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NOVEMBER 13, 2019

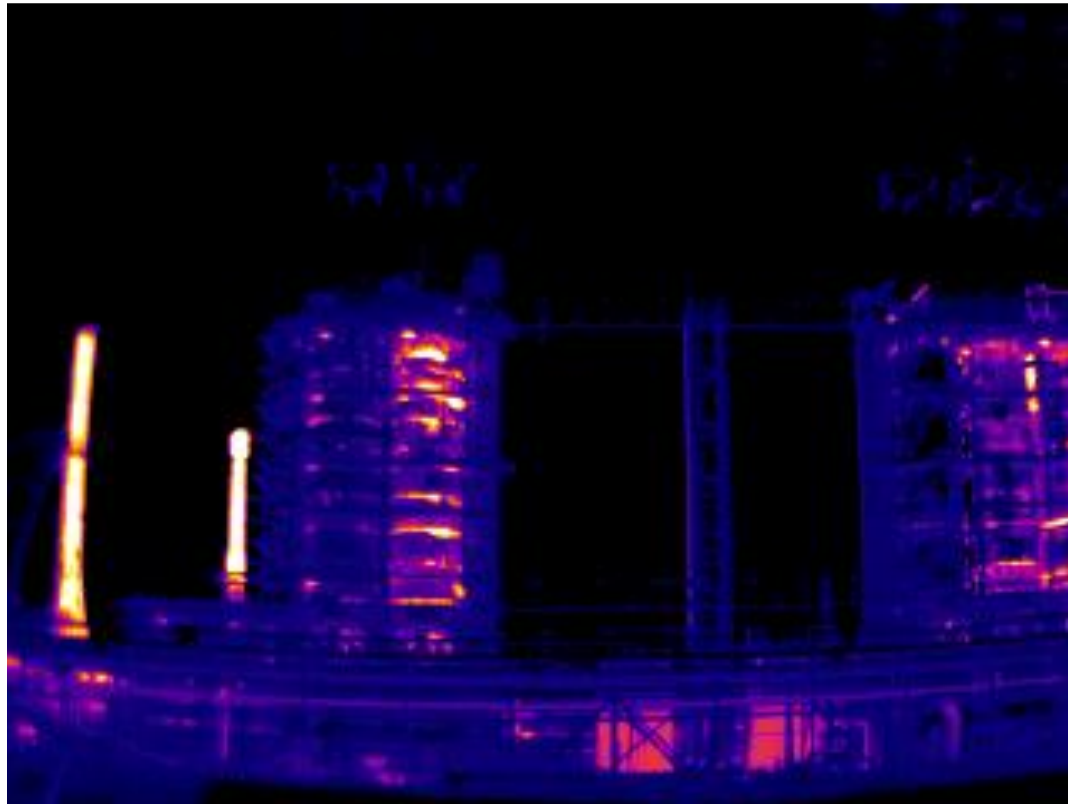
BEST PRACTICE THERMAL INSULATION FOR DCU PERFORMANCE & LIFESPAN

REFCOMM
MUMBAI 2019

ST-001-C-014

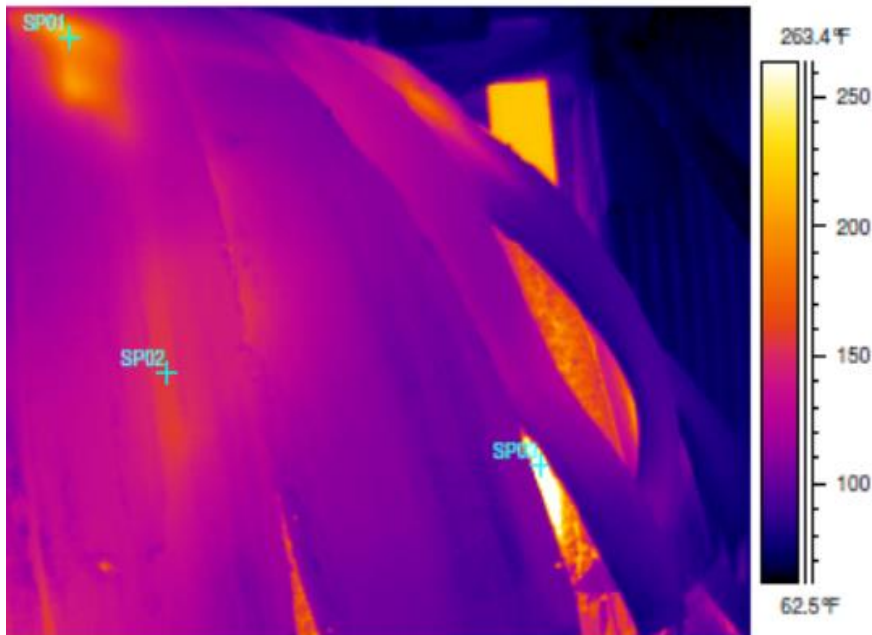
IR SCAN OF DELAYED COKER WITH 6" MINERAL WOOL

