan
- Radiant products cooled by quench coolers producing SHP (105 bar) steam
- Effluent sent to Quench Section

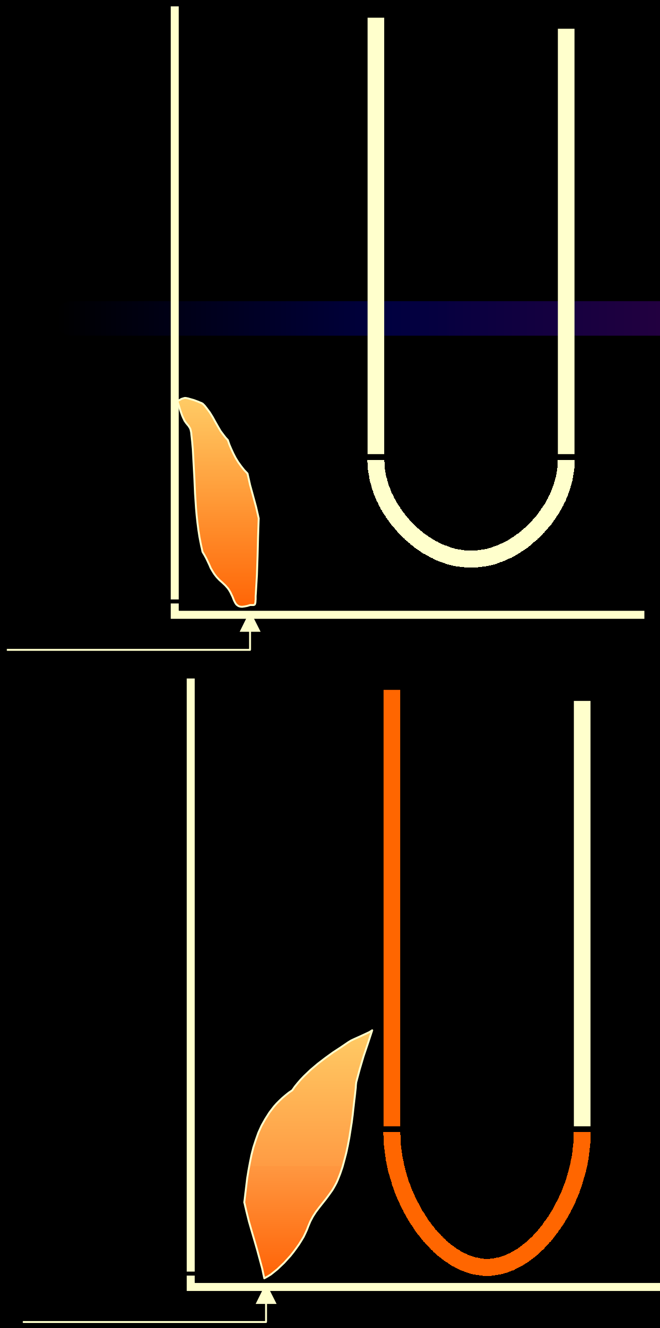
Furnace Layout



1st Opportunity : Coil Elongation - scenario

- Creep rate is between 60 - 78 mm per year in one zone example
- Coil needs shortening approx. every 5 years
- Recycle zones are fired harder to achieve optimum yield causing higher Tube Metal Temperature (TMT)

