



## Major Economic Choices When Designing a New Coker and Revamping an Existing Coker

Gary C. Hughes  
Senior Principal Consultant

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# Qualities of a Top Quartile Coker

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- Safety – Every worker goes home safe
- Environmental safeguarding
- Energy efficiency
- Reliability and flexibility
- Economic and robust
- Critical: Your design basis

  
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# Delayed Coker Safety by Design

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## Address Source of Safety Issues

## Not Just Symptoms!!

- Remove worker from the hazard
- Protect from inappropriate actions
- Emergency protective systems
- Other safety design features

# Delayed Coker Safety by Design

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## Remove Worker From the Hazard

Remote Unheading Valves



[http://www.curtisswright.com/art/oil/large\\_oil2.jpg](http://www.curtisswright.com/art/oil/large_oil2.jpg)

Remote Cutting Operations



<http://news.thomasnet.com/images/large/467/467569.jpg>



[http://www.cia-inspection.com/inspection\\_overview.htm](http://www.cia-inspection.com/inspection_overview.htm)

Remote Valve Actuation



Use of Clean, Air Conditioned Cabin



<http://www.coking.com/Vendor/Oxbow.htm>

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# Delayed Coker Safety by Design

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## Protect from Inappropriate Actions

- Operator training and procedures
- Interlocks
  - Prevent loss of hydrocarbon containment
- Layouts
  - Minimizes multi-deck design
- Visual critical instrumentation



# Delayed Coker Safety by Design

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## Emergency Protective Systems

- Egress routes from coke drum structure
- Radiant shielding of stairways and valve controls
- Drill cabin – fire rating with blast protection
- Water deluge systems for top and bottom heads
- Solid decks: top and bottom unheading decks
- Ongoing auditing of safety systems

# Delayed Coker Safety by Design

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## Emergency Protective Systems



Courtesy of Billings Refinery

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# Delayed Coker Safety by Design

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## Other Safety Design Features

- Relief valves on coke drums, not on overhead line
- Fixed sloped-wall and pit design
- Ejector application on top of coke drums
- Open deck piping lay-out



# Environmental Safeguarding

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## Minimize Emissions

Dust



<http://anchertrading.com/imagens/img13.jpg>

**Through Coke Handling Design**

Furnace Stack



<http://www.questrutec.com/Portals/0/heater.jpg>

**Through Furnace Design,  
Use of State-Of-The Art  
Technology**

Flare Emissions



[energizenowinitiative.blogspot.com](http://energizenowinitiative.blogspot.com)

**Through Good Equipment Design  
and Operating Procedures**

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# Environmental Safeguarding

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## Closed Blowdown System

- Minimizes air, water, and noise pollution
- Recover steam and hydrocarbon vapors from off-line coke drums
- Minimize coke drum relief impact on the flare



[http://thumbs.dreamstime.com/thumb\\_227/1200604108B54Twj.jpg](http://thumbs.dreamstime.com/thumb_227/1200604108B54Twj.jpg)

  
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# Environmental Safeguarding

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## Sludge Processing

- Greatly reduces refinery waste
  - Inject sludge into closed blowdown system
  - Inject sludge directly into coke drums
- Reduces refinery operating cost!!



[http://thumbs.dreamstime.com/thumb\\_227/1200604108B54Twj.jpg](http://thumbs.dreamstime.com/thumb_227/1200604108B54Twj.jpg)

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# Energy Efficiency

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## Fuel Requirement is Largest Coker Energy Cost

- Optimize feed pre-heat and furnace design
  - Utilize pinch technology to maximize efficiency, minimize cost
  - Design for low excess air to maximize furnace efficiency
  - Include high efficiency furnace heat recovery system
  - Consider ceramic coating for furnace tubes and refractory

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# Reliability and Flexibility

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- On-stream factor
- Furnace design
- Coke drum design
- Coke handling system

  
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# Reliability and Flexibility

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## On-Stream Factor

- Target 97% on-stream factor
- On-stream factor affected by:
  - Operating duration between major turnarounds
  - Furnace design
  - Coke drum life
  - Flash zone design
  - Learning from experienced designers, equipment suppliers, and operations personnel
- Operation of 35,000 BPD (5600 metric tons per day)
- Coker can be worth more than \$1 million per day

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# Reliability and Flexibility

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## High Efficiency, Low Fouling Rate, Furnace Design!!

