Flowserve
Remote & Automated Coke Cutting

Andrew Worley
Global Product Manager Coke Cutting Systems
Agenda: Remote & Automated Cutting

• Flowserve Overview
• Coke Cutting Process Evolution
• Coke Drum Monitoring
  • Audio
  • Video
  • Vibration
• Remote Coke Cutting
• Automated Coke Cutting
Hydraulic Coke Cutting Systems History

1938  Process patented by Shell
1938  Original Jet pumps & valves by
1940  PACIFIC® enters the market
1947  First Pacific Pump Decoking Installation
1979  First Combination Cutting Tool (Axial)
1980  First Simple Automated System Commissioned
1985  Pacific & Worthington merge
1992  Pump Divisions of Ingersoll-Rand & Dresser form joint venture
1994  First 4000 psi (27600 kPa) Jet pump
1995  On Deck Remote System Commissioned
2000  Flowserve acquires IDP
2004  First Autoshift™ Cutting Tool
2008  First 5000 psi (34473 kPa) Jet pump with 6235 psi (42989 kPa) MAWP
2010  Fully Automated System Shipped
2011  Off Deck Remote System Commissioned
2013  Fully Automated System Scheduled for Commissioning

Flowserve has built over 200 coke cutting systems over the past 70 years with drum diameters exceeding 32 ft
Coke Cutting Evolution
Hydraulic Coke Cutting Systems History

Manual Cutting – Old systems

- Personnel located on cutting deck
- Operate winch and rotary joint controls
Hydraulic Coke Cutting Systems History
Hydraulic Coke Cutting Systems History

Current Local Cutting Standard Cutting

- Electronic Joystick
- All equipment PLC Controlled
- HMI with full system information
Coke Drum Monitoring
Coke Drum Monitoring

Systems to help operator monitor progress

Audio

Video

Vibration

Fig. 2 - Decoking Operation
Coke Cutting Monitoring - Audio

- Allows the operator to hear the jet hit the drum
- More direct than standing at the cutting deck
- Can be routed to on deck or off deck operator shelters

Operator Shelter

MIC

Audio Server

Speaker

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Coke Cutting Monitoring - Video
Video Design Considerations

- **Flexibility**
  - Cameras options
    - Fixed
    - Pan & tilt capability, degrees
    - Zoom capability
    - Infra Red Cameras
    - Weather equipped
      - Lens wiper capable
      - Heater defroster blower
      - De-icing feature
Location in the Delayed Coking Unit

- **Location of the equipment is key**
  - Clear field of access
  - Protected from outside disruptions
  - Adequate utility availability
    - Junction box
    - Cabling connections
Coke Cutting Monitoring – Drum Vibration

- 4 Vibration probes mounted on coke drum
- Signals routed to Flowserve IPS Apex™ for analysis
- Signals displayed on the HMI
Coke Cutting Monitoring – Drum Vibration

Vibration systems

- Signals routed to Flowserve IPS Apex™ for analysis
- Can be displayed on stand-alone HMI or integrated with control system
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Coke Cutting Monitoring – Drum Vibration
Coke Cutting Monitoring – Drum Vibration

Vibration Strip Charts

Instantaneous Vibrations
Coke Cutting Monitoring – Drum Vibration

Field Information

Push Button Controls
Coke Cutting Monitoring – Drum Vibration

Drum Cleanliness will be indicated here
2. Remote Coke Cutting
Remote Coke Cutting

**Move operator from the cutting deck to a remote location**

**Benefits**

**Increased Safety**

**Personnel no longer exposed to:**

- High-pressure water
- Hot spots or steam eruptions
- Hydrogen sulfide vapors
- Mechanical hazards
Remote Coke Cutting

Equipment required

- AutoShift™ cutting tool
- Remote winch and rotary joint operation
- Remote operator enclosure
- Automatic Guide Plate or Tool Enclosure
- Vibration/acoustical devices
- Video equipment

