METHANE GUIDING PRINCIPLES

REDUCING METHANE EMISSIONS

Best Practice Guide: Venting

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Disclaimer

Summary

Venting is the process of releasing gas into the atmosphere. This guide intends to help you identify the major sources of venting and reduce methane emissions from them.

The general strategies for reducing emissions are as follows.

Best practice for reducing methane emissions from venting

Keep an inventory of emissions from venting

Avoid or reduce venting from the following

- Hydrocarbon liquid storage tanks
- Compressor seals and starter motors
- Glycol dehydrators
- Removing liquids from gas wells
- Well-completion operations
- Oil well casinghead venting

If methane needs to be released, use vapor recovery or flaring rather than venting if possible

For gases that cannot be sold as natural gas or natural-gas liquid, find alternative uses on-site (such as generating electricity)

Consider reinjecting waste gas

Monitor vents and evaluate for further improvements and controls

Introduction

Venting simply means releasing gas into the atmosphere. Methane can be vented intentionally from processes or activities that are designed to vent gas, or unintentionally when equipment malfunctions or operations are not normal.

This guide focuses on a few common venting sources and strategies for reducing emissions. It does not deal with all venting sources. In this guide, venting refers to natural gas vented from key equipment, such as wellheads, storage tanks, compressors and dehydrators. Note that many programs consider emissions from compressor seals as fugitives, however this document treats them as direct vents. It also deals with gas from the following activities:

- well completions, and
- removing liquids from gas wells

Venting occurs across all parts of the natural gas supply chain and from a variety of activities. This guide focuses on equipment and activities that are known to be major sources of emissions. Table 1 below sets out which types of equipment are major sources of emissions from venting. Table 2 sets out the activities that are major sources of emissions from venting.

Table 1: Equipment known to be major sources of emissions from venting

Equipment	Where emissions come from	When emissions occur	Condition when emissions occur	Area of operations
Storage tanks for produced liquids, such as condensate, crude oil, or water	Flash gas at tanks with no vapor-recovery units (uncontrolled tanks)	Tanks can have emissions related to the flashing of light gases that result from receiving pressurized liquids from other vessels. Most often tanks are near atmospheric pressure, but upstream vessels can be at a much higher pressure.	Normal operation	Most 'produced liquids' storage tanks exist in production, but some also exist in processing and in transmission and storage.
	Tank loading and unloading, and tank gauging	Gas is released when a tank is opened at the hatch or when there is loading into the truck or rail tanker.	Routine activity	
	Vapor blowthrough to a tank	Gas is released from the tank as a result of a gas stream unintentionally sent from an upstream vessel.	Faulty or inadequate upstream equipment, especially at separators	

Equipment	Where emissions come from	When emissions occur	Condition when emissions occur	Area of operations
Compressors[1]	Packing around rods on reciprocating compressors	Normal losses occur at the mechanical seal of the packing around the rod.	Normal operation	Compressors are used in production, gathering and boosting, processing, and transmission and storage, and also the export of liquid natural gas.
	Wet seals on centrifugal compressors	Normal losses occur at the mechanical seal of the rings around the rotating compressor shaft.	Normal operation	
	Starter motors (gas powered)	Periodic emissions are released from the starter motor when an idle compressor is started.	Normal operation	
Glycol dehydrators	Regenerator vent stack not routed to flare	Water absorbed by the circulating glycol exits through the regenerator reboiler's vent stack to the atmosphere. Absorbed methane is also released. If a gas assist lean glycol pump is used, this can add to emissions.	Normal operation	Dehydrators are used in production, gathering and boosting, and storage.
Wellheads	Casinghead vent gas	Some oil wells that do not produce gas to sales will vent gas accumulated inside the annular space in the casing to the atmosphere.	Normal operation	Production of oil

