Performance Review of Remote and Direct Flare Combustion Efficiency Monitor

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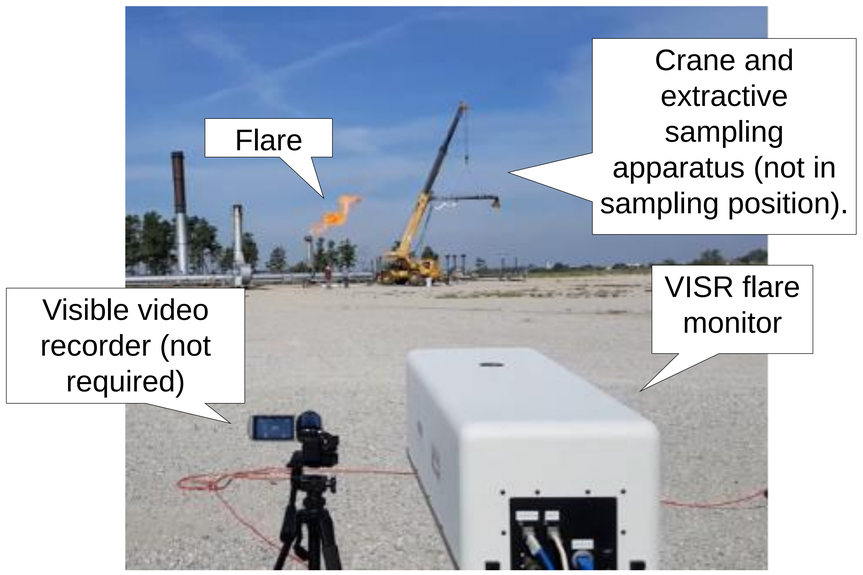
Introduction

A remote, direct, autonomous, and continuous flare monitor based on Video Imaging Spectral Radiometry (VISR) methodology has been developed, validated and is now commercially available. The VISR flare monitor is designed to be used in lieu of the GC or Calorimeter based indirect flare monitoring method specified in the new Refinery Sector Rule (40 CFR 63.670), which will become effective on January 30, 2019. The VISR flare monitor can also be used in lieu of Passive FTIR for short term flare studies.

The VISR flare monitor has been subjected to vigorous testing using extractive measurements to validate the technology. The results of these tests are summarized in this presentation. The VISR flare monitor has demonstrated superior performance to both indirect methods for continuous flare monitoring and to Passive FTIR for short term flare studies. These benefits are highlighted in this presentation.

Validation Test Setup



72 Validation Tests
44 of them were blind tests

Accuracy: within 1% !!!

Flare Regulations		
	For Refineries 40 CFR 63.670 (Continuous Monitoring)	**Other Facilities 40 CFR 60.18**
Presence of pilot flame	Para. (b) and (g) Thermocouples	Para. (c)(2) and (f)(2) Thermocouples
No visible emissions	Para. (c) and (h) EPA Method 22, daily	Para. (c)(1) and (f)(1) EPA Method 22
High combustion efficiency	Para. (d)-(f) and (i)-(n) Indirect method using online GC or calorimeters and 9+ instruments	Para. (c)(3)-(6) and (f)(3)-(6) Stack testing

Process Conditions Tested

- ✓ Type of flare: steam flare, air flare, and sonic flare/ground flare
- ✓ Vent gas flow rate: 10 lb/hr to 10,000 lb/hr
- ✓ Steam or air flow rates: various to achieve desired combustion zone net heating value (NHVcz)
- ✓ Combustion Zone Net Heating Value:
  - ✓ For steam flare: 120 to 1,250 Btu/scf. (270 Btu/scf. in the new RSR)
  - ✓ For air flare: Dilution Net Heating Value (NHVdil) from 6.7 to 244 Btu/ft^2 (22 Btu/ft^2 in the new RSR).
- ✓ Fuel composition: Methane, propane, propylene, and natural gas, pure or blended with nitrogen or hydrogen (up to 75% H_2 by vol.).

Environmental Conditions Tested

- ✓ Any distance is acceptable as long as there is a recognizable flame in the image (distances from 150 - 700 feet have been tested; this range should not be construed as a limit)
- ✓ Wind direction (crosswind, wind oriented towards VISR imager, and wind oriented away from VISR imager)
- ✓ Wind speed
- ✓ Time of day (daytime, nighttime)
- ✓ Sky (blue sky, overcast, moving clouds)
- ✓ Sun in the field of view
- ✓ Rain (light/moderate rain has been tested, no data under heavy rain conditions)
- ✓ Fog (dense fog can introduce a small bias, ~1-2% in CE)

VISR Is the Best Method for Continuous Flare Compliance Monitoring

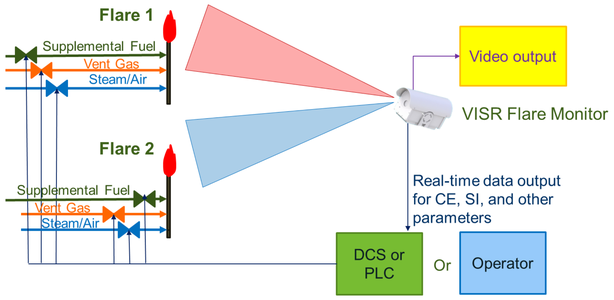
1 = 10+

- ❑ No online GC or calorimeter
- ❑ No flow meter, pressure transducer, or temperature transducer for each stream (typically 3 streams, 3 sets of instruments)
- ❑ No process shutdown for installation
- ❑ Non-contact and autonomous operation – nearly maintenance free
- ❑ CE is directly monitored – no assumption, no misrepresentation
- ❑ The only practical method to achieve “Incipient Smoke Point” (ISP) operation
- ❑ Data cycle of 1 sec. – no latency as in the case of GC or calorimeter
  - Deviation avoidance
  - Saving on supplemental fuel
- ❑ Closed-loop flare control
- ❑ Compliance deviation is minimized
- ❑ Comparing to the indirect method, the VISR method has substantially lower capital cost and negligible O&M costs. Cost savings will be more dramatic when one VISR monitor is used to monitor two flares

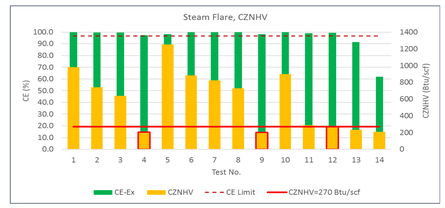
VISR flare monitor can replace daily manual EPA Method 22 visible emission determination and associated recordkeeping

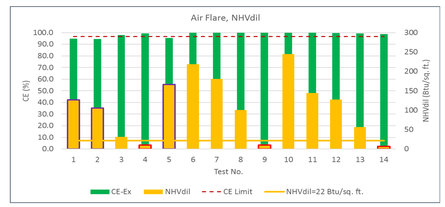
VISR flare monitor can monitor the presence of pilot flame, eliminating the hassle and cost associated with replacing thermocouples near the flare tip.

One VISR unit monitors two flares



NHVcz is not reliable





VISR Is the Best Method for Short Term Flare Testing

- ❑ Testing flare performance 100-1,000 feet away from flare.
- ❑ No facility support is needed.
- ❑ No site preparation. Testing can start within 10 minutes upon arrival of the site. Results can be viewed instantly.
- ❑ Testing can be conducted from outside the fenceline.
- ❑ Frame-by-frame images can be provided for special engineering study, flare optimization, or troubleshooting.

Comparison with Other Flare Measurement Techniques