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Enforcement Alert

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EPA Enforcement Targets Flaring Efficiency Violations

Purpose

EPA is devoting significant enforcement resources to correcting regulatory noncompliance at flares. This Alert is intended to inform flare owners and operators of this enforcement initiative and to educate them on proper flare operation. EPA hopes this Alert will spur improvement of flare operating practices, including better control and monitoring of supplemental gas, air, and steam, and thereby reduce harmful emissions to the environment. Better flare operation practices will have the potential to improve public health by: 1) reducing emissions of toxic air pollutants that may pose a health risk; and 2) reducing volatile organic compound emissions which will in turn reduce the formation of ozone which is potentially harmful to vulnerable populations including the young, elderly, and those with respiratory problems. Moreover, improving flare combustion efficiency can result in cost savings due to reduced steam usage.

Introduction

Chemical and petroleum facilities generate waste gases that need to be controlled safely, economically, and in a manner that protects the public health and the environment. The law requires facilities to use good air pollution control practices to minimize the emission of waste gases, see EPA's October 2009 Enforcement Alert, http://www.epa.gov/compliance/resources/newsletters/civil/enfalert/flaring.pdf.

Because, not all waste gases can be prevented or recovered, various control technologies are used to reduce the impact of these waste streams on the environment; one common technology is flaring. A flare is a mechanical device used to combust and thereby destroy volatile organic compounds, toxic compounds, and other pollutants at refineries and other industrial sites.

EPA investigations have found flares that were operated so poorly that there was likely no combustion taking place at all. In these circumstances the flare was merely venting pollution directly to the atmosphere.

Federal requirements for flares are found in the New Source Performance Standards (NSPS) in § 60.18 and National Emission Standards for Hazardous Air Pollutants (NESHAP) in § 63.11. At a minimum, these rules require flares to be:

- Designed and operated with no visible emissions using EPA Method 22 (except for periods not to exceed 5 minutes in 2 hours);
- Operated with a flame present at all times, confirmed by the use of a thermocouple or equivalent device;
- Used only when the net heating value of the gas to be combusted is 300 BTU per standard cubic foot (BTU/scf) or greater (if the flare is steam- or air-assisted), or 200 BTU/scf or greater (if the flare is nonassisted); and
- Designed for and operated with an exit velocity less than 60 feet per second (ft/sec). An exit velocity of greater than 60 ft/sec but less than 400 ft/sec may be used if the net heating value of the gas being combusted is sufficiently high.

Through its inspection and enforcement programs, EPA has identified many instances where flares have been improperly monitored and operated. The consequences are lower combustion efficiency and potentially significant quantities of excess emissions of volatile organic chemicals, sometimes including hazardous air pollutants.

Flare Design Characteristics

Flares are specifically designed to combust gases. Many flares employ steam or air to promote mixing of oxygen within the Vent Gas to ensure combustion occurs without smoke.

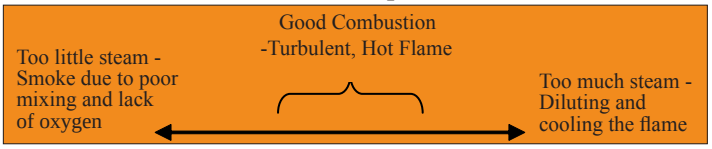
Smoke is an indication that hydrocarbons are not being combusted completely.

There are many parameters that affect the combustion efficiency of a flare. One important parameter is the heating value of the gases that are to be combusted, often measured in BTU/scf. The heating value is a measure of the combustibility of the gas. Generally, it is easier to maintain a stable flame and achieve high efficiency for gas streams with higher heating

values. The NSPS and NESHAP requirements regulate the net heating value and require gases contain at least 300 BTU/scf if they are being combusted in an air or steam assisted flare. If this heating value minimum cannot be met by the Vent Gases alone, then supplemental gas, such as natural gas, must be added.

Federal regulations prohibit extended periods of smoking at flares. Adding the proper amount of steam or air to avoid smoke is beneficial, but adding excessive amounts is detrimental. Excess steam or air mixed with the Vent Gas cools the flame and dilutes the Vent Gas thereby lowering the heating value. Steam addition is usually measured as the ratio of pounds of steam per pounds of Vent Gas (lb/lb). There is no single steam-to-Vent Gas ratio that is appropriate for all flares. The types of compounds being combusted, and to some extent the flare design, determine the proper ratio. There are, however, general guidelines that suggest approriate ratios, with the most important being the manufacturers' recommendations, which tend to be between 0.1 and 1lb steam per lb of Vent Gas.

Vent Gas is the mixture of gases that are to be combusted, usually found just inside the flare. The Vent Gas consists of combustible process gases, supplemental gas, inert compounds, purge/sweep gases, and other material.