Information required

Data sent remotely to operator

- Cutting tool position and rotational speed
- Cable tension and AutoShift mode
- Drum status
- Video Feedback for Pit, Winch, & Top of Drum
Remote Coke Cutting – First On Deck Site

Modular Cutting Shack Design – Inside

- Speaker
- Video camera Display
- Coke Cutting Operating Controls
- Cutting System Permissives and Operations Status Lights

Photo courtesy M.Moloney, ExxonMobil
Remote Coke Cutting – 2011 Installation

- Video camera
- Display
- Speaker
- Coke Cutting Operating Controls
- Cutting System Permissives on HMI
Remote Coke Cutting - Boring

Drum Information through Vibration Monitoring
Winch & Rotary Joint Information
System Pressure Information

• Progress monitored on customizable display screens
Remote Coke Cutting - Boring

Drum Information through Vibration Monitoring
Winch & Rotary Joint Information
System Pressure Information

• Progress monitored on customizable display screens

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Key Learnings & Successful Practices

Video is essential ‘kit’ for a coke handler. Site requires a system which is reliable and will provide at least four views simultaneously. (Open head, winch drum, chute, and crane location.)

Consider “serious controls” on human presence on the cutting deck during unheading and decoking. Routine human presence may come to be viewed as necessary, and reduce the benefit of the effort.

HMI graphics need to be simple to use, consistent, and well understood by the coke handler.
Key Learnings & Successful Practices

Consider hydraulic or electric winches.

Take care in arranging commissioning activities and resources, especially if remote decoking is being commissioned in conjunction with other complex changes. Missing a step or double-booking a resource can easily cost you hours or days.
Automated Coke Cutting
Automated Coke Cutting

History

• 1980s – Simple Boring & Time Based Cutting

• mid 2000’s – BP Gelsenkirchen – On deck, time based, with some vibration feedback

• 2010 - Fully automated systems
  • Embedded intelligence and advanced algorithms to process signals and control the cutting process
  • Automatic coke cutting with continuous feedback
  • Operator consulting only required for exceptions
Automated Coke Cutting - Equipment

PLC cuts coke. Operator needed for abnormalities

Equipment required
- AutoShift™ cutting tool
- Remote winch and rotary joint operation
- Remote operator enclosure
- Automatic Guide Plate or Tool Enclosure
- Vibration Drum Monitoring

Information required
- Data received by PLC and transferred to IPS APEX
  - Cutting tool position and rotational speed
  - Cable tension and AutoShift mode
- Data received directly by IPS APEX
  - Drum status
Automated Coke Cutting

Basic operation

*Use vibration sensors mounted on the coke drum to provide feedback on the state of cleanliness of the drum wall*

*Sensors provide interactive feedback on the cutting status that can optimize the cutting time*

*Program is customized based on site-specific cutting practices and configured with end user*
Automated Coke Cutting

- APEX Cutting Algorithm
- Preprogrammed Algorithm
- Manual Backup
Automated Coke Cutting - Benefits

**Improved cutting personnel safety**
- Automated cutting system integrated with PLC interlocks
- Minimize probability of operator mistake
- Eliminates shortcuts sometimes taken by cutting personnel
- Standardized cutting procedures reduce risk of aggressive cutting practices

**Process efficiency and consistency**
- Advance the cutting program as soon as possible based on vibration feedback
- Consistent cutting times with standardized cutting procedure
Automated Coke Cutting - Benefits

**Improved equipment reliability**

- Less damage from ramming tool into coke bed during boring
- Less chance of damage from aggressive cutting techniques
- Can monitor performance of jet pump and other decoking equipment for predictive maintenance

**Data recording for process optimization / troubleshooting**

- Data recorded and can be compared w/process data to optimize cycle times
- Ability to access data for troubleshooting in case of any failure event
- Ability to monitor performance of jet pump and other decoking equipment for predictive maintenance
Remote & Automated Coke Cutting

Thank You

Andrew Worley
aworley@flowserve.com