**Design Should Provide 60 C Surface Temperature
Actual Temperature 198 C Per IR Scan**



SAME DRUM TOP HEAD

Top of Drum #5 West Side



| Label | Value |
|-------|-------|
| SP01 | 215°F |
| SP02 | 157°F |
| SP03 | 510°F |



WHAT IS THE IMPACT OF POOR INSULATION?

- High Temperature Impacts Instrumentation
 - Instrumentation Housing Damage
 - Misreading Bed Heights
 - Lost Production Potential
 - Safety Concern With Nuclear Devices
 - Other Maintenance Headaches
- Energy and Production Losses
 - Current Situation Heat Loss is 350% Greater Than Design
 - \$ Impact Depends On \$ of Energy \$24K/Year
 - Greater Energy Loss = Lower Outlet Temp = Lower LHC Yield
 - 2.3 C Loss in Temperature Equates to > \$2 Million USD/Year
 - Super Insulation Gives Up to 3.2 C Increase in Outlet

WHAT IS THE SOLUTION

SUPER INSULATION WITH PYROGEL HPS

| Incumbent Material (Base Case) Performance | | | | |
|--|-----|------------------|-------|-------------|
| Thk (in) | | Q" (Btu/hr-sqft) | ΔQ" | T_surf (°F) |
| 6.0 | | 61.7 | | 128.8 |
| Pyrogel HPS Solutions | | | | |
| Plies | mm | Q" (Btu/hr-sqft) | ΔQ" | T_surf (°F) |
| 1 | 10 | 320.5 | -420% | 279.0 |
| 2 | 20 | 176.8 | -187% | 202.3 |
| 3 | 30 | 122.3 | -98% | 169.5 |
| 4 | 40 | 93.6 | -52% | 150.9 |
| 5 | 50 | 75.8 | -23% | 138.9 |
| 6 | 60 | 63.7 | -3% | 130.3 |
| 7 | 70 | 55.0 | +11% | 124.0 |
| 8 | 80 | 48.4 | +22% | 119.0 |
| 9 | 90 | 43.1 | +30% | 115.0 |
| 10 | 100 | 39.0 | +37% | 111.8 |
| 11 | 110 | 35.5 | +42% | 109.0 |
| 12 | 120 | 32.6 | +47% | 106.7 |
| 13 | 130 | 30.2 | +51% | 104.7 |
| 14 | 140 | 28.1 | +54% | 103.0 |
| 15 | 150 | 26.2 | +57% | 101.5 |