Coil Elongation - theory



- Flame impingement

  - burner tip blockage

- Heat maldistribution

  - uneven firing

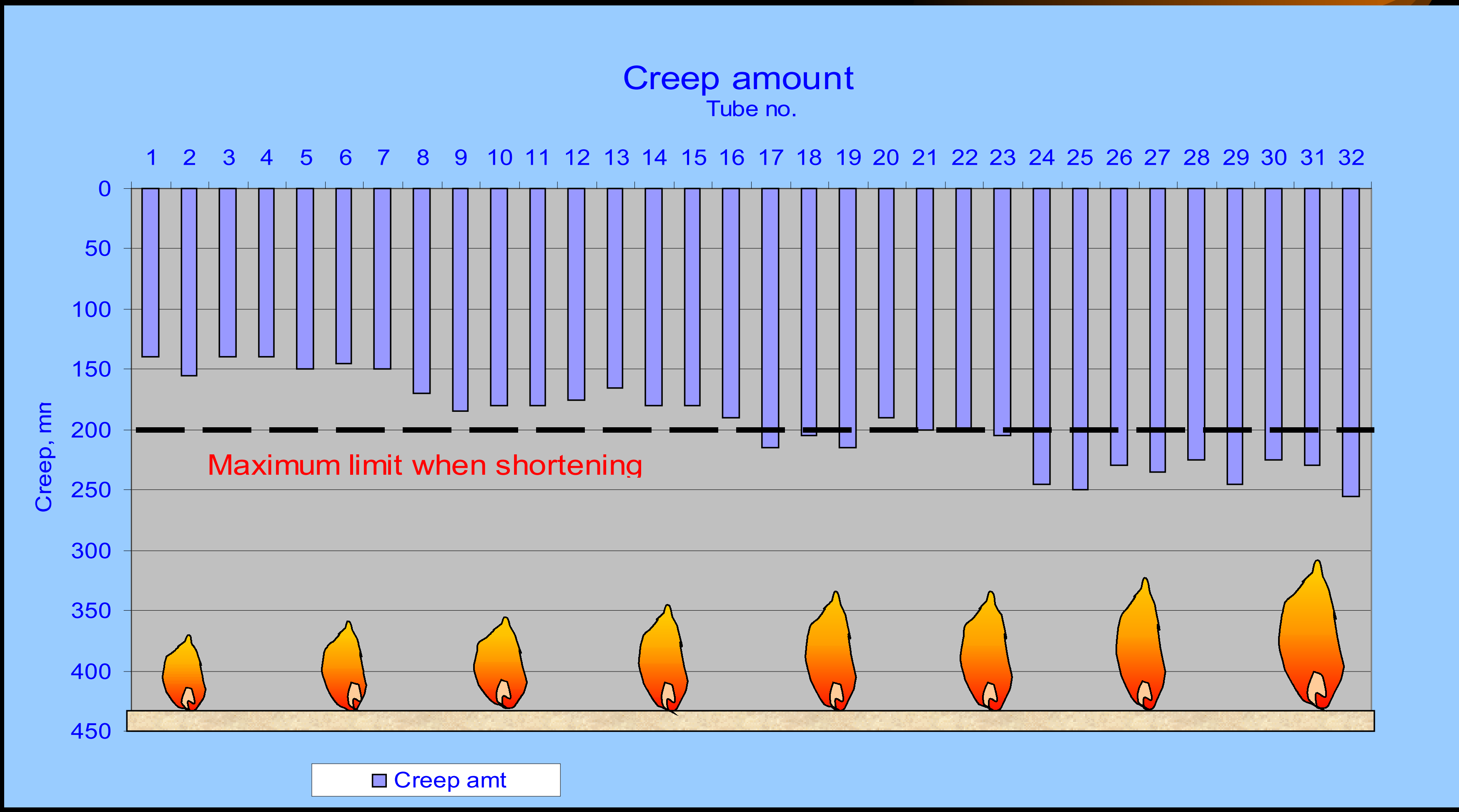
  - mixture of old & new burner tips

- ASWT

  - average sound wall thickness

  - thicker walls more prone to creep

Coil Elongation -a glance



Coil Elongation -current & future mitigation

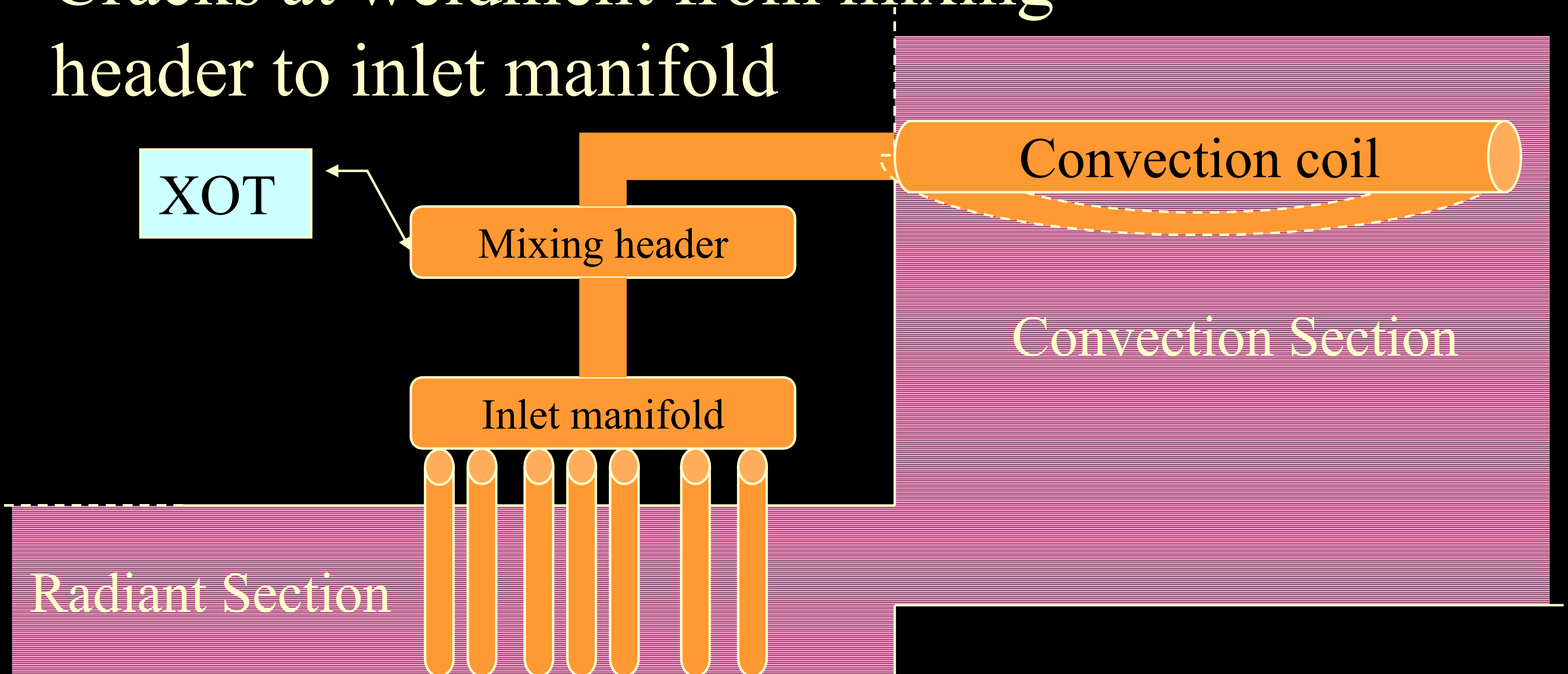
- Burner tip cleaning and maintenance
- Coil elongation monitoring
- Future:-