Table 2: Activities known to be major sources of emissions from venting

Activity	What causes emissions	When emissions occur	Condition when emissions occur	Area of operations
Well completions	Clearing unwanted liquids, solids and gas from the well after drilling and fracturing, or some well workover	After drilling, a new well is brought into production by clearing the well of drill cuttings, sand and fracturing fluid. This process, and the process of testing the well afterwards, can result in venting or flaring of gas.	Normal process	Production only
Removing liquids from gas wells (also called "liquids unloading")	Removing accumulated liquids from low-pressure gas wells	Gas is often released to the atmosphere when a well is allowed to flow directly to a lower-pressure source, such as an atmospheric tank, to clear the well.	Well is offline and gas flows to the atmosphere. This only occurs for certain types of liquids unloading procedures.	Production only
Pipeline network maintenance	Opening the pipeline	Prior to maintenance, during pipeline readiness or pigging operations	Part of pipeline preparation and pigging process	Maintenance
Production of oil, where there is no associated gas recovery infrastructure	Venting/flaring of associated gas	When associated gas is vented or flared	Normal process	Production

Methane emissions from venting sources make up 16% of the total methane emissions from the US petroleum and natural gas systems.[1,2]

Some sources of venting are covered in other best-practice guides, such as venting during equipment maintenance blowdowns, which is covered in the guide on operational repairs, venting from pneumatic devices, which is covered in a separate guide on pneumatics, and venting from unlit flares, which is covered in the flaring guide.

There is a general trend in existing and upcoming regulations to prohibit unnecessary or excessive venting (and flaring). Recent examples include Council of European Union (EU) and in North America (States of Colorado and New Mexico).

Quantifying emissions

Quantification methods for methane emissions deliver a rate, such as mass per time (e.g. kilograms per hour) or volume per time (e.g. standard cubic meters per hour), and can be produced by engineering estimations, by direct measurement of the methane sources, or by use of models. Vented emissions are quantified based on the following methods:

- **Default emission factors** – emissions are quantified by multiplying the number of pieces of equipment (or venting activities) by the average emission rate per piece of equipment or per process.
- **Engineering calculations** – equations to calculate emissions may use a variety of information gathered locally to quantify the rate from certain processes or activities. In some cases, this may involve running a computer program (for example, tank flash emissions and glycol dehydrator regenerator emissions). In those cases, a simulation program may be used to predict emissions based on first principles and equations of state.
- **Direct measurement of emissions** – this may be done using information from routine monitoring or, in some cases, continuous monitoring.

There are several accepted and recommended methods of direct measurement of venting in 'Best Practice Guidance for Methane Management in the Oil and Gas Sector' (United Nations Economic Commission for Europe).3 Those methods include using:

- a calibrated vent bag;
- a high-volume sampler;
- flow meters; or
- anemometers.

Direct measurement requires a repeatable approach with written procedures, and different measurement approaches carry their own unique uncertainties. In some cases, getting an accurate direct measurement can be difficult, and engineering approaches may be preferred.

Mitigation strategies

Strategies for reducing emissions from venting involve the following.

- Reducing or eliminating emissions from sources through effective operations, design and actions.
- Directing the emissions to a control device to prevent direct emission of methane to the atmosphere.
- If methane needs to be released, use vapor recovery or flaring rather than venting if possible.
- For gases that cannot be sold as natural gas consider reinjecting in depleted wells or finding alternative uses on-site.
- Where venting cannot be avoided, vents should be tracked and/or monitored and evaluated for further improvements or controls.

Methane is a valuable product that can be sold, so equipment and activities have been designed to minimize venting. The need for some venting can be reduced by making changes to operations, recovering gas to be reused, or flaring (burning) the gas. Some venting will be necessary for safety, technical or cost-efficiency reasons. When venting is necessary, it should be monitored and assessed to make sure it is minimized whenever possible.

The emission sources covered in this guide have been studied for decades. There are several guides on reducing these methane emissions. The guides and programs specific to natural gas systems include the following.

