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2015 Bakken Oil Show

Dickinson ND

April 15-16, 2015

Regulatory Update – Flare Options and Performance

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Zeeco Key Account Manager

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Zeeco Product Lines

Process & Power Burners

Gas & Liquid Flares

Gas & Liquid Incinerators

Flare Gas Recovery Systems

Test Facility and Testing Capabilities

(16) Full Scale Test Furnaces and Boiler

Flare R&D and Testing Facility

Flare System Applications

- Well site for NSPS Quad O compliance
- Central Wellpad Gathering Facility for safely flaring of vents, Air Assist Flares
- Gas Processing plants for safely flaring of relief vents, Multipoint Flares
- Flare monitoring advancements
- Causes for low destruction removal efficiency (DRE)

Well Site flare applications

- On November 21, 2013, the US EPA amended the final ruling for the first federal air standards for oil and natural gas production
- New Source Performance Standards (NSPS, 40 CFR Part 60, Subpart OOOO) for crude oil and natural gas production, transmission and distribution. Ruling applies to new and modified affected facilities that commenced construction after August 23, 2011 “Quad O”
- National Emission Standards and Hazardous Air Pollutants (NESHAP, 40 CFR Part 63 subpart HH & HHH) directly impacts the oil and gas production and natural gas transmission and storage facilities. Revised rule, applies to existing and new affected facilities
- www.epa.gov/airquality/oilandgas

Standards for Storage Tanks

- Includes storage tanks located at well site, gathering & boosting stations, NG processing facilities and compressor stations

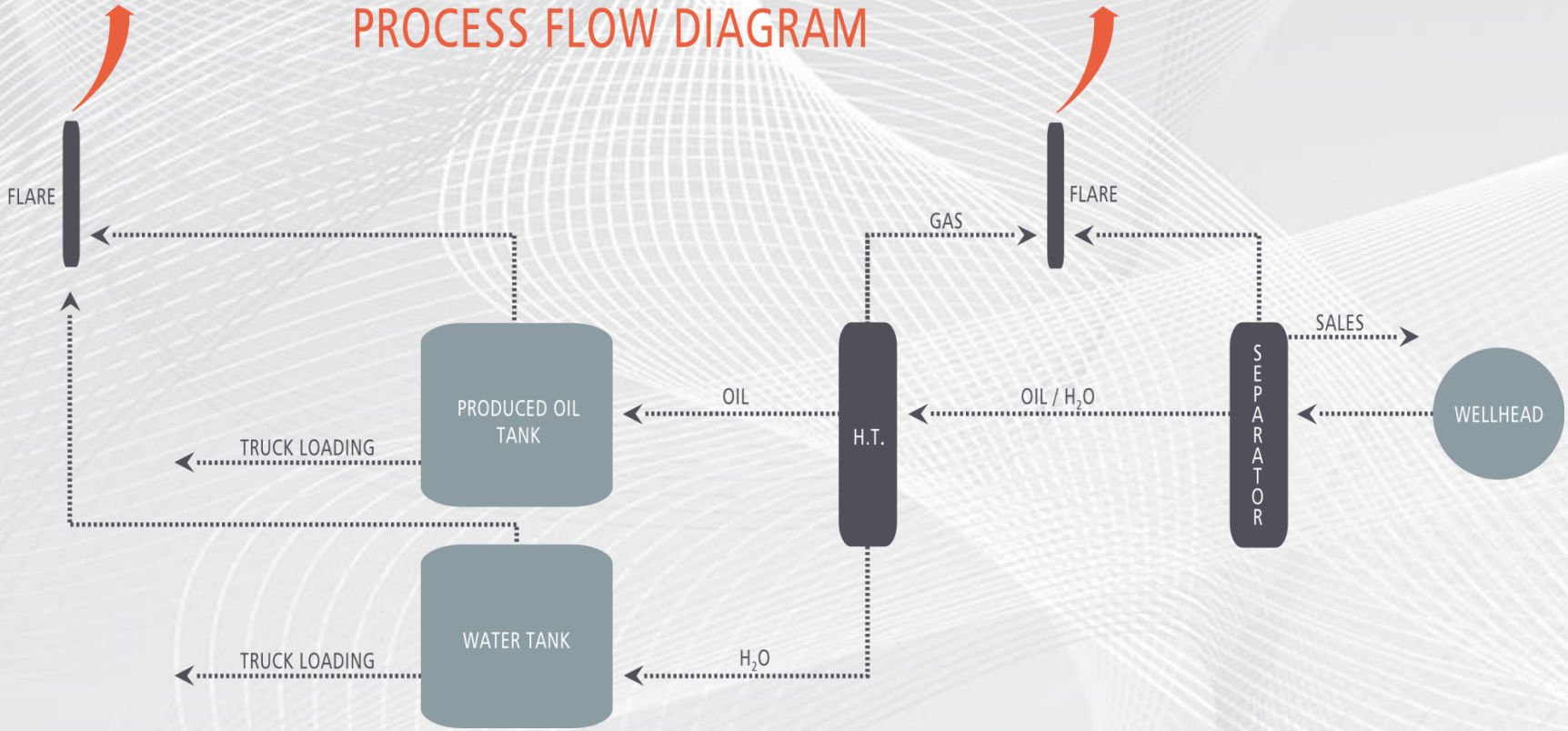
- Targets sites with VOC emissions level of six tons per year or more (opt out if less than 4 tpy)