  Kubota MERT tubes - lowers TMT’s by increasing heat transfer

  Auto Excess O2 control - lowers firing needs

2nd Opportunity : Convection Coil Bowing - scenario

- Bottom section of convection bank bowed approx. 30cm
- Cracks at weldment from mixing header to inlet manifold



Convection Coil Bowing - theory

- Zone mainly recycle feed
- Recycle cracking requires higher Coil Outlet Temperature for conversion
- Excess heat recovered in convection

Convection Coil Bowing - theory

- Too much excess heat raises XOT temperature which initiates premature cracking
- Metallurgy limits promotes creep and expansion

Convection Coil Bowing - a glance

Convection Coil Bowing -current & future mitigation

<u>Current</u>

- Stress analysis required on piping and full understanding of metallurgy limits
- Spring hanger adjusted to relief piping stress
- Bowed convection coils replaced
- Secondary steam injection optimized

Convection Coil Bowing -current & future mitigation

Future

- Upgrading of crossover and convection material
- protect convection coils by insulative material

3rd Opportunity - Shadow Box Hotspots- scenario

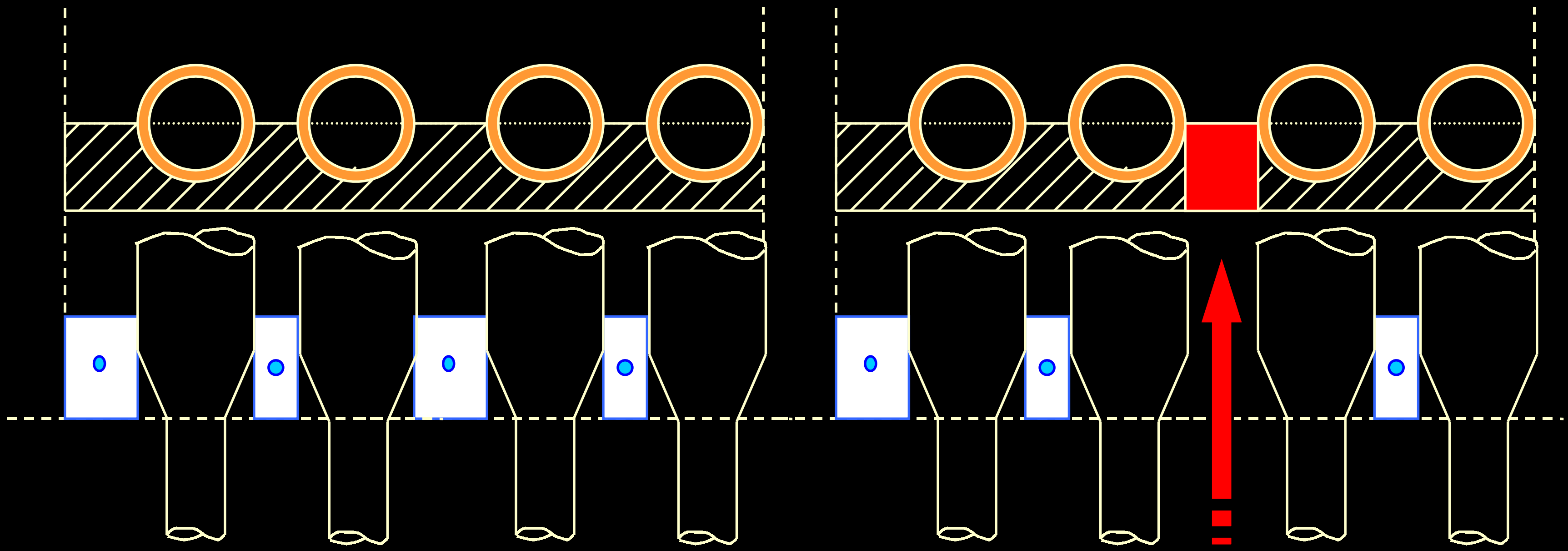
- Insulation around radiant outlet replaced and shadow box plates upgraded to SS304 after turnaround
- Hotspots detected on shadow box during thermograph survey