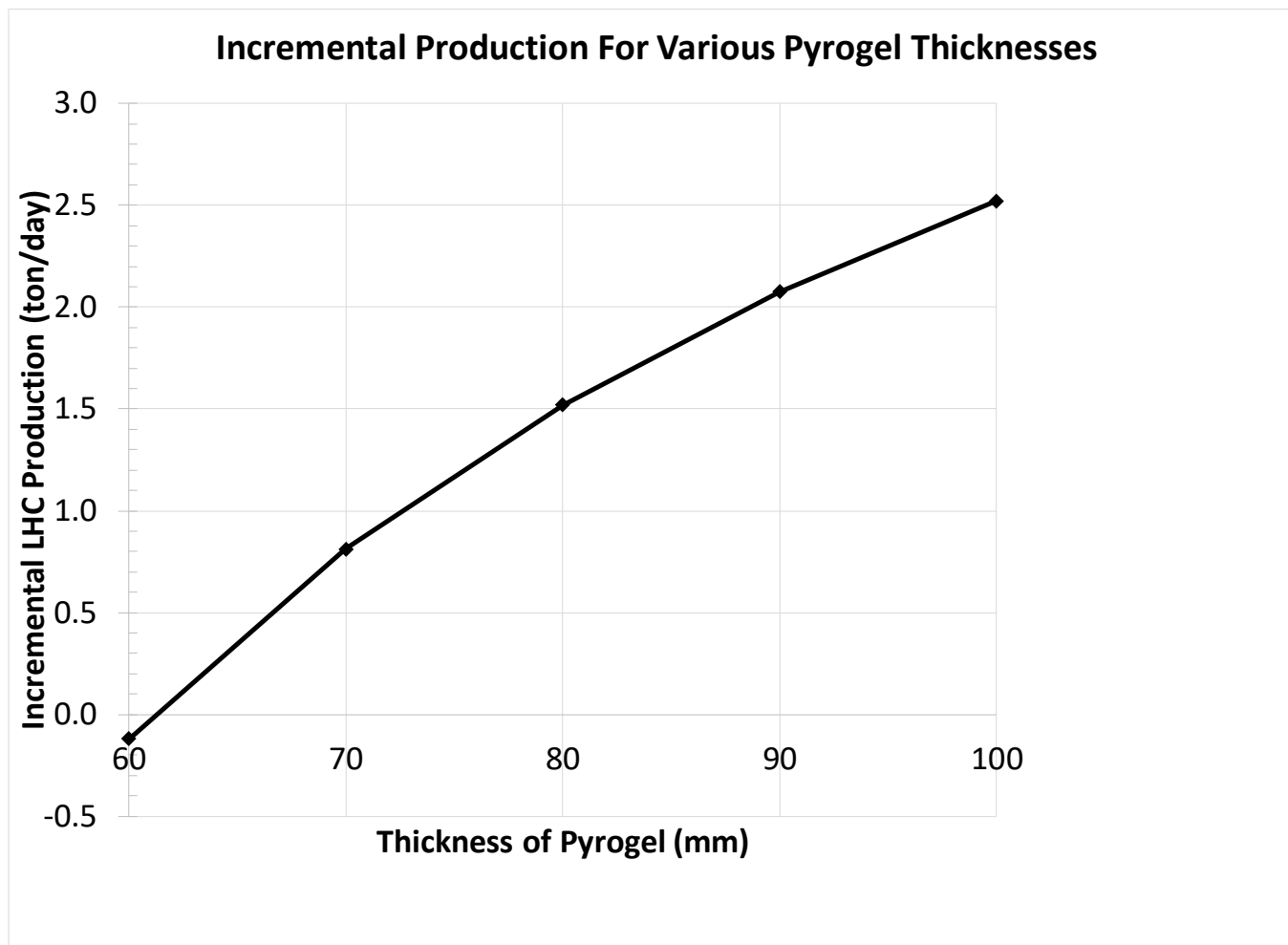
Can Match Design Heat loss with 60mm of Pyrogel HPS

