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Innovation in Control System Design for Coke Drum Switching

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Introduction

- This control system design innovation makes best utilization of available hardware and with the proper software contributes significantly to prevent mal-operation in Coker switching operations.

- The purpose of this presentation is to:
  - Explain the design in simple terms
  - Identify how this innovation overcomes deficiencies of past designs
  - Identify how this design will assist in Operational Excellence, enhance Safety and minimize downtime

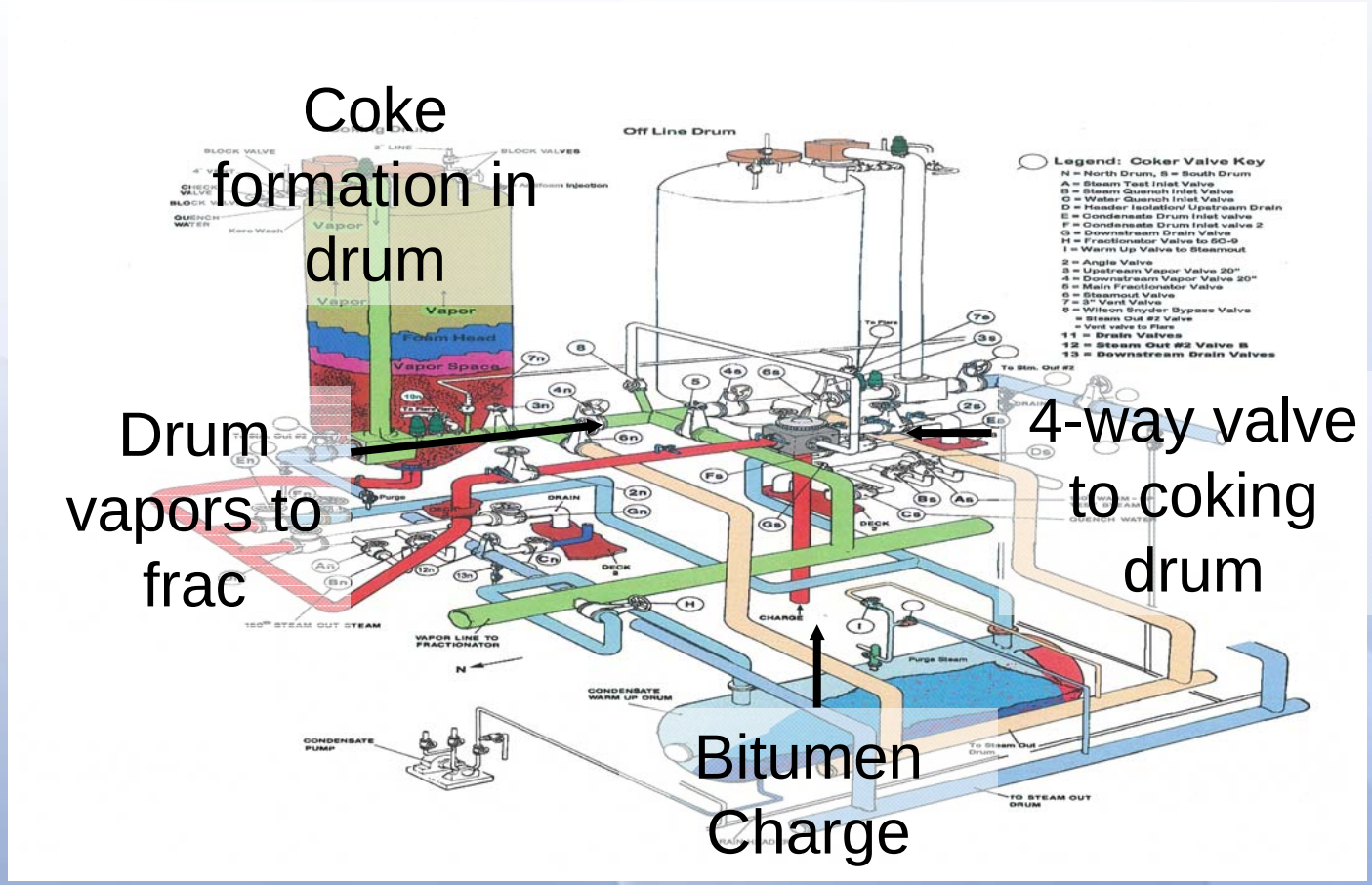
Background: Delayed Coker Drum Operation

- Definitions
  - **Coke Drum Valve Switching Sequence** : the orderly operation of valve positions around the coke drums to support the various phases of coke drum operation
  - **Permissive**: a determination by the control system if a valve should be permitted to move
  - **Inhibit**: a limitation to the valve actuator that must be removed via a satisfied permissive before the valve can move
  - **Interlock**: a control system initiated action based on input parameters / process conditions

Background: Delayed Coker Drum Operation

- Delayed Cokers use paired drums operating in a batch process to thermally crack heavy bitumen into coke and light hydrocarbons such as gas oil, kero, etc.
- Heated bitumen at approximately 1000 °F is directed to the on-line drum to allow coke to be formed in the drum and the products recovered via a common fractionator
- As one drum is being filled with coke, the other drum is being de-coked by cooling, cutting, and reheating the drum in preparation for its next coking cycle
- Numerous valves are operated to achieve the desired flow direction / isolation based on the stage of the cycle

Background: Delayed Coker Drum Operation



The Concern

- Bantrel's Delayed Coker Unit (DCU) team evaluated the hazards and risks associated with the various operating modes of the coke drums.

- Valve switching operations were critically reviewed because significant incidents of mal-operation are known to occur at this stage. This process is typically designed local manual which further exacerbates the situation.