- Shadow Box Hotspots- scenario

- Plates deteriorated and warped
- Some insulation cladding melted
- Insulation material noticed on firebox floor

Shadow Box Hotspots - theory

- Heat escaping shadow box due to improperly installed insulation
- Gaps existed which allowed heat to escape the radiant box

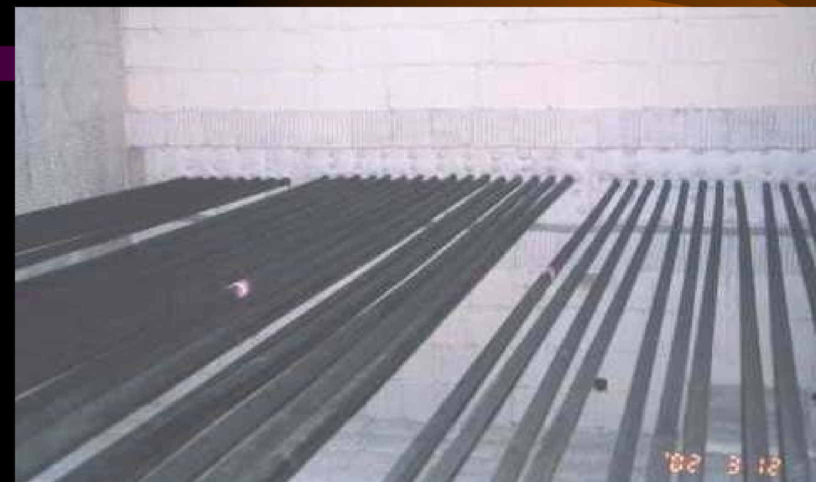


Shadow Box Hotspots - a glance

The Past

Shadow Box Hotspots - a glance

The Present

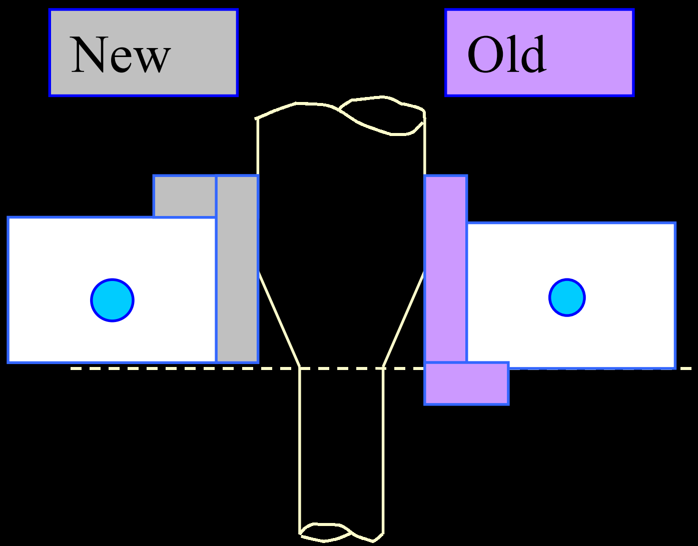


Shadow Box Hotspots - current & future mitigation

- Insulation stuffed from outside and inside
- Reengineer installation procedure and shadow box plate

Shadow Box Hotspots - current & future mitigation

- Final assessment of insulation integrity must be carried out each time furnace insulation replaced