70mm gives >10% Improvement and Will Increase LHC Yield vs. Current

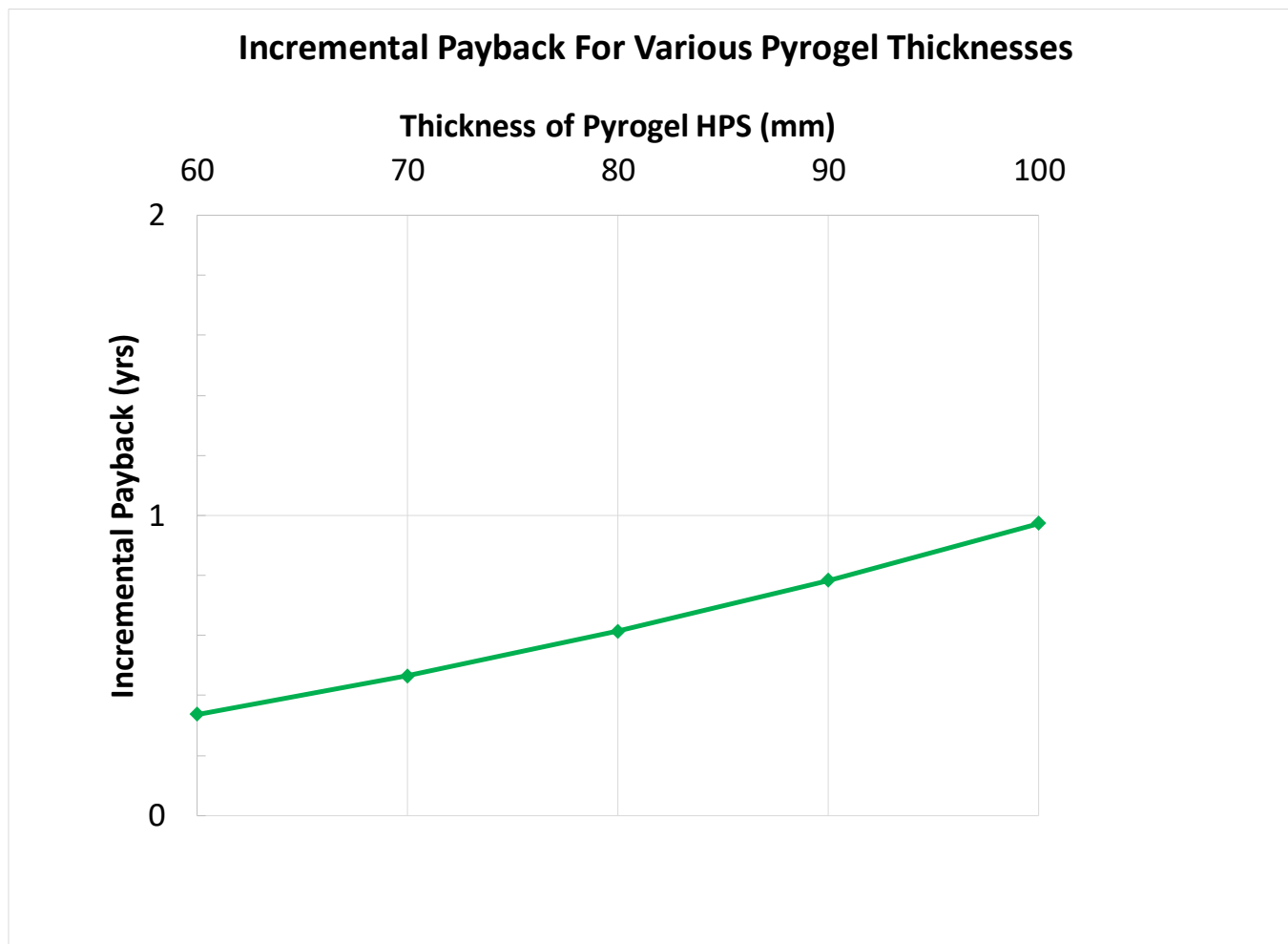
90mm Provides Cost/Performance Balance

150 mm Highly Effective Greatest Energy Savings and Yield Improvement

INCREASE PRODUCTION VS THICKNESS



PAYBACK FOR VARIOUS THICKNESSES



ESTABLISHED TRACK RECORD

- In 2012 a refiner replaced two drums in their six-drum unit, and insulated them with 60mm of Pyrogel
- After a year in service, they noticed that new drums were running 10°F warmer than the four older drums that were still insulated with aging mineral wool
- On their next new 4 drum unit they installed 100mm of Pyrogel
 - The additional material cost was paid for by the unit's higher production of liquid hydrocarbons
- 8 years later this refiner continues to "Superinsulate" with Pyrogel. New Drums Contracted and in Fabrication are specified with 60 mm of Pyrogel HPS.

Pyrogel is now a the standard for every new DCU at a major global refiner



DOES IT LAST?

CONE INSULATED SAME TIME AS DRUM AND HEAD BUT WITH PYROGEL INSTEAD OF MW

Bottom of Drum #5 East Side



| Label | Value |
|-------|-------|
| SP01 | 124°F |
| SP02 | 97°F |
| SP03 | 178°F |

Reflected temperature



DURABILITY OF THE MATERIAL

SUSTAINED PROTECTION

- In September, 2008, Category 4 Hurricane “Ike” tore through a Gulf Coast Refinery
- A 4-drum DCU was stripped bare of its insulation, rendering it inoperable & delaying the refinery’s re-start
- With no time re-insulate properly, they wrapped the drums with three layers of a then-new material, Pyrogel, as a temporary measure and left it exposed, with no jacketing
- 10 years later...
 - Still operating with the “temporary” Pyrogel, still with no jacketing
- 2019 drums being reinsulated with Pyrogel and proper Jacketing





WHAT ABOUT TRANSFER LINES

PROVEN BENEFITS OF LOWER HEAT LOSS AND INCREASED RUN TIMES

**Refiner Experiencing 10C Drop From Furnance to Coker in Transfer Line
Greater than original design Forcing them to Increase Furnace Temp**