In addition to the numeric standards governing flares (*e.g.*, net heating value, exit velocity), there are NSPS and NESHAP general provisions that require process and pollution control equipment be operated using good air pollution control practices to minimize emissions, and in accordance with the equipment's design. Since it would be impossible for EPA to list all "common practice" actions for equipment owners (*e.g.*, keep equipment from freezing, keep electrical equipment dry), these two narrative standards minimally require a flare operator to follow the equipment manufacturers' specifications, and to stay abreast of and apply the current state of scientific knowledge on flare operation and combustion to minimize emissions.

Federal requirements for equipment operators' general duty are found in the NSPS and NESHAP.

- "At all times, including periods of startup, shutdown, and malfunction …the operator shall operate and maintain any affected source, including associated air pollution control equipment in a manner consistent with safety and good air pollution control practices for minimizing emissions." *See, e.g.*, 40 CFR § 63.6(e), 40 CFR § 60.11(d).
- "Operators of control devices that are used to comply with the provisions of this subpart shall monitor these control devices to ensure that they are operated and maintained in conformance with their design. *See, e.g.*, 40 CFR § 63.172(e), 40 CFR § 60.482-10.

A number of studies have been conducted to assess flare efficiencies and to identify the factors that affect flare performance. One simple and critical parameter already mentioned is the steam-to-Vent Gas ratio. Another parameter with an even better correlation to combustion efficiency for steam assisted flares is the heating value of the combustion zone gas. EPA's recent settlements define combustion zone gas as all Vent Gas, pilot gas, and all steam just outside the flare tip, where combustion is supposed to take place. This parameter is not to be confused with the net heating value of Vent Gas found in current regulations which does not include steam or pilot gas and is measured just inside the flare. In the enforcement context, EPA may analyze the heating value of the combustion zone gas to estimate a flare's combustion efficiency. A finding of low combustion efficiency is indicative of a potential failure to comply with the general duty provisions discussed above.

Recent Flare Testing and the Net Heating Value of the Combustion Zone Gas.

- The net heating value in the combustion zone (NHVcz) gas correlates well with combustion efficiency for steam assisted flares. It is a better indicator of efficiency than the heating value of the Vent Gas alone.
- NHVcz is currently not a regulatory requirement, and is different from the current Vent Gas heating value minimum standards of 200 and 300 BTU/scf.
- NHVcz is calculated using the Vent Gas heating value, the flow rates of Vent Gas, steam and the pilot gas (as per recent settlements).
- NHVcz is closely related to another parameter, the Lower Flammability Limit of the Combustion Zone.
- Recent testing provides insight into NHVcz and its relationship to efficiency:
  - o "TCEQ 2010 Flare Study", Texas Commission on Environmental Quality, August 1, 2011. http://www.tceq.texas.gov/assets/public/implementation/air/rules/Flare/2010flarestudy/2010-flare-study-final-report.pdf
  - o "Performance Test of a Steam-Assisted Elevated Flare with Passive FTIR" for Texas City and Detroit, Marathon Petroleum Corporation, September 2009 and July 2010. http://www.epa.gov/compliance/resources/publications/civil/programs/caa/texascity-report.pdf http://www.epa.gov/compliance/resources/publications/civil/programs/caa/detroit-report.pdf
  - o "PFTIR Tests of Steam-Assisted Elevated Flares - Port Arthur", Flint Hills Resources Port Arthur, LLC, June 2011. http://www.epa.gov/compliance/resources/publications/civil/programs/caa/portarthur-report.pdf

Factors Affecting Flare Performance:

1. Flame Quenching in the Combustion Zone

Mixing is important because the Vent Gas and oxygen must be well mixed to complete combustion. Studies indicate that the assist-to-gas (steam-to-Vent Gas or air -to-Vent Gas) ratios are critical to combustion efficiency. Generally speaking, steam-to-Vent Gas ratios ranging between approximately 0.2 and 1.0 will result in the highest efficiency. Supplying a mass of air less than approximately 7 times the stoichiometric mass of air will result in the highest efficiencies.

Problems occur when flame quenching takes place, sometimes termed "oversteaming" or "overaeration," which occurs at high assist-to-gas ratios. The problems occur because:
- Facilities mistakenly believe that excess steam or air will allow good combustion.
- Facilities fail to reduce steam or air when Vent Gas flow transitions from high to low.
- Facilities have minimum steam addition rates to protect the flare tip from overheating. During low waste gas flow, the resulting steam-to-Vent Gas ratio can be very high, causing oversteaming.
- The steam control equipment associated with a steam-assisted flare lacks adequate flow adjustment precision, which results in excess steam flow at low waste gas flow.
- The air blower associated with an air-assisted flare lacks adequate flow adjustment, which results in excess air at low waste gas flow.

These problems lead to significantly lower flare combustion efficiencies.