- The Oil & Gas Methane Partnership 2.0 (OGMP 2.0) technical guidance documents[4] covers various quantification methodologies and emission sources including purging and venting, starts and stops and other venting events related to normal processes and maintenance events.
- Climate and Clean Air Coalition's (CCAC) Oil and Gas Methane Partnership technical guidance documents:[5-11]
    - Number 3: 'Centrifugal Compressors with Wet (Oil) Seals', 2017
    - Number 4: 'Reciprocating Compressors Rod Seal/ Packing Vents', 2017
    - Number 5: 'Glycol Dehydrators', 2017
    - Number 6: 'Unstabilized Hydrocarbon Liquid Storage Tanks', 2017
    - Number 7: 'Well Venting For Liquids Unloading', 2017
    - Number 8: 'Well Venting/Flaring During Well Completion for Hydraulically Fractured Gas', 2017
    - Number 9: 'Casinghead Gas Venting', 2017
- Natural Gas Star Program's 'Recommended Technologies to Reduce Methane Emissions', a program by the United States Environmental Protection Agency.[12] Note that a number of mitigation technologies or practices have a sunset date of 10 years, i.e., the length of time the technology or practice can continue to accrue emissions reduction after implementation.
- United Nations Economic Commission for Europe's 'Best Practice Guidance for Methane Management in the Oil and Gas Sector', August 2019[3]
- Norwegian Environment Agency's 'Cold venting and fugitive emissions from Norwegian offshore oil and gas activities', a summary report prepared by Add Energy, April 2016[14]

This best-practice guide does not provide information on all reduction methods available as not all methods apply to the vented emissions this guide covers.

It is generally recommended that preventing the need for venting should be the primary mitigation strategy followed by beneficial use, then flaring. For alternatives to flaring see "Flaring" Best Practices Guide. For specific vented sources, recommended mitigation strategies for specific vented sources are summarized in Table 3.

Table 3: **Mitigation strategies for emissions from venting**

Source of emissions	Mitigation strategy	Description	Effectiveness	Source of information
Storage tanks – flash gas	Add vapor-recovery units (VRUs)	The main option is installing a VRU for directing the emission to be reused, sold or flared.	95% reduction in emissions if the VRU has a high reliability.	CCAC[9] technical guidance document 6 EPA Gas Star[13] NEA[14]
	Eliminate tanks at production sites	Add lease automatic custody transfer (LACT) systems directly from the separators to transfer the oil or gas to a pipeline.	100% reduction	EPA Gas Star[13]
Storage tanks – opening and loading liquids from tanks to trucks	Add automatic gauging systems	Automatic gauging may eliminate the need to open tank hatches, and so can reduce tank emissions.	100% reduction	Emerson guide[15]
	Introduce a system to balance or exchange gases between the tanks and tanker vehicles	Vapor return lines can be installed to collect or control gases displaced in the truck when transferring liquids from tanks to trucks. The gases may either be returned to the tanks (vapor balance) or sent direct to a control device.	Variable	EPA Gas Star[13]

Source of emissions	Mitigation strategy	Description	Effectiveness	Source of information
Storage tanks – vapor blowthrough from upstream vessels	Add pressure monitors to tanks	Tank pressure monitors in a SCADA (supervisory control and data acquisition) system can alert operators of overpressure conditions that may result in direct emissions to the atmosphere.	Variable	US EPA Settlements[16, 17, 18]
	Routine monitoring	Routine monitoring of dump valves to make sure they are working properly, and routine monitoring of storage-tank hatches and safety valves, such as with an OGI camera, will allow earlier detection of vapor blowthrough.	Variable	CCAC[9] technical guidance document 6 NEA[14]