- Good double fired furnace
- Minimize fouling
  - Low peak to average flux
  - High velocity
  - Short residence time
- On-stream spalling capability
- Pigging capability
- Proper instrumentation



Billings Refinery Coker Courtesy of CoP

  
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# Reliability and Flexibility

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## High Efficiency, Low Fouling Rate, Furnace Design!!

- Radiant tube support design
- Correct metallurgy
- Return bend design
- Special piping from furnace outlet



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Good Design Minimizes Downtime, Gets More Throughput

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# Reliability and Flexibility

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## Coke Drum Design

- Achieved long drum life
  - Design for 7000 drum cycles
  - Expect 9000+
- Consider drum fatigue
  - Stress due to drum cycle
  - Circumferential weld
  - Skirt attachment
- Achieve bulge resistance
- Minimize maintenance cost



<http://www.coking.com/Vendor/AS/mvc-256s.jpg>

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# Reliability and Flexibility

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## Coke Handling System

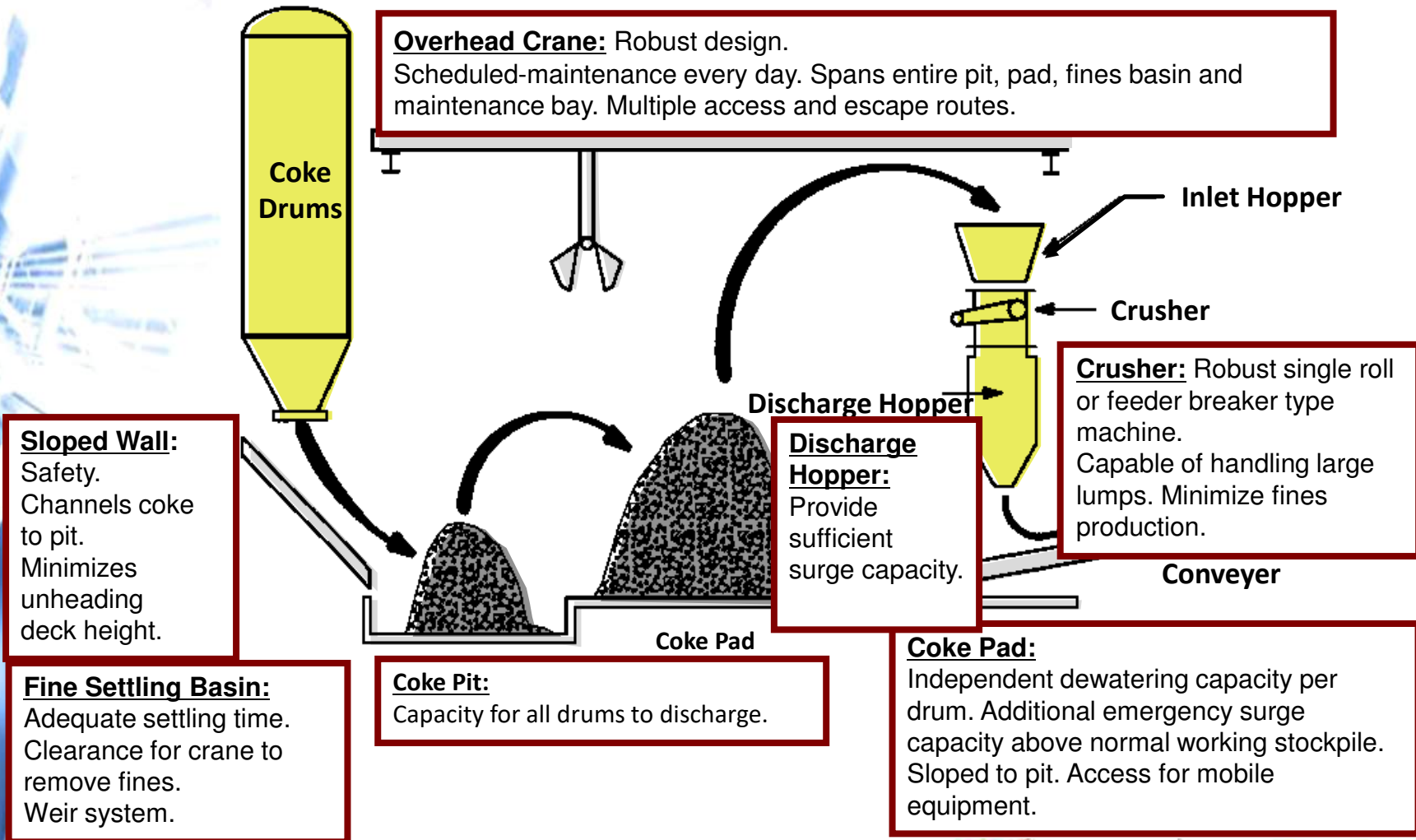
- Design coke handling system to never slow down process operation
  - Simple
  - Efficient
  - Cost effective
  - Low maintenance
  - Environmentally Friendly