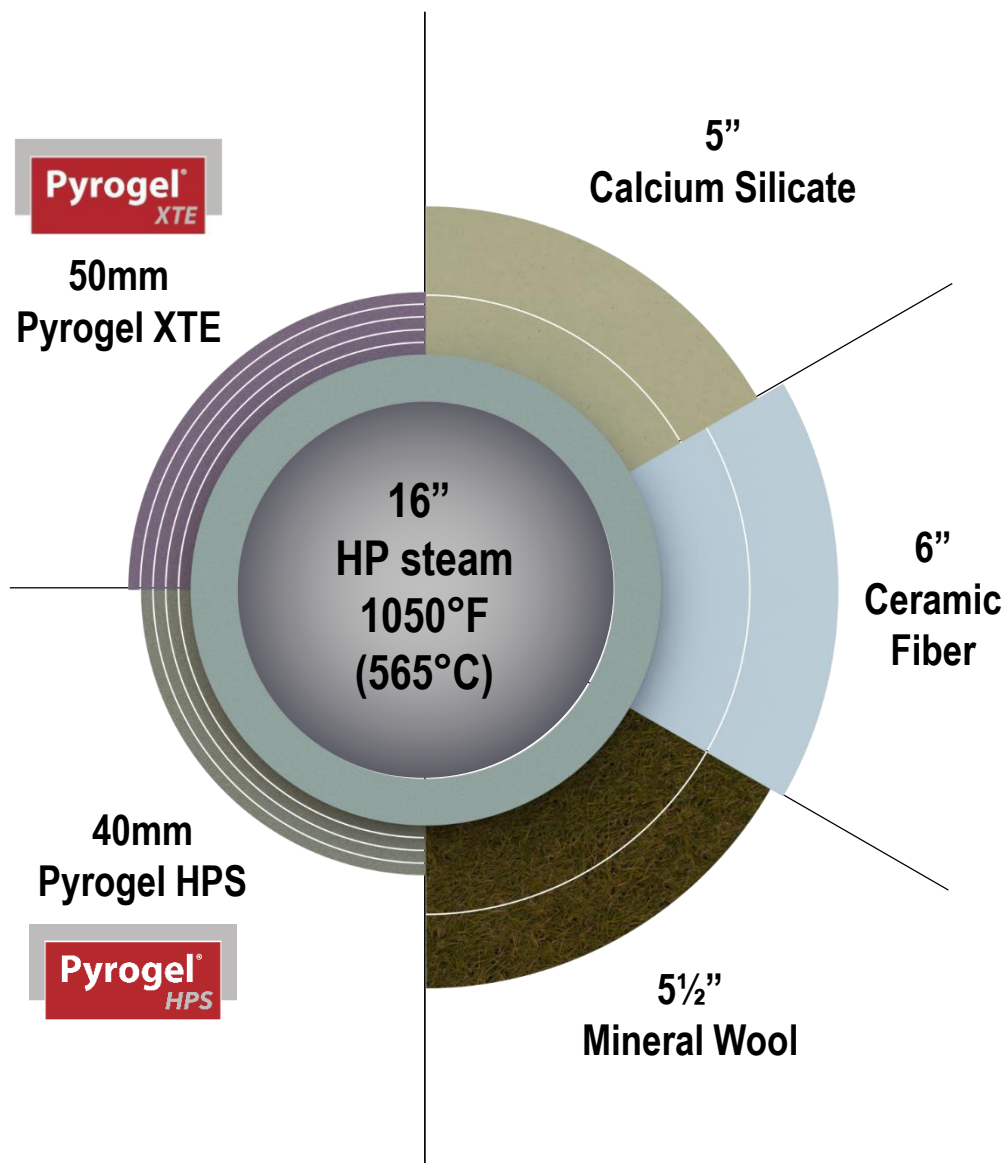
16" line 84 Meters Long

Insulated with 130mm of Mineral Wool

Looking to reduce furnance outlet from 491C back to 488 C



Pyrogel HPS The High Temperature Solution



SOLUTIONS BEING CONSIDERED

Table 1: Current Temperature Drop Comparison to Possible Solutions

| Insulation Type | Thickness (mm) | Calculated Temperature Drop (°C) | % Change Better than Current Temperature Drop |
|------------------------------|----------------|----------------------------------|---|
| Newly Installed Mineral Wool | 130 | 7.0 | 30% |
| | 190 | 5.3 | 47% |
| Pyrogel HPS | 40 | 7.3 | 27% |
| | 50 | 6.0 | 40% |
| | 60 | 5.1 | 49% |
| | 70 | 4.5 | 55% |
| | 80 | 4.0 | 60% |
| | 90 | 3.7 | 63% |
| | 100 | 3.4 | 66% |

“

***After completing the feed line
re-insulation with Pyrogel
HPS, the duty rate on the DCU
furnace reduced, we also
increased time between
spalling from weeks to
months.***

—Process Engineer on Mid West Refinery

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User Feedback





LONG TERM ECONOMIC BENEFITS

FINANCIAL PAYBACK & SUSTAINED PERFORMANCE

- Increased Coker Outlet Temperature Leads to Higher LHC Yields

5.6°C \approx 1%

Control & Flexibility of Process Temperature

- Feed & Overhead Lines
- Drums
- Better bottom coke formation
- Heat up cycle

Economic Benefits including

- Increased liquid yield
- Reduced Maintenance
- Lower Furnace Firing
- Reduced Drum Stress

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