Source of emissions	Mitigation strategy	Description	Effectiveness	Source of information
Compressors – packing around rods on reciprocating compressors	Conduct regular monitoring	Add regular monitoring to a periodic leak detection and repair (LDAR) program. This program can help identify excess or abnormal emissions when normal venting thresholds are exceeded. The information from the program can be used to either assess opportunities for reducing venting or monitor improvement after mitigation efforts.	Variable	CCAC[6] technical guidance document 4
	Regularly replace packing around rods	The timing of replacements can be scheduled or based on inspections. Scheduled replacements should be carried out at least every three years, or as soon as excessive venting is identified. This strategy is most relevant to compressors that are spared (can be stopped without affecting production).	A 50 to 65% reduction in emissions is expected	CCAC[6] technical guidance document 4
	Direct emissions to a control device	Emissions could be directed to a flare or another device such as catalytic destruction control.	95% reduction	CCAC[6] technical guidance document 4

Source of emissions	Mitigation strategy	Description	Effectiveness	Source of information
Compressors – wet seals on centrifugal compressors	Regularly monitor sources of vented emissions	Add to periodic LDAR program. The information from the LDAR program can be used to either assess opportunities for reducing venting or monitor improvement after mitigation efforts. For information on developing an LDAR program, please see the best-practice guidance relating to equipment leaks.	Variable	CCAC[5] technical guidance document 3 NEA[14]
	Direct emissions to a control device	Emissions could be directed to a flare or another device such as catalytic destruction control.	95% reduction	CCAC[5] technical guidance document 3 NEA[14]
	Convert wet seals to dry seals	Dry seals generally use less power and are more reliable. However, replacing seals requires a lengthy and often expensive compressor shutdown. Operators should buy new compressors that have dry seals (about 90% of products on the market have dry seals).	Variable	CCAC[5] technical guidance document 3 EPA Gas Star[13]

Source of emissions	Mitigation strategy	Description	Effectiveness	Source of information
Compressors – gas starter motors	Convert gas starter motors to electric starter motors	Gas starter motors use the energy in the pressurized gas to spin a turbine to start the compressor. Converting to electric power eliminates the need for gas power. (Note: An electricity supply is sometimes unavailable, or less reliable than gas pressure at the site.)	100% reduction	EPA Gas Star[13] NEA[14]
	Switch starters to compressed air (EPA Gas Star)	A compressed-air system at a facility often cannot power gas starter motors and is less reliable than gas pressure at the site.	100% reduction	EPA Gas Star[13] NEA[14]
	Recover or flare the gas from the starter motor	There must be large short-term capacity in the VRU or flare.	95% reduction	EPA Gas Star[13]
Glycol dehydrators – regenerator vent stack	Replace a gas-assist lean glycol pump with an electric lean glycol pump	Replacing the pump eliminates the need for gas that is discharged into the glycol stream and then vented.	100% reduction in pump-added emissions	CCAC[7] technical guidance document 5
	Install a flash tank separator, recover gas, and optimize glycol-circulation rates	(Note: Some newer control systems automatically shut down the dehydrator if the VRU system recovering the flash tank gas goes down.)	90% reduction	CCAC[7] technical guidance document 5 NEA[14]
	Replace with a 'near-zero emissions' dehydrator system	Change technology for dehydration (for example, desiccant) dehydrators.	100% reduction	CCAC[7] technical guidance document 5

Source of emissions	Mitigation strategy	Description	Effectiveness	Source of information
Well casinghead vent	Recover or flare the gas from the oil well casinghead vent	Gas can be recovered by a new vapor recovery unit (VRU) or by routing the gas to an existing vapor recovery unit on tanks if one already exists at the site. If recovery is not possible, flare the gas.	95% reduction in emissions if the VRU has a high reliability. For flare, 95%.	CCAC[12] technical guidance document 9
Well completions	Introduce a reduced-emission (green) completion system	The objective of the technology is to capture the flowback gas so it can be sold, or flare it as soon as possible, rather than venting. This step requires special flowback equipment. Install portable equipment during the final stage of a well completion that is designed for a high flow rate of water, sand and gas, and capture gas so it can be sold.	Roughly 90% reduction	CCAC[11] technical guidance document 8 EPA Gas Star[13]
Pipeline network maintenance	Reduce pipeline pressure, recompress gas in next pipeline section	Remove gas from pipeline section to be maintained with mobile recompression unit and possibly combine with nitrogen operations to displace final amount of gas remaining in the pipeline	Pressure in pipeline prior to maintenance can be down to 0.2 barg. Combined with nitrogen, <0.5% of gas vented	Mobile gas recompression equipment datasheets (LMF, Baker Hughes) + Case studies[9]