- Have until April 15, 2014 (Group 2) or April 15, 2015 (Group 1), to install necessary controls

- NSPS requires 95% VOC reduction, no visible emissions (EPA Method 22)

- Properly designed, engineered flare will achieve 98% VOC reduction

Well site Flare Options



Well site flare options – Open flame

- Engineered flare system design
- High pressure vents off separator
- Low pressure vents off the tanks
- Combination flare for both streams
- Multiple Flares for scalability

Well site flare options – Enclosed flame

- High pressure vents off separator
- Low pressure vents off the tanks
- Combination flare for both streams
- Properly designed, engineered enclosed flare will provide for greater than 98% VOC reduction

Recent Flare Monitoring Advancements

- Infrared camera technology
  - Can pinpoint emission sources

Pilot Flame Issues

Inspection in Permian Basin

- 46% of sites with pilot flame loss
  - 101 Combustors
  - 119 Flares

Possible Causes

- Poorly Designed Pilots
  - Does it Meet API 537?
- Insufficient Pilot Gas
- Liquids in Pilot/Flare Gas

Existing Solutions

- Monitoring Equipment
  - IR Camera
  - Thermocouple
  - Flame Ionization
- Datalogging
- Liquid Knock-Out/Scrubber
- Redundant Systems

Pilot Stability Testing

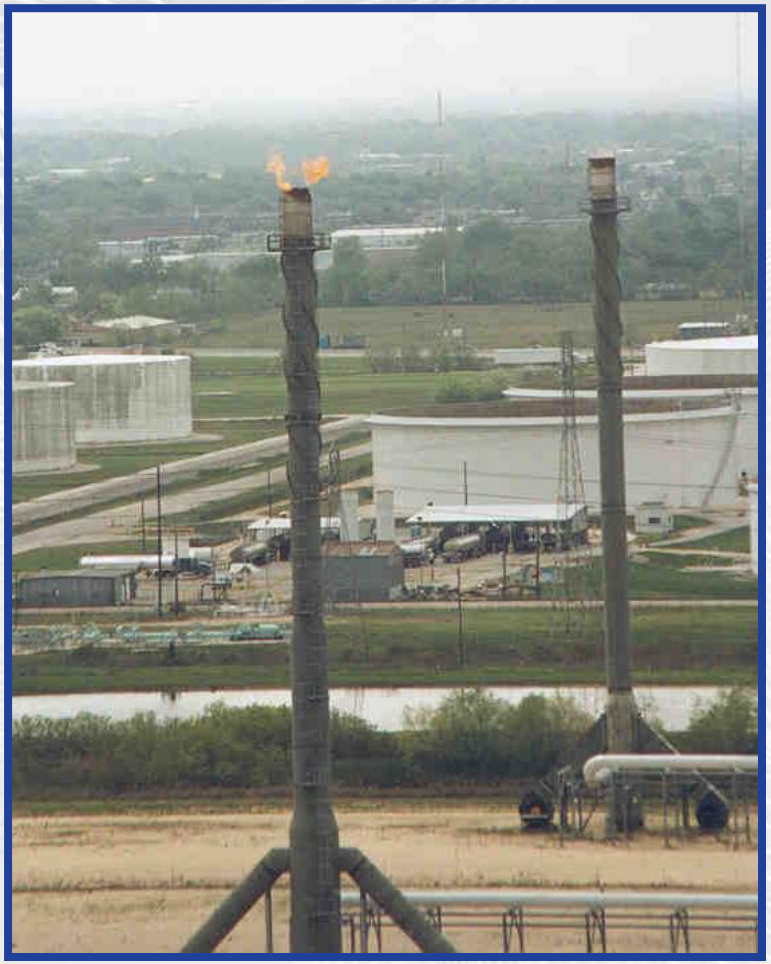
- Pilot should be designed per API 537 and tested to industry standards to ensure flare will meet environmental performance requirements
- Stable flame in minimum wind speeds of 150 mph with 10 inches of rain/hour
- Ability to reignite automatically without operator interface or electric power
- Ability to monitor for the presence of a flame and record for environmental records verification
- Continuous Burning Pilot Flame required by NSPS during “ALL” times of operation.

Air Assisted Flare Tip Types

Air Injection Nozzles

Air Plenum

Air Assisted Flares



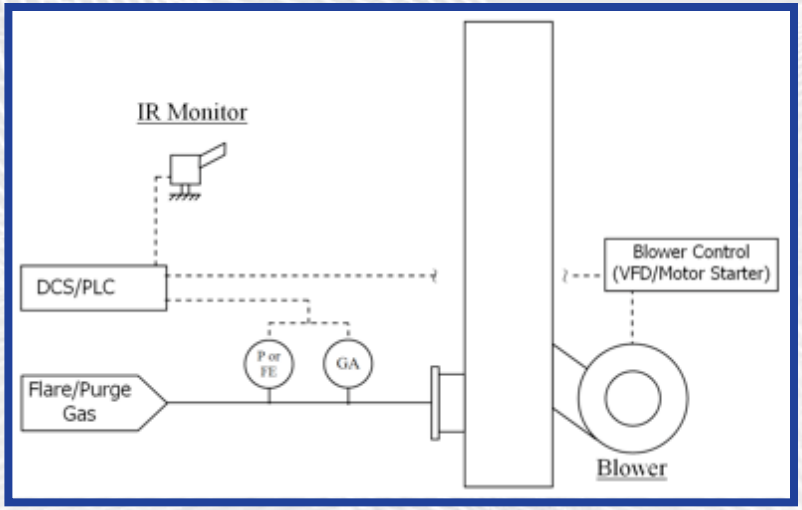
Current Flare Emissions Regulations

- 40 CFR 60.11 to 60.18
- US EPA AP 42 Chapter 13.5
- Chemical Manufacturers Association testing
  - At least 98% combustion efficiency when properly operated

TCEQ Flare VOC

Air Assist Control Methods

- Single speed fan
- Two speed fan
- Multiple fans
- Variable frequency drive (VFD)
- Variable inlet vane dampers
- Combinations of the above