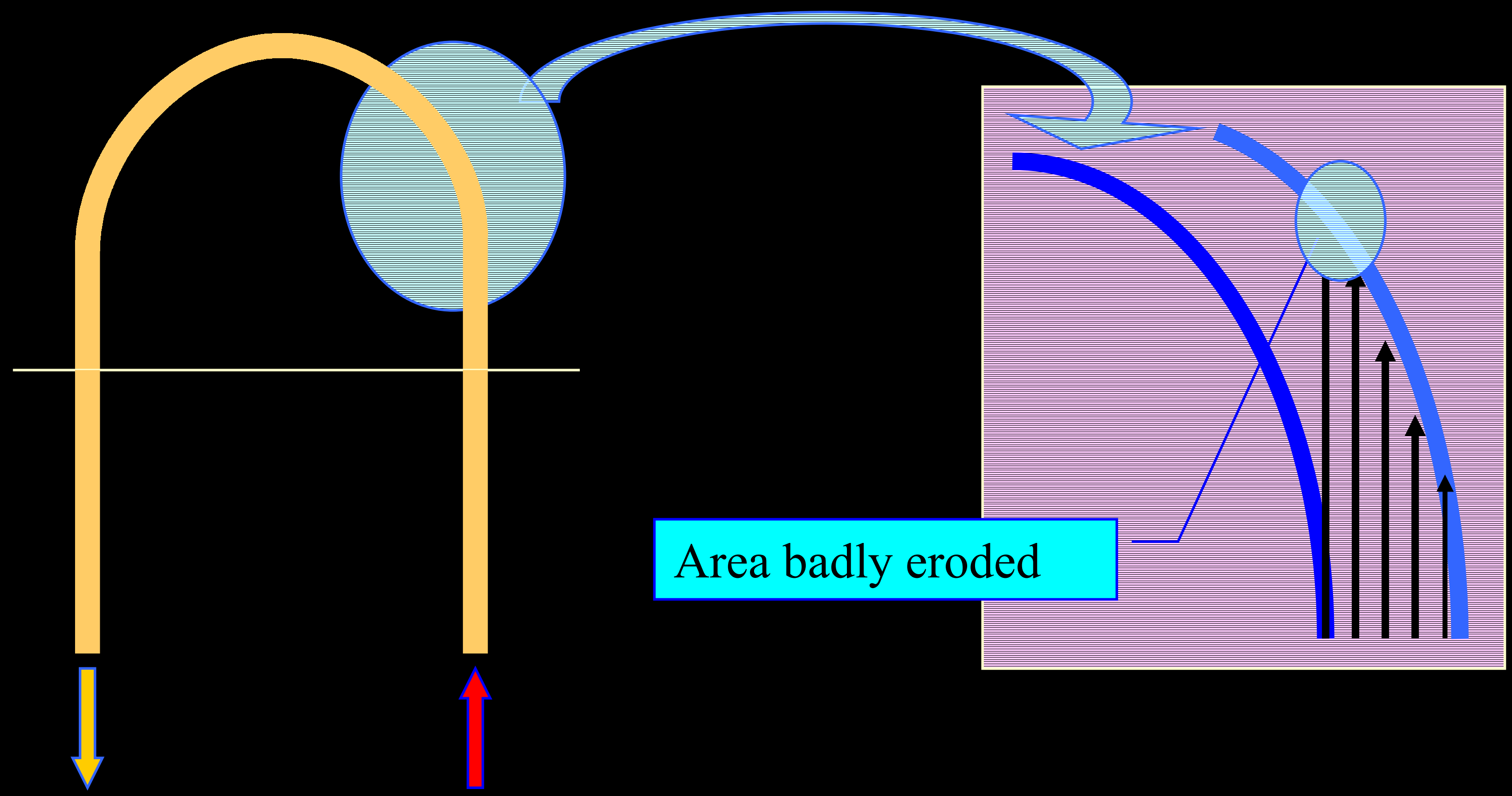
SLE U-Bend Erosion - scenario

- Thinning 1mm per year at the inlet sweep bend
- Change U-bend if thickness drops below 3.5 mm from initial of 8.8mm
- Replacement every 3 years