Source of emissions	Mitigation strategy	Description	Effectiveness	Source of information
Removing liquids from gas wells (also called "liquids unloading")	Manual liquids unloading: minimize time	Remove liquids by manually venting the well through an atmospheric tank, but only under direct supervision (eliminate unattended unloadings).	Unknown, variable	CCAC[10] technical guidance document 7
	Alter the well and downhole operation so that periodic venting is not needed	Operators have a number of options for removing liquids from the well that would eliminate the need for venting. Examples include adding foaming agents, soap strings or surfactants; installing velocity tubing; installing gas-lift compressors; or adding well pumps.	100% reduction	CCAC[10] technical guidance document 7
	Use automated liquids unloading	In some cases, an operator can install an automated plunger lift system that periodically drops a plunger to remove liquids. This method can be designed to eliminate venting.	Unknown, variable	CCAC[10] technical guidance document 7
Venting of associated gas, where there is no gas recovery infrastructure	Find alternative use for associated gas	Operators may use the vented associated gases to generate electricity or other products using mini-LNG, mini-CNG, mini-GTL, microturbines, etc.	Unknown, up to 100% reduction	GFR Technology Overview – Utilization of Small-Scale Associated Gas (2023)[19]
	Flaring	Route associated gas to a common flare unit	90-98% reduction, if monitored	MGP Flaring Guide

Checklist

The following checklist allows you to assess your progress in reducing methane emissions from venting. You can introduce the strategies across all sites and equipment or start with only a selection.

Activity	Completed	Percentage of equipment or sites
✔ Keep an inventory of sources of vented gas		
✔ Avoid or reduce venting from the following • Oil well casinghead venting • Hydrocarbon liquid storage tanks • Compressor seals and starter motors • Glycol dehydrators • Removing liquids from gas wells • Well testing and completion operations • Pipeline network maintenance		
✔ If gas recovery infrastructure (pipeline to market) exists, route waste gas for sale including use of mobile gas recompression during pipeline network maintenance.		
✔ If gas recovery infrastructure (pipeline to market) does not exist, then consider the following options: a. Use flaring rather than venting b. Store through reinjection into gas or oil reservoirs, c. Compress natural gas and transport it by road or rail d. Find alternative use for gas, such as generating electricity or other products using mini-LNG, mini-CNG, mini-GTL, microturbines, etc.		
✔ Monitor vents and evaluate for further improvements and controls		

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4. Climate and Clean Air Coalition's Oil and Gas Methane Partnership Technical Guidance Documents: available at https://www.ccacoalition.org/content/oil-and-gas-methane-partnership-technical-guidance-documents
5. Climate and Clean Air Coalition's Oil and Gas Methane Partnership Technical guidance document 3: 'Centrifugal Compressors with Wet Oil Seals' (2017)
6. Climate and Clean Air Coalition's Oil and Gas Methane Partnership Technical guidance document 4: 'Reciprocating Compressors Rod Seal/Packing Vents' (2017)
7. Climate and Clean Air Coalition's Oil and Gas Methane Partnership Technical guidance document 5: 'Glycol Dehydrators' (2017)
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This series of 10 Best Practice Guides have been designed to improve performance in methane emissions management across the natural gas supply chain. Each Guide provides a summary of current known mitigations, costs and available technologies as of the date of publication. The Guides are available, upon request, in English, French, Arabic, Mandarin, Russian and Spanish.