Central Processing Plant Facilities

- Forthcoming EPA regulations will likely require additional controls if assist media is being utilized for smokeless operation, typically steam or low pressure air blowers, to reduce excessive VOC emissions (CZNHV)

- http://www.tceq.texas.gov/airquality/stationary-rules/stakeholder/flare_stakeholder.html

- Affected facility operators need to remain aware of both the newly published and likely forthcoming regulations and consider a potential engineered flare system design that would meet requirements for new facilities

Multipoint Ground Flare History

- Developed Early 1970's
- Zeeco founder was one of the original inventors and listed on Original Patent
- Original Installation In 1972
- Many Improvements over past 43 years in Burner technology
- Basic Overall Concept Today is Same as Original

Burner Development in Past Years

Common MPGF Design Concept

- Many small burners – each able to pull in air
- Staging system to Ensure Operation in Optimum Pressure Band – leading to smokeless operation
- Burners in Service are Proportional to Gas Flow
- Typically Used for High Pressure, Heavy Hydrocarbon Service
- Allows for Controlled Flame Length from Burners

Typical Installations

Sonic Flare Testing at Zeeco for DRE

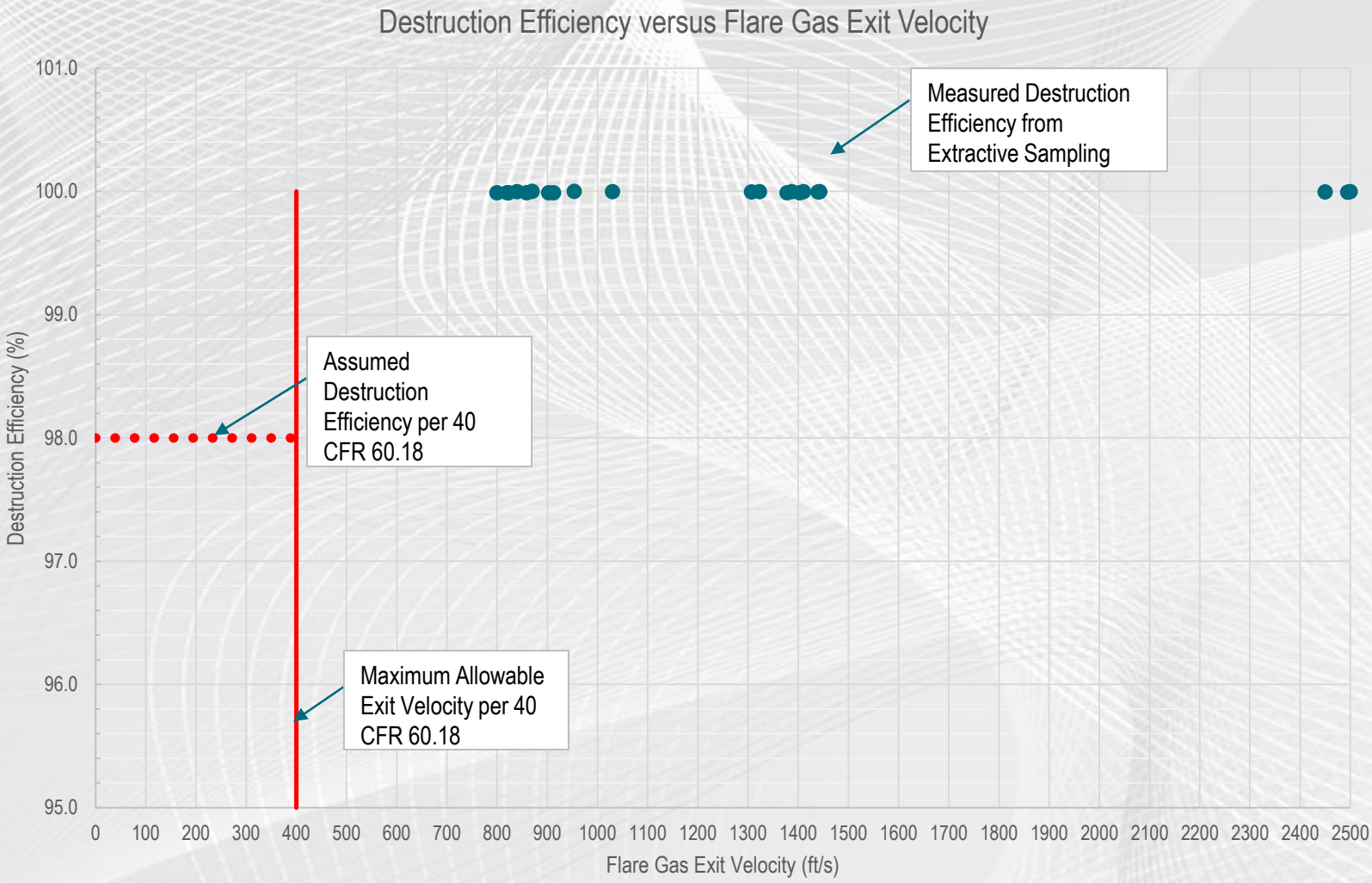
- Natural Gas
- Propylene
- Propane
- Inert / H2 Mixtures
- Consistently over 99.5% DE
- Summer 2013, Fall 2013, Fall 2014, Spring 2015