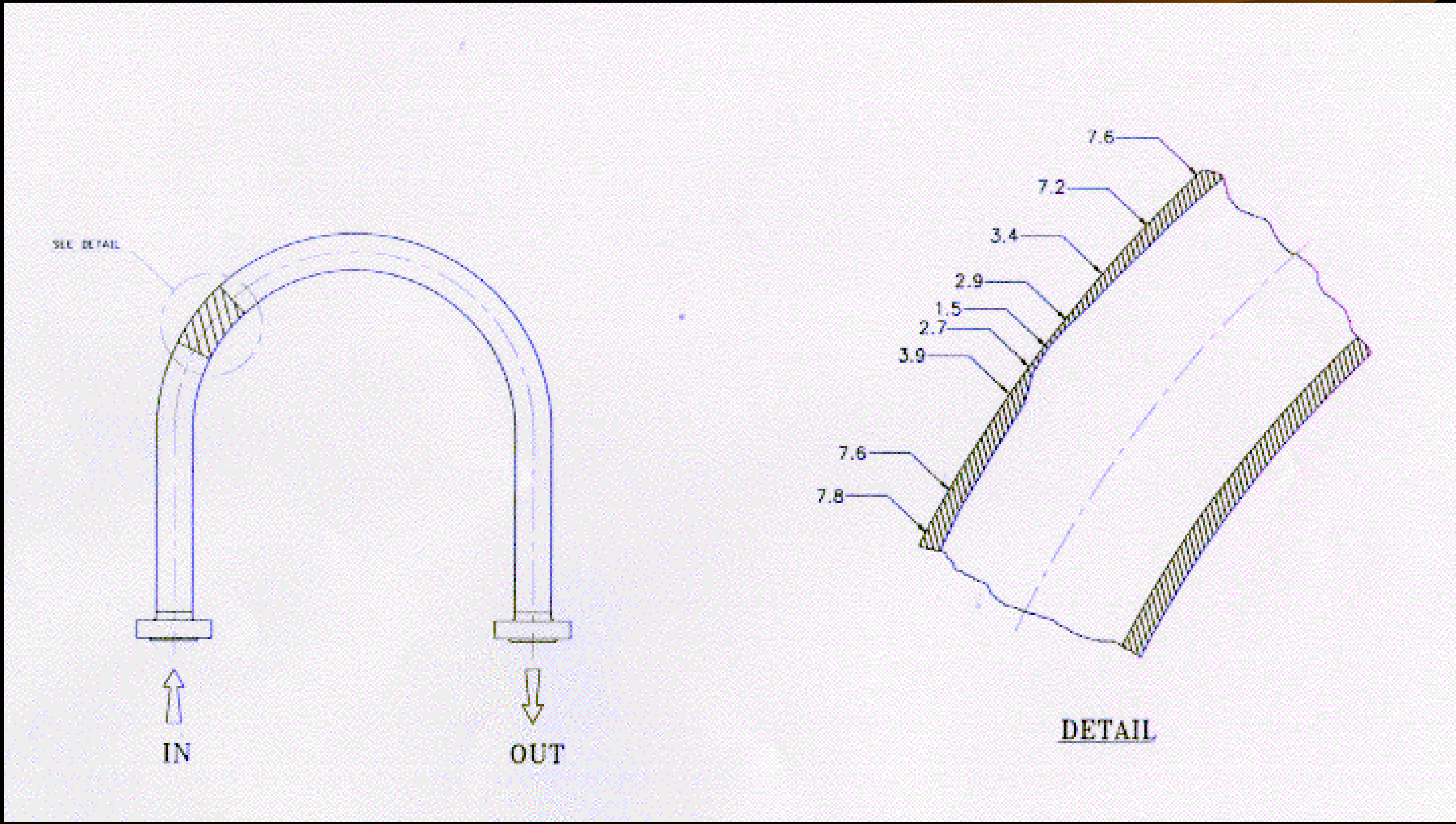
SLE U-Bend Erosion - theory

- Erosion main contributing factors include solid presence, material specification and flow path geometry
- Initially, gradual transition in flow section and shallow-angle intersections was enough to mitigate erosion

