Flare Steam-Assist Optimization

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Overview

• Case for action
• Flare steam-assist optimization
• Plant pilot study
• Early results and learnings
Case for Action

• New, credible flare test results show excess steam can adversely affect combustion efficiency

• Agencies & flare experts working to translate new data into monitoring/control requirements

• Rule development will take time

• New information cannot be ignored
Case for Action

• Industry trades informing the regulatory process
  – Safety cannot be compromised
  – Potential $multi-billion cost across industries
  – Large flaring reductions must be considered

• ExxonMobil proactively taking action
  – Accounting for new information in flare operations
  – Supports continuing objective to minimize flare emissions
  – Learnings used to inform the regulatory process
Steam Optimization Basics

• Focus on optimizing steam usage
• Focus on improvements using existing facilities
  – Procedural
    ➢ Education, procedure updates, training
  – Automation
    ➢ Instrumentation, Distributed Control Systems
Steam Optimization Basics

• Program objective is to move as far “to the right” as possible using existing facilities and improved procedures
Steam Optimization Overview

• Goals
  – Evaluate flare steam usage while meeting prevailing regulatory requirements
  – Identify enhancements to flare procedures to minimize steam usage

• Desired Outcomes
  – Establish steam operating envelope that results in a smokeless visible flame
    ➢ Presence of visible flame indicates high CE
  – Develop tools that will help achieve consistent operation within the envelope
Plant Application - Pilot Study

• Organize Implementation Team
  – Emissions control technology leader
  – Environmental engineer
  – Combustion expert
  – Federal air regulatory advisor
  – Plant personnel
    ➢ Operations, applications, SHE
Plant Application - Pilot Study

• Preparations and Data Collection
  – Identified sources and typical/lowest rates of flare flows
  – Characterized relevant flare facilities
  – Compared data against installed equipment
  – Identified & addressed items before testing
    ➢ Calibration of monitoring equipment
    ➢ Maintenance/repair items
Plant Application - Pilot Study

• Preparations and Data Collection
  – Determined minimum required steam rate based on the higher of:
    ➢ Equipment, operational, or configuration requirements
    ➢ Minimum steam flow rate that is “controllable” and “measureable”
  – If possible, created DCS calculated tags based on existing instrumentation
  – Ensured understanding of desired flame appearance and environmental constraints
Plant Application - Pilot Study

Unacceptable

Regulations do not allow visible emissions (smoke) for more than 5 minutes in a 2-hour period.

Flare at “incipient smoke point” - transient wisps of smoke. **Maximum operating window.**

Flare with visible, slightly “marbled” flame.

Flare with visible flame with some regions of transparency.

Flare with small, visible, transparent flame. **Minimum operating window.**

Flare with steam plume and no visible flame. Steam could be quenching the flame.

Unacceptable

Visual Cue Card
Plant Application - Pilot Study

• Evaluation Approach
  – Performed field trials to determine flare operating envelope at typical flare gas rates
  
  ➢ Established operating envelope as “incipient smoke point” to an “intermittently visible flame”
  
  ➢ Adjusted steam rate along this continuum and tested automated steam controls, where available
  
  ➢ Assessed different flare rates and “feeds”
    ▪ Base load, cases with added gas, cases with varying compositions
  
  ➢ Used instrumented parameters where available
  
  – Recorded information along full test continuum
Early Results

• Identified limiting constraints to further optimizing steam rate with existing facilities

• Showed that existing infrastructure provides options for automatic steam control
  – Steam-to-flare gas ratio (SFR) control possible for most flares
  – Combustion Zone Net Heating Value (CZNHV) control possible on some flares
  – Operating window between smoking and “no visible flame” can be very narrow
Early Results

• Establishing operating envelope for steam usage on all continuous flares
  – Goal: control to visible smokeless flame

• Developing & implementing flare-specific operating procedures

• Training operators & setting expectations
Early Learnings

- Every flare system different, requiring unique and customized control strategy
  - When objective clear, plant personnel find most reliable/cost-effective means to achieve it
  - Although “returns” early, some flares may be able to achieve objective with no new cap. investment

- Accuracy/range of existing meters/analyzers for flare gas & steam flow rates are important elements of robust/reliable control scheme
  - Accurate measurement of flare gas rate and steam rate at low rates is challenging
Early Learnings

• **Continuous heating value (BTU) analyzer may be necessary**
  – Depends on variability of flared gas heating value and regulatory requirements
  – Control using BTU analyzer & CZNHV may be necessary for flares with significant variation in flare gas rate

• **Steam valve position can be sufficient to determine SFR or CZNHV operating range for some flares**
Early Learnings

• Operator/site training critical to improvement
  – Operators need to understand risks and consequences of too much or too little steam

• Objective of maintaining visible flame easily understood by everyone in organization

• Communication with community & neighbors about possible changes to flare appearance is part of education process
  – Some agencies engaged in this education
Questions??

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