MINES Responsible Gas Initiative

The Payne Institute for Public Policy

COLORADO SCHOOL OF MINES EARTH • ENERGY • ENVIRONMENT

Payne Institute Responsible Gas Glossary of Terminology

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This document outlines a number of key terms for Responsible Gas and is updated periodically.

In an oil field, oil is almost always associated with a certain quantity of natural gas: newer oil wells are equipped for the recovery of both natural gas, natural gas liquids and crude oil and hence the gas is an additional resource of the oilfield. In some basins, natural gas is the primary hydrocarbon resource. However, the recovery of natural gas presumes that there are the transportation infrastructures and markets available. When the quantity of gas recovered from the oilfield as a "secondary" product is limited, economic solutions maybe not exist. Hence the problem arises of what to do with the associated gas.

Regulators to consider revising natural gas flaring policy | North Dakota News | bismarcktribune.com

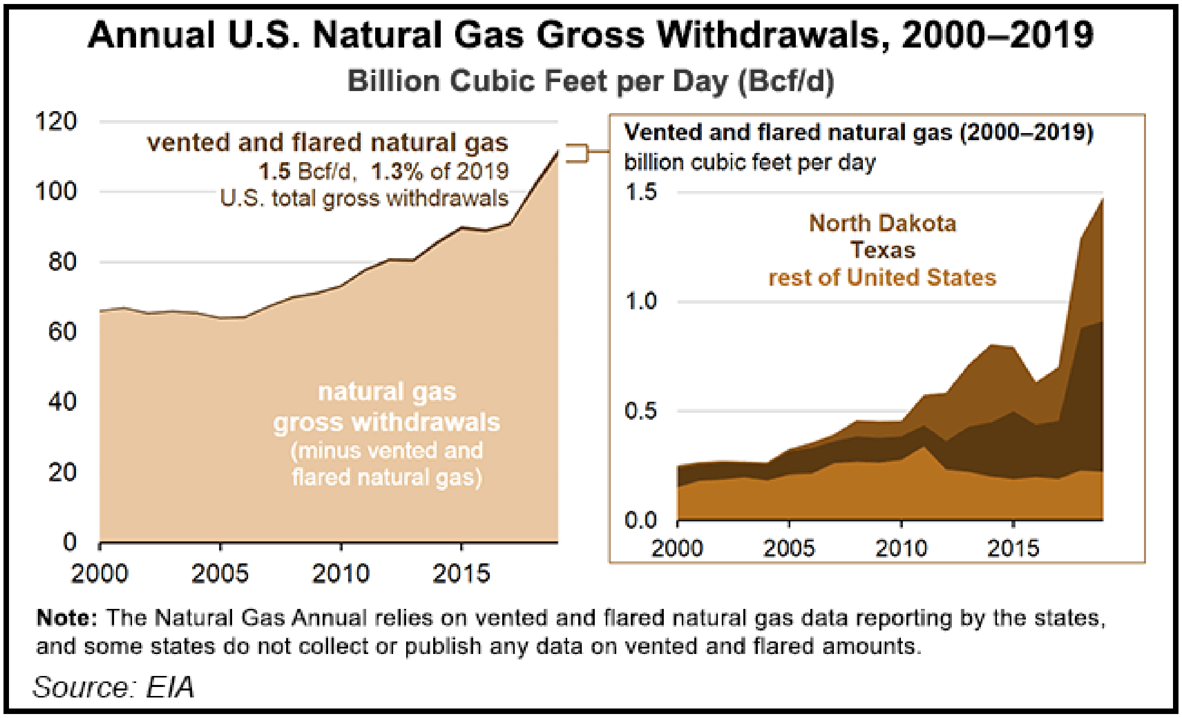
Flaring is the controlled burning of natural gas. A gas flare, also known as a **flare stack**, is a gas combustion device used in industrial plants (i.e. petroleum refineries), chemical plants, natural gas processing plants, landfills and at oil and gas production sites, both offshore and onshore. Unplanned flaring happens when an unexpected gas volume has to be addressed as a safety issue. Planned flaring happens when the pipeline infrastructure doesn't exist to economically transport the natural gas to market.