The Concern

- Examples of such incidents:
  - accidental un-heading of a live drum
  - accidental atmospheric discharge from a live drum

- It was determined that a system should monitor critical process parameters to ensure safe conditions prior to valve operation. This system will protect both workers and assets.

The Concern

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The Design

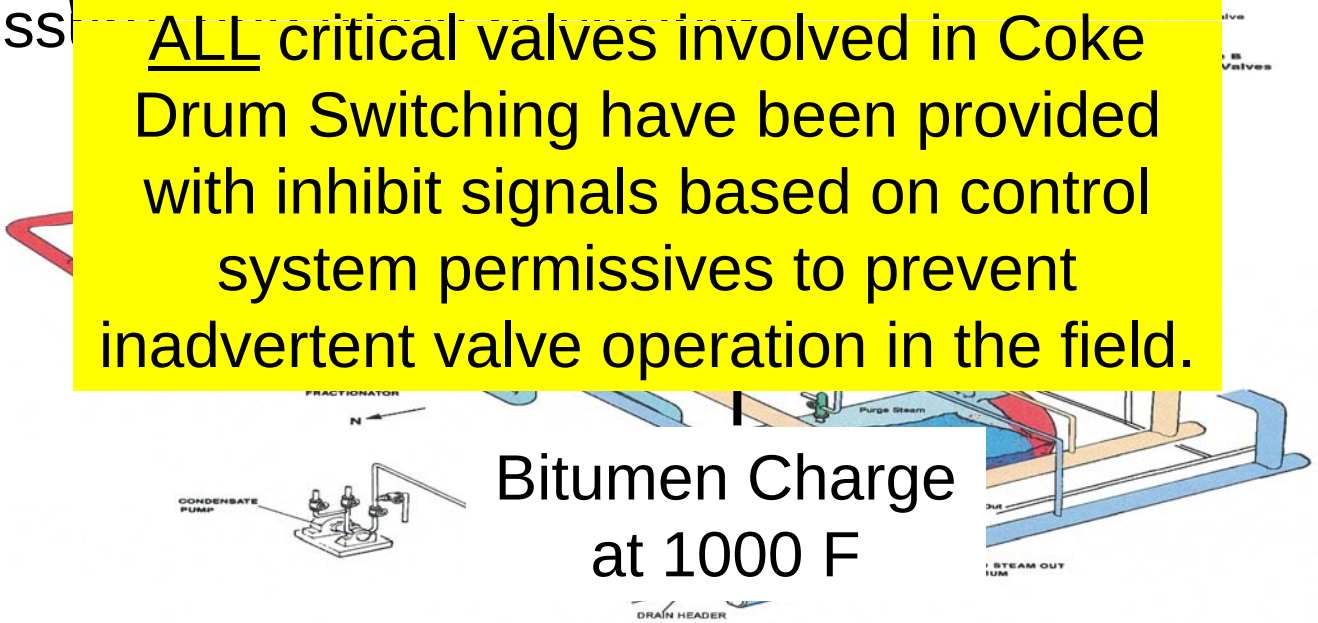
- The design monitors valve positions and process conditions in the drums to determine the operating mode at any given time via the central control system (DCS).
- Depending on the operating mode, the control system will enforce pre-established permissive(s) that must be met before certain valves can be moved.
- Valve actuators will then be disabled from the control system, making valves impossible to move from the field until the permissive is met.

The Design

Drain valve to
based on drum
pressure, and
press

Drum overhead valve to frac inhibited to open based on drum temperature and pressure, and valve positions

ALL critical valves involved in Coke Drum Switching have been provided with inhibit signals based on control system permissives to prevent inadvertent valve operation in the field.



Bitumen Charge at 1000 F

The Challenge

- Conventional design methods to monitor and control these valves would be expensive and complicated to install, requiring extensive wiring and dedicated equipment.
- Coke build up on valve internals makes it difficult to operate valves to their complete limits. This makes it difficult to trigger the discrete limit switches installed on the valves to verify their position.
- Earlier designs had limited success as safety interlocks were built for only three of the valves on each set of coke drums (4-way and inlet isolation valves).
- How to restrict the operator from bypassing interlocks indiscriminately?

The Solution

- Digital Communication Bus technology was employed to obtain valve position, torque, and other critical valve parameters.
- A single hardwired inhibit signal to the valve actuator was employed to limit it from being moved via the push button station in the field, limiting wiring and system cost.
- Valve information was coupled with existing control system process parameters, such as drum pressure and temperature, to determine operating mode and associated permissives/inhibits for ALL critical valves.

The Solution

- Analog signals are employed in place of Discrete signals for valve positions used in permissive determination. This makes it possible to tune set points, thus reducing downtime. E.g. if the valve position is 98% or more, consider it fully open.

- To mitigate indiscriminate bypasses of interlocked valves, this design actually facilitates bypasses via the control system, but with stringent supervision. In addition, the bypass is built for a specific permissive that might be holding a valve from moving instead of the valve itself.

The Solution

- These bypasses require concerted action by the field operator and DCS operator who has an overview of all the drums and the process.
  - Field operator sets an enable bypass on the drum using a secured key-locked switch
  - DCS operator sets the actual individual bypass for the same drum
  - The control system logic will only validate a bypass request for the same drum. This avoids inadvertent mal-operation of a valve on a wrong drum.
- The use of digital communication bus technology allows remote valve switching, thus the operator is not required on the Switching Deck.

The Benefit

- Elimination of incidents from inadvertent valve operation, protecting personnel and assets.
- Orders of magnitude lower capital cost compared to a conventional system vs. digital communication bus technology
- Supervisory control of any critical valve bypasses, ensuring safe operation.
- Meeting production targets is easier thanks to tuning ability of permissives and available bypasses.
- An Operator is not required on the Switching Deck due to provision of remote operation.

Questions