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# Reliability and Flexibility

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**Coke Handling System**



# Reliability and Flexibility

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## Coke Handling System

**Robust design of  
coke and water  
handling system**

**=**

**No reduction  
of  
throughput**

  
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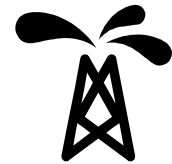
  
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# Reliability and Flexibility

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## Must Have Flexible Design

- Low cost, upside throughput expansion capability
- Must handle variations in feedstock properties
- Must handle variations in product property targets
- Must handle variations in product yield targets
- Ability to utilize distillate recycle technology



  
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# Reliability and Flexibility

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## Use of Distillate Recycle in Coker Design

- Maximizes revenue
- Flexibility to shift product distribution
  - Toward most valued products
  - To best utilize processing facilities
  - To adjust for seasonal operation
  - For future expansion objectives
- Attractive for new and retrofit coker's

  
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# Reliability and Flexibility

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## Important Plot Plan Items

- Furnace to coke drum distance
- Spacing between drums
- Maintenance accessibility
- Lower project cost

# Economic and Robust

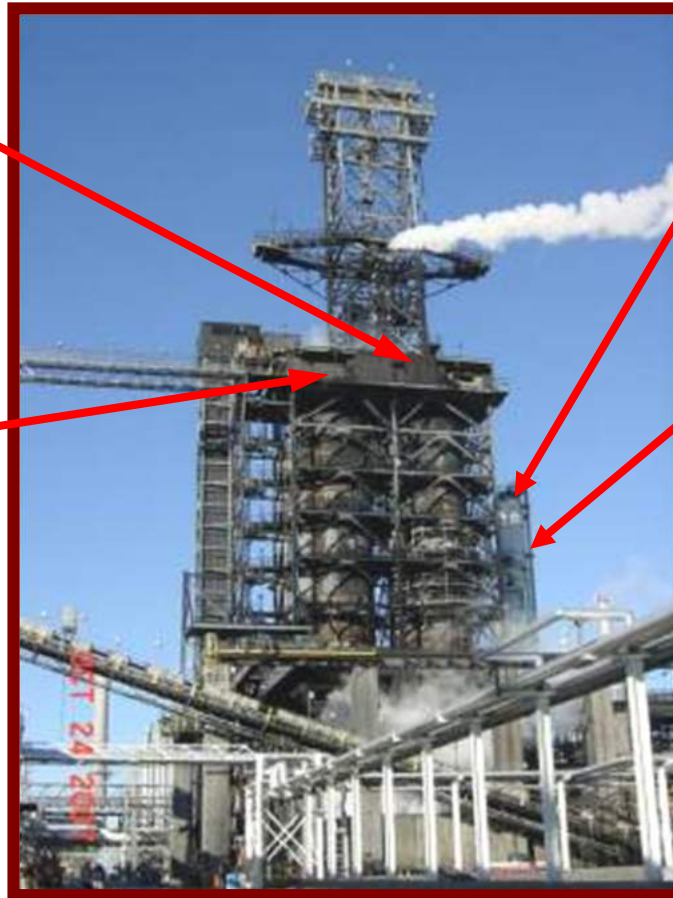
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## Maximize Yield Value