The practice of flaring has resulted in the burning of large quantities of gas with the consequent production of huge amounts of carbon dioxide together with sulfur dioxide and nitrous oxide, which have contributed substantially to atmospheric pollution. In order to better understand the scale of the problem, it is sufficient to observe nocturnal images of Earth from space: the gas flaring activity in regions corresponding to the major petroleum-producing areas are a proof that cannot go unnoticed!

https://www.minesnewsroom.com/news/earth-observation-group-wins-galileo-award-international-dark-sky-association

Natural gas venting and leaks are the discharge of unburned gases into the atmosphere, often carried out in order to maintain safe conditions during the different phases of the treatment process. During venting operations methane, carbon dioxide, volatile organic compounds, sulfur compounds and gas impurities are released. In many cases gases that are being vented could be flared. Flaring (combustion) oxidizes methane into carbon dioxide and water vapor which have overall a smaller environmental impact. Methane has more than 80 times the warming impact of carbon dioxide over the first 20 years after it reaches the atmosphere.

Currently, the above-mentioned practices (flaring and venting) are subject to strong restrictions, both for economic (the gas produced could be sold and consumed rather than wasted!) but especially for environmental reasons. Under the Kyoto Protocol, there are incentives for the construction of plants that have minimum environmental impact and which, at the same time, do not waste precious resources.



https://www.naturalgasintel.com/lower-48-natural-gas-venting-flaring-reached-record-high-in-2019-eia-says/

The flaring intensity in most of the Permian basin dropped from about 5% to 1.6% in the fourth quarter of 2020 - the lowest level for eight years. The huge drop is attributed to stalled production of oil and gas during several months when the price of oil dropped to zero. https://www.forbes.com/sites/ianpalmer/2021/01/29/profit-and-loss-from-flaring-of-natural-gas-in-permian-basin-wells-of-new-mexico/?sh=4544ca7778bf

In more developed countries, this practice has been almost totally abandoned because it is a waste of an important resource and the infrastructures required to utilize the gas in situ are not difficult to establish. On the contrary, in many developing countries the gas is often not required at the production site and the costs of transportation are very high. For this reason, there are incentives to implement practices that are more feasible and less costly such as, for example, natural gas reinjection into the reservoir to increase its pressure and consequently its efficiency, small-scale natural gas liquefaction plants on the production site, the generation of electricity in situ, the distribution of natural gas to neighboring urban areas, its use for transportation, etc. while costly operations, such as the construction of pipelines, are carried out only when the natural gas extracted justifies the high costs. (www.eniscuola.net/en/argomento/natural-gas1/environment-and-territory1/gas-flaring-and-gas-venting/)

Leaks can come from either operational causes or fugitive causes:

Operational emissions - Some flaring and emissions are essential for safety and maintenance reasons, particularly at the start of operations, during repair or in sudden shutdowns. Here the solutions are better design, process optimization or equipment upgrades. But the more important problem globally is routine flaring and super-emitter sites. That means burning off gas that is found when drilling for oil rather than using, reinjecting or selling it – and it points to the crux of the issue which is a lack of infrastructure, regulations, markets and incentives. When these are not in place, it's far simpler and cheaper to flare the gas – or even worse, vent it – than find a way to use or sell it. https://www.ogci.com/talking-transition-putting-a-stop-to-flaring/

Fugitive emissions are leaks and other irregular releases of gases or vapors from a pressurized containment - such as appliances, storage tanks, pipelines, wells, or other pieces of equipment - mostly from industrial activities. In addition to the economic cost of lost commodities, fugitive emissions contribute to local air pollution and may cause further environmental harm. Common industrial gases include refrigerants and natural gas, while less common examples are perfluorocarbons, sulfur hexafluoride, and nitrogen trifluoride.

Most occurrences of fugitive emissions are small, of no immediate impact, and difficult to detect. Nevertheless, due to rapidly expanding activity, even the most strictly regulated gases have accumulated outside of industrial workings to reach measurable levels globally. Fugitive emissions include many poorly understood pathways by which the most potent and long-lived ozone depleting substances and greenhouse gases enter Earth's atmosphere.

Process Control

Calibration - The comparison and adjustment of a measuring device (an unknown) against an equal or better standard.

Drift - A systematic change in reading or value that occurs over long periods. Changes in ambient temperature, component aging, contamination, humidity and line voltage may contribute to drift.

Notification - A notification is a message sent to a responsible party in response to either an alert, incident, event, or alarm.

> An **alert** is a notification that a particular event (or series of events) has occurred, which is sent to responsible parties for the purpose of spawning action. In general, an **incident** is a human-caused, malicious event that leads to (or may lead to) a significant disruption of business. An **event** in general terms is an observed change to the normal behavior of a system, environment, process, workflow, or person. Events can control peripheral equipment or processes, or act as an input for another control or control loop.
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> An **event** in the context of continuous monitoring is any instance in which VOC (volatile organic compounds) or methane concentrations rise above baseline levels. Events could be a result of a regularly scheduled and permitted operational procedure or they could be the result of a gas leak/fugitive emission.
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> **Alarm** – A **deviation alarm** warns that a process has exceeded or fallen below a certain range around the set or reference point. Alarms can be referenced at a fixed number of degrees, plus or minus, from an established reference point. A **process alarm** warns that process values exceed the process alarm setting. A fixed value independent of set point. A set point is the desired or target value for an essential variable, or process value of a system.
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> When every event triggers a notification, operational staff can become overwhelmed by the volume of non-actionable notifications (i.e., corresponding to operational emissions). When

significant alerts trigger notifications, operators are only made aware of significant issues, which makes addressing these issues easier. In short, notifications are the messages that bring events, alerts, alarms, and incidents to the attention of the appropriate staff.