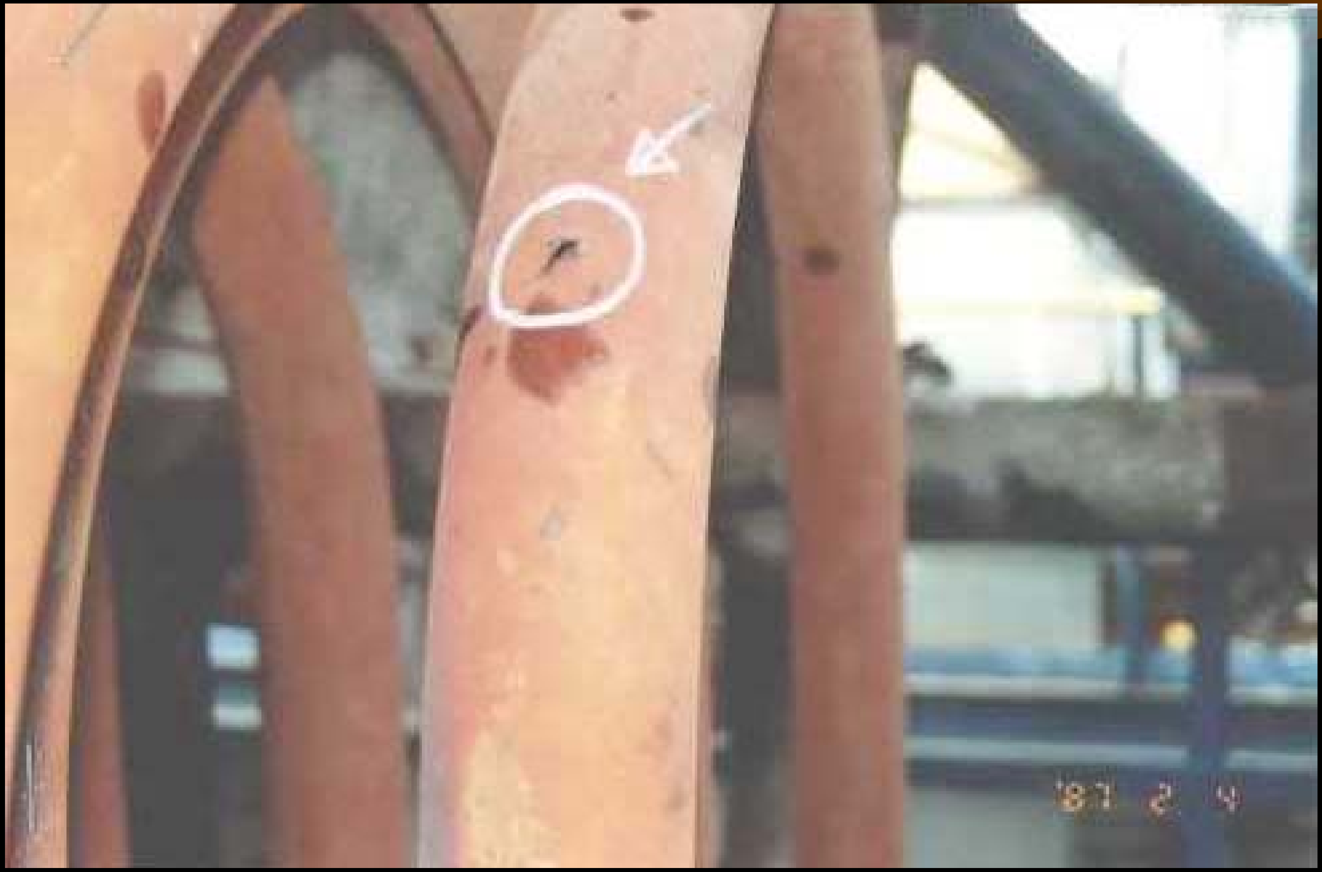
SLE U-Bend Erosion - theory



SLE U-Bend Erosion - theory



SLE U-Bend Erosion - a glance



SLE U-Bend Erosion - current &future mitigation

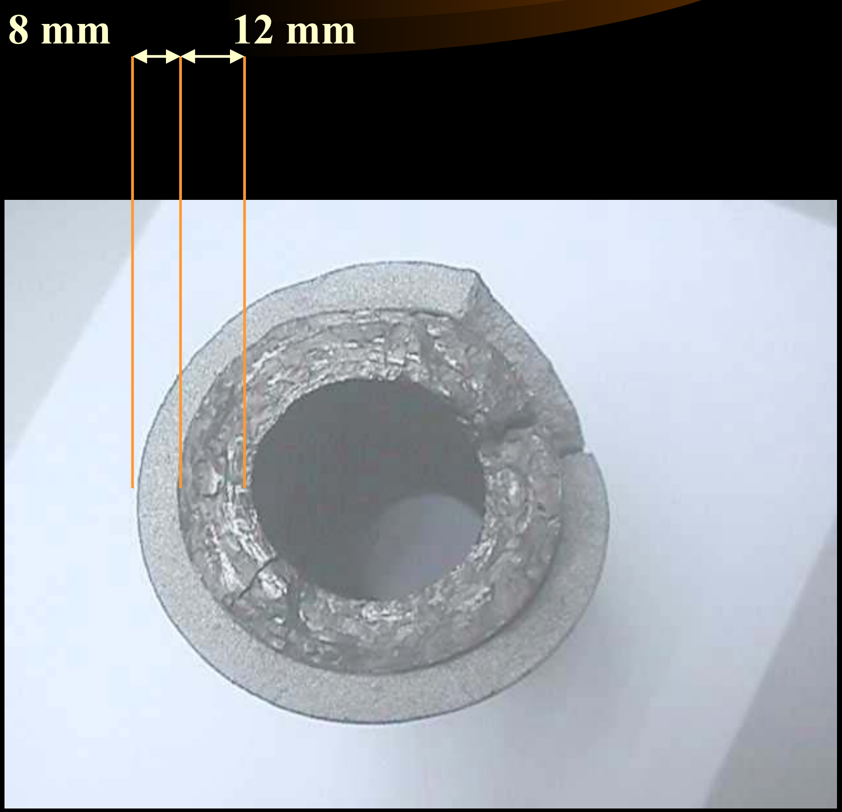
- Inlet and outlet sweeps alternated to even out erosion effect
- Ultrasonic Thickness Scanning (UTS) to detect thinning and make replacements
- Modify U-bend to increase integrity of pipe inline with increasing flow turbulence

5th Opportunity Radiant Coil Thermal Shock -theory

- Coke formation is an undesirable feature of the cracking process
- The carbon coats the inside surface of the tubes, increasing in thickness

Radiant Coil Thermal Shock -theory

- The coke layer can reach > 10 mm thickness depending on the type of feedstock and severity



Radiant Coil Thermal Shock -theory

- The thickness of the coke is a function of the TMT

Radiant Coil Thermal Shock -theory

- Coke layer is hard, relatively brittle, and has a lower coefficient of thermal expansion than the tube metal
- With coke presence during sudden shutdown two things can happen:-