To correct these potential problems, facilities can use one or a combination of techniques, including:
- Continuously measure the flow rate of the waste gas and continuously measure, and then control, the steam or air being added as assist gas. Follow the manufacturer's recommendations and publicly available documents in setting proper assist gas rates.
- Utilize automatic damper actuators or variable frequency drives on the air supply system.
- Reduce the "minimum" or "cooling" steam rates as low as possible while still being protective of the physical integrity of the flare.

Factors Affecting Flare Performance:

2. Low Heat Value in Vent Gas

Vent Gas Heating Value is important because sufficient combustible material must be present to maintain flame stability and achieve high efficiency.

Problems occur because facilities use flares to control waste gases that have low heating value without adding supplemental fuel to raise the Vent Gas heating value to the regulatory minimum of 200 BTU/scf or 300 BTU/scf. *See, e.g.*, 40 CFR 60.18(c)(3)(ii). This issue is not to be confused with NHVcz and flame quenching discussed above. Low heating value in Vent Gas occurs because:
- Facilities use flares to control a variety of streams with varying quality. When only one or a few low-flow sources are venting to the flare, the volumetric flow and combustible material concentrations can be minimal.
- Batch processes are inherently variable and will have periods of very low flow or high inert (*e.g.*, nitrogen) concentrations. Inert gas lowers the heating value of the gas mixture.
- Supplemental fuel requirements can be costly; facilities may choose not to incur that cost and will combust the low heating value stream alone.
- Facilities conduct compliance tests under themaximum conditions where problems with low heating values are unlikely. In practice, flares are not always operated at these "ideal" rates.

These problems lead to lower flare combustion efficiencies.

To correct these potential problems, facilities can:
- Ensure that the Vent Gas meets the current regulatory heating value limits of 300 BTU/scf for assisted flares, and 200 BTU/scf for unassisted flares, at all times. This will require evaluating the heating value of Vent Gas over the full range of operating scenarios.
- Determine the heating value of the Vent Gas as a whole, not only the hydrocarbons in the Vent Gas, just before it leaves the flare tip. The heating value evaluation includes nitrogen and any other compounds that make up the gas mixture that is present just inside the flare tip.
- Monitor the Vent Gas flow and automatically supply supplemental fuel if the Vent Gas does not have sufficient heating value.
- Evaluate other control options and limit flare use to true emergency situations.

Well Operating Flare – High Combustion Efficiency

Marathon, BP North America, and Ongoing Enforcement

Two recent judicial settlements, one with the Marathon Petroleum Company and another with BP North America, include injunctive relief designed to address potential oversteaming issues and limit the level of future flaring. See, http://www.epa.gov/compliance/resources/cases/civil/caa/marathonrefining.html and http://www.epa.gov/compliance/resources/cases/civil/caa/bp-whiting.html. These settlements highlight, in addition to liability related to the general duty provisions discussed above, potential New Source Review (NSR) liability at flares. This liability stems from periods of low combustion efficiency that result in higher pollutant emissions. A source's failure to recognize and account for these emissions can result in NSR violations. In addition, oil refiners face possible NSPS Subpart J/Ja liability because of the potential of burning non-compliant gas in flares.

Flare compliance is an ongoing priority for EPA generally and under the Air Toxics National Enforcement Initiative specifically. http://www.epa.gov/compliance/data/planning/initiatives/initiatives.html#airtoxic. EPA encourages any company that believes it may have operated flares in a manner that resulted in poor combustion efficiency to expeditiously disclose and correct violations.

If Vent Gas is being sent to a flare but there is no visible flame, or if only a steam plume is visible, the flare may be operating at low combustion efficiency. It is better for the environment for a flare to produce a large orange/yellow flame than no flame at all when Vent Gas is present.

Penalties for Violations

Violating federal requirements for flares can result in a penalty, under the Clean Air Act, of up to $37,500 per violation, per day. To knowingly violate a flare requirement, including knowingly making a false or fraudulent statement or omiting material information required concerning a flare and its operation, can subject a person to criminal prosecution. Convictions can result in fines, imprisonment, or both.

Conclusion

EPA Enforcement is investigating and seeking resolution of low heating value and excess steam or air addition at industrial flares. When flaring is unavoidable, Vent Gas must be monitored and its heating value adjusted as necessary in order to meet the current regulatory standards for the heating value of Vent Gas. Moreover, monitoring the Vent Gas and steam or air flow and applying steam or air and supplemental gas in an amount that results in high combustion efficiency helps assure compliance with the general duty requirements. Finally, flare owners are expected to operate in accordance with the manufacturer's recommendations and publicly available documents, including the long-available literature from EPA, and generally available documents regarding the current state of scientific knowledge on flare operation and combustion.

Poorly Operating/Over Steamed Flare - Low Combustion Efficiency