LDAR – Leak Detection and Repair

LDAR regulations were put into place by the Environmental Protection Agency (EPA) because of the amount of volatile organic compounds (VOCs) and volatile hazardous air pollutants (VHAPs) being emitted by leaking equipment such as valves, pumps, and connectors in industries such as petroleum refining and chemical manufacturing. In an effort to curb the emissions, the EPA instituted regulations and compliance programs. LDAR managers and technicians are to follow fundamental LDAR procedures, such as Method 21 monitoring techniques and analyzer calibration procedures, to keep their LDAR programs in compliance.

Thermal Imaging cameras - Infrared (IR) thermal imaging cameras are commonplace in the oil and gas industry. For years, companies have used them for a number of tasks such examining pipe integrity within process equipment. Recently, though, a highly specialized version of these cameras has made its way into the marketplace for a new application—the monitoring of volatile organic compounds (VOCs), such as methane, being vented into the atmosphere. Forward-looking infrared (FLIR) cameras are one common type of IR thermal imaging camera in use. https://jpt.spe.org/optical-gas-imaging-new-solution-methane-detection

Laser absorption spectrometry (LAS) refers to techniques that use lasers to assess the concentration or amount of a species in gas phase by absorption spectrometry (AS). Optical spectroscopic techniques in general, and laser-based techniques in particular, have a great potential for detection and monitoring of constituents in gas phase.

QMRV (quantification, monitoring, reporting and verification) is a record keeping protocol of greenhouse gas (GHG) emissions at natural gas production hubs. The motive behind the QMRV goal to interact with the natural gas producers is gaining better knowledge of the upstream GHG emissions and accelerating the adoption of sophisticated monitoring technology and methods.

SCADA - Supervisory control and data acquisition (SCADA) is a control system architecture comprising computers, networked data communications and graphical user interfaces for high-level supervision of machines and processes. SCADA systems also cover sensors and other devices, such as programmable logic controllers, which directly interface with process plant or machinery equipment.

Analytical Techniques

Time-Series analytics - Time series analysis is a statistical method to analyze the past data collected at different points in time, often with the goal of forecasting future observations.

Geospatial analytics - Geospatial analytics gathers, manipulates and displays geographic information system (GIS) data and imagery including GPS and satellite photographs. Geospatial data analytics rely on geographic coordinates and specific identifiers such as street address and zip code. They are used to create geographic models and data visualizations for more accurate modeling and predictions of trends.

Emissions Factors - Emissions factors have long been the fundamental tool in developing national, regional, state, and local emissions inventories for air quality management decisions and in developing emissions control strategies. More recently, emissions factors have been applied in determining site-specific applicability and emissions limitations in operating permits by federal, state, local, and tribal agencies, consultants, and industry.

An emissions factor is a representative value that attempts to relate the quantity of a pollutant released to the atmosphere with an activity associated with the release of that pollutant. These factors are usually expressed as the weight of pollutant divided by a unit weight, volume, distance, or duration of the activity emitting the pollutant (e.g., kilograms of particulate emitted per megagram of coal burned). Such factors facilitate estimation of emissions from various sources of air pollution. In most cases, these factors are simply averages of all available data of acceptable quality, and are generally assumed to be representative of long-term averages for all facilities in the source category (i.e., a population average).

The general equation for emissions estimation is:

$$E = A \times EF \times (1 - ER/100)$$

where:

- E = emissions;
- A = activity rate;
- EF = emission factor, and
- ER =overall emission reduction efficiency, %

https://www.epa.gov/air-emissions-factors-and-quantification/basic-information-air-emissions-factors-and-quantification

https://www.infrared-camera-blog.com/the-best-infrared-cameras-for-optical-gas-imaging-ogi/

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The mission of the Payne Institute at Colorado School of Mines is to provide world-class scientific insights, helping to inform and shape public policy on earth resources, energy, and environment. The Institute was established with an endowment from Jim and Arlene Payne, and seeks to link the strong scientific and engineering research and expertise at Mines with issues related to public policy and national security.

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