  ~ coke falls off - spalling that leads to tube blockage

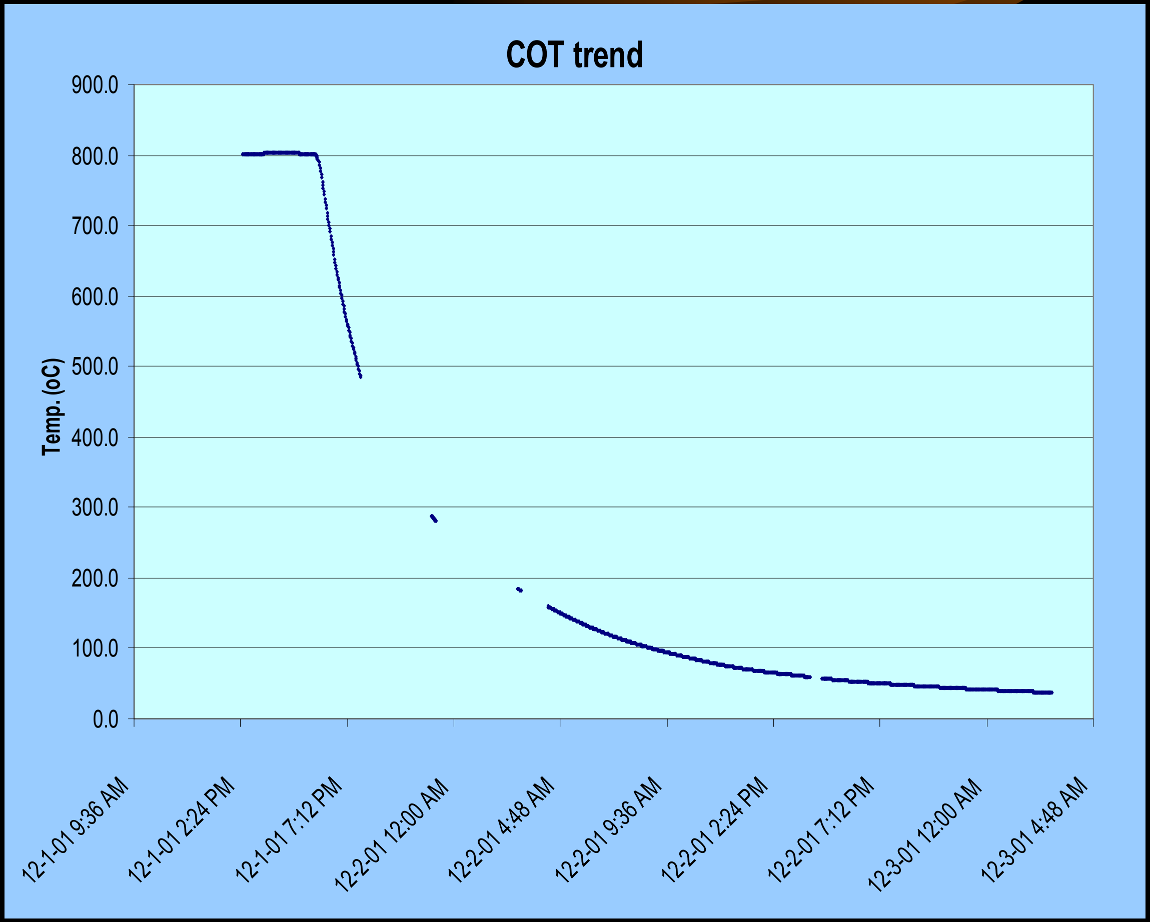
  ~ coke remains - coil splitting due to it's faster rate of contraction

Radiant Coil Thermal Shock -scenario

- 1st Dec 01 power supply interruption due to national power grid
- Steam from utilities lost during power outage
- Furnace damper goes to minimum opening to avoid heat loss
- Bottom air register dampers manually closed

Radiant Coil Thermal Shock -scenario

- Coil temperature drops 100 ~200 ºC in 1st hour after trip
- Allowable temp. drop is <80 ºC



Radiant Coil Thermal Shock -scenario

- Difference in cooling rate depends on amount of coke and insulation condition
- Coils inspected after temperature almost ambient : ~ 70 coils needed replacement

Radiant Coil Thermal Shock -scenario

Radiant Coil Thermal Shock -scenario

Radiant Coil Thermal Shock -mitigation

- Decoke End Of Run tubes as soon as possible before shutting down furnaces
- Avoid unnecessarily furnace emergency shutdowns
- Ensure reliability of Uninterrupted Power Supply (UPS)

Pyrolysis Furnace Opportunity & Strategic Improvements

Conclusion

- Reviewed Furnace layout
- Reviewed Furnace opportunities
- Reviewed current and future improvement strategies

Pyrolysis Furnace Opportunity & Strategic Improvements

Conclusion

- Implemented improvements to reduce Equipment Opportunity Losses
- Prolonged life and operability of equipment, thus reducing downtime and maintenance cost
- Further opportunities to improve are being evaluated

Thank You

Q & A