We are bringing together the ‘power of three’, harnessing the inherent strengths of Wood Group, Amec and Foster Wheeler – three great brands, to create a new company of significant global scale and enhanced capability. Together we are stronger, more sustainable and more efficient, enabling us to meet more of today’s challenges and to unlock many opportunities in the future.

Robin Watson, CEO
Power of three:

A new global leader in technical, engineering and project services

60+ operating in more than 60 countries

$11BN over $11bn revenue

160 over 160 years experience
Foster Wheeler SYDEC™
Delayed Coking Technology

Resources & Geography

55,000
People

60+
Countries

400+
Offices
Markets Served

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Foster Wheeler SYDEC™
Delayed Coking Technology
Is there anything new?
Foster Wheeler SYDEC® Technology

Andy Hemmingway
SVP Process Technology

Steve Beeston
VP Technology Licensing

Rick Conticello
Director-Technology and Resource Management

Srini Srivatsan
Director – Coking Technology

Patrick Bernhagen
Director of Sales (Fired Heater)

Juan Sanisviero
Technical Services Manager
Delayed Coking

- Most commonly used residue upgrading process
  - Refineries and upgraders
  - Over 5,500,000 BPSD installed capacity
- Very attractive economics
- Complete residue conversion
  - Gas
  - Naphtha
  - Gas oils
  - Coke (disposal not an issue)

Maximized diesel yield with hydrocracker integration
Delayed Coking

- First Delayed Coker - 1929
  Standard Oil of Indiana at Whiting
- What’s new almost 90 years later?
- Lots
Foster Wheeler SYDEC<sup>SM</sup> Delayed Coking Technology

SYDEC<sup>SM</sup> Simplified Flowscheme
What’s New? – Recent DCU Developments

- Process considerations
- Equipment improvements
- Safety
- Environmental
- Reliability
Process Considerations

- Maximize liquid yields
  - Low pressure
  - Low recycle
  - Distillate recycle
  - Zero recycle
  - Integration with Solvent Deasphalting
- Heavier feeds
- Shot coke
- Reduced cycle times

Typical LCGO and HCGO distribution in total liquid product
• Revamp existing DCU to increase capacity
• Add SDA to maintain DCU capacity
Foster Wheeler SYDEC^SM^ Delayed Coking Technology Safety
Safety Improvements

- Focus on simplifying operations or getting operators off the structure during critical operations
  - Increased automation
  - Interlocks
  - Safer operations
  - Remote working

Wood Safety Rules

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Coke Drum Unheading

- Slide Valve Unheading Systems
Remote Coke Cutting

Remote cutting enclosure at grade, typically outside ISBL

Cutting shelter on top deck
Automated Batch Control of Delayed Cokers

Why automate?
- Reduces risk to onsite operators and plant personnel personnel
- Increase use of permissive and interlocks reduces the risk of onsite and offsite consequences
- Improves consistency, repeatability, and reliability of the batch coking process

“The safest risk is the one you didn't take.”
Automation Structure

- A fully automated coker consists of
  - Automatic Batch Control of Delayed Coker (ABCoDC)
  - Fully automated decoking system
  - Automated coke handling system
- Wood has an alliance with BP to promote ABCoDC
12 Isolation Points per Coke Drum
Foster Wheeler SYDEC®SM
Delayed Coking Technology

Batch Controller System

- Resides in the SIS
- Each coke drum has 42 defined steps.
- The sequencer
  - Moves the appropriate valves required to safely run the coker
  - Provides an independent process confirmation of that move
- Milestone Controller
  - Supervisory controller that monitors
    - The coke drums
    - Key milestones
    - Coke drum cycle times.
Foster Wheeler SYDEC™ Delayed Coking Technology

ABCoDC Benefits

• Decreases manhours spent on the structure
  – Operator rounds are the only planned time on structure.
  – Non-planned time on structure includes instrumentation troubleshooting.

• Decreases the risk of mis-operation of valves
  – BP estimates ~300,000 automatic moves since 2014 start-up
  – Many human errors likely avoided during that time

• Minimizes coke drum cycle
  – Allows easy testing and optimizing of individual steps
  – 10% reduction in cycle time to date
ABCoDC Benefits (Continued)

- Consistent operation

- Trend clearly shows when automation was engaged
- Early detection of mechanical issues by monitoring a change in step duration.
Foster Wheeler SYDEC SM
Delayed Coking Technology
Equipment
Equipment Developments

- Double-fired heater
  - Foster Wheeler Terrace-Wall\textsuperscript{SM} heater
- Coke drums
  - Uniform wall
  - Large diameter
- Automated slide valve unheading
- Coke cutting
  - Autoshift cutting tool
- Steam purged valves
- Motor operated valves
- Interlocks

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**Foster Wheeler Terrace-Wall Double Fired Heater**

**Features**
- High average heat flux
- Reduced coil volume
- High in-tube velocities
- Independent pass control
- Sloped wall design for even flux
- On-line spalling & pigging

**Benefits**
- Process difficult feeds
- Provides feedstock flexibility
- Longer run lengths
- More profitable operations
Coke Drums

- Single thickness wall
- Skirt-shell connection
  - Hot box
  - Weld build up / Forged ring
- 1¼ Chrome steel with cladding
- Proprietary plate chemistry, welding and finishing specifications
- Long life (>7,000 cycles) with forged ring design
- Largest coke drums in operation – 9.8 m diameter
DeltaValve Center Feed Device

- Simulates traditional bottom feed entry
- Based on slide valve unheading technology
Foster Wheeler SYDEC\textsuperscript{SM} Delayed Coking Technology

Center Feed Device (CFD)

- Commercially operating (over 5 years successful operation) in 3 locations
- Benefits observed
  - Minimum to zero banana effect
  - Drastic reduction in frequency of hot spots and blowouts
  - Low differential thermal gradients observed during coking and quenching
- Now standard on all new Foster Wheeler cokers
Temperature Profile Improvement With CFD

- Large circumferential temperature gradients
- Non-uniform flow in the drum
- Uniform temperature gradients
- Uniform flow
- Coke insulation layer
- Lower wall cooling rates during quench
Foster Wheeler SYDEC®SM
Delayed Coking Technology

Environmental
Foster Wheeler SYDEC™
Delayed Coking Technology

- Enclosed blowdown system with vent vapor and unconverted oil recovery
- NOx
  - Low NOx burners
  - SCR
- Coke particulates
  - Wind barriers and wetting systems
  - Enclosed coke conveyors
  - Covered storage
  - Closed coke slurry system
- Water reuse
- Refinery sludge disposal
Foster Wheeler SYDEC℠ Delayed Coking Technology

Summary
Summary

- There continues to be innovation and development in Delayed Coking
  - Safety
  - Operability
  - Maintainability
  - Environmental
- Delayed Coking continues to be the residue processing technology of choice
  - Economics
  - Flexibility
  - Experience
  - Low risk
Is There Anything New?

Yes!