Low Coke Drum  
Overhead  
Pressure

Optimum Coke  
Drum Overhead  
Temperature

On Stream Factor



Distillate Recycle

Zero  
Natural Recycle

Feed Stock  
Flexibility

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# Economic and Robust

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## Maximize Yield Value

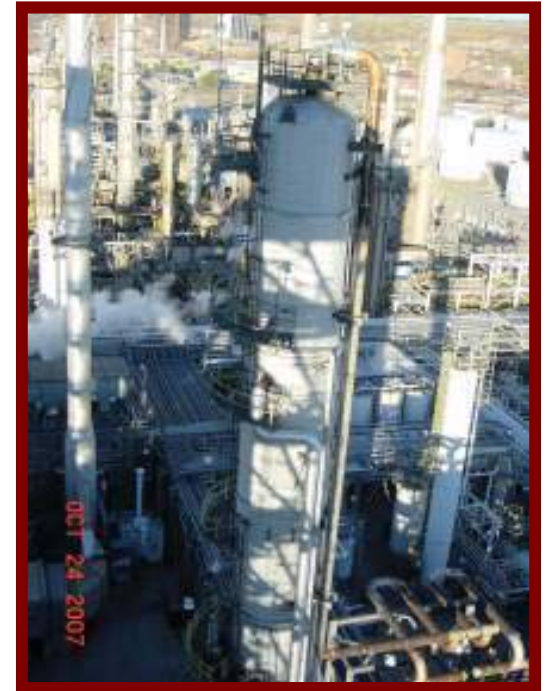
- Design or revamp coker to operate at:
  - Low coke drum overhead pressure
  - Coke drum overhead temperature target
  - Target 20 volume % distillate recycle
  - Move toward zero natural recycle
- Target to lower coke make and maximize liquid yields

# Economic and Robust

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## Use 20% Distillate Recycle

- Excellent payout
- Flexibility
  - Which liquid yields to maximize
- Future expansion
- Better on-stream factor



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# Economic and Robust

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## Maximize Yield Value

- Options for flash zone gas oil
  - Recycled to extinction in the coker
  - Sent back to the vacuum unit
  - Feed to another conversion unit
- Provides large economic advantage



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# Economic and Robust

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- Design to reduce capital cost while maximizing throughput capability
  - Design for low coke drum cycle time
- Design to minimize maintenance cost
  - Top quartile interval between turnarounds, months (>72)
- Build what you design
  - Modeling and mechanical walk-downs

# Critical: Your Design Basis

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## Design Basis is Crucial When Designing a Top Quartile Performance Coker!!



Developing the Correct Design Basis Can Make a Huge Difference!!

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# Critical: Your Design Basis

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## Design Basis is Crucial When Designing a Top Quartile Performance Coker!!

The decisions made during the earliest stages of the project have the biggest effect at reducing project cost and meeting project objectives



Good Technical Support is Key to Forming the Correct Design Basis!!

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# Critical: Your Design Basis

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## **Early Project Decisions Impact All Areas of Project!!**

- Safety results
- Environmental impact
- Energy efficiency
- Reliability and flexibility
- Short and long term economics

**Success Depends on Getting A Good Design Basis Set Early In The Project!!**

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# Critical: Your Design Basis

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## Consider Two Design Cases

- Bracket intended operation
  - Case 1 sets liquid sizing requirements
  - Case 2 sets coke handling sizing requirements
- Allow for recycling different cuts if needed
- Seasonal and future operation



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# Critical: Your Design Basis

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## Have You Done Your Homework?

- Most need support!
- Get good help early!!

**Only students that do their homework correctly and efficiently  
at the beginning of the project reach the Top Quartile**

## Be The Best!!



  
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## Questions



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