Multipoint Sonic Flare Testing at Zeeco

Details for Recent Sonic Testing

Flare Gas Fuel Type	Flare Gas Lower Heating Value (Btu/SCF)	Max Allowable Exit Velocity per 40 CFR 60.18 Regulation (ft/s)	Flare Gas Exit Velocity in Zeeco Test Facility (ft/s)	Destruction Efficiency % from Extractive Sampling of Zeeco Flares	Combustion Efficiency % from Extractive Sampling	Combustion Efficiency % from IMACC PFTIR Measurement	Operating Pressure (psig)
Propane	2316	400	800	99.99	99.99	99.6	16
54mol% Propane/46mol% N2	1251	400	903	99.99	99.99	99.9	10.3
Propylene	2183	400	823	99.99	99.96	99.6	16.9
Tulsa Natural Gas	937	400	1378	99.99	99.99	99.5	15
Propane	2316	400	820	99.99	99.99		15.1
55mol% Propane/ 45mol% N2	1274	400	913	99.99	99.99		10.2
Propylene	2183	400	859	99.99	99.99		15.4
Tulsa Natural Gas	937	400	1403	99.99	99.98		15.3
TNG	937		1443	99.997	99.9955		20
TNG	937		1440	99.9949	99.9943		20
87TNG/13N2	800		1411	99.9988	99.9976		20
65TNG/35N2	600		1323	99.9983	99.9971		20
76TNG/24N2	700		1387	99.9972	99.9887		20
54TNG/46N2	500		1307	99.9964	99.9882		20
30TNG/70H2	465		2500	99.9985	99.9964		20
30TNG/70H2	465		2450	99.9951	99.9923		20
30TNG/70H2	465		2495	99.9941	99.9925		20
Propane	2316		840	99.9977	99.9947		20
Propylene	2183		870	99.9991	99.9968		20
63Propylene/37N2	1375		954	99.9992	99.9971		20
37Propylene/63N2	808		1030	99.9979	99.9957		20

Destruction Efficiency, Sonic Velocity



Conclusions - Flare System Applications

- NSPS Quad O compliance flares with 98%+ DRE
- Central Wellpad Gathering Facility for safely flaring of vents, Air Assist Flares with 98%+ DRE
- Gas Processing plants for safely flaring of relief vents, Multipoint Flares with 99.5%+DRE
- Causes for low destruction removal efficiency (DRE)
  1. Pilots per API 537 design and tested
  2. Engineered Flare Systems, right MOC…
  3. Technical Resources and Field support

Thank you !

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