

References

1. http://en.wikipedia.org/wiki/Paraguan%C3%A1_Refinery_Complex
2. Draft National Oil and Gas Extraction Agenda - August 2010: For Occupational Safety and Health Research and Practice in the U.S. Oil and Gas Extraction Industry - Developed by the NORA Oil and Gas Extraction Council (<http://www.cdc.gov/niosh/nora/comment/agendas/oilgas/>)
3. <http://www.cdc.gov/niosh/programs/oilgas/projects.html>
4. <http://www.cdc.gov/niosh/topics/confinedspace/>
5. http://en.wikipedia.org/wiki/Job_safety_analysis
6. GLOBAL STRATEGY ON OCCUPATIONAL SAFETY AND HEALTH: Conclusions adopted by the International Labour Conference at its 91st Session, 2003 http://www.ilo.org/wcmsp5/groups/public/@ed_protect/@protrav/@safework/documents/policy/wcms_107535.pdf
7. Guidelines on occupational safety and health management systems (ILO-OSH 2001) http://www.ilo.org/public/english/region/afpro/cairo/downloads/wcms_107727.pdf
8. http://ec.europa.eu/energy/oil/offshore/standards_en.htm

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Vasyliv Nataliia

Assistant of Department of Environmental Protection Technology
Ivano-Frankivsk National Technical University of Oil and Gas

AIR EMISSIONS IN OIL AND GAS DEVELOPMENT SECTOR

Toxic air monitoring is essential in the oil and gas industry for ensuring worker safety, environmental protection, and operational efficiency.

By detecting harmful airborne contaminants, toxic air monitors play a critical role in maintaining safe working conditions and preventing health hazards.

This paper explores the types of toxic air monitors used, common contaminants detected, their applications, and the benefits they provide.

Occupational safety in the context of air pollution from the oil and gas industry is a critical concern due to the presence of hazardous airborne substances that can significantly affect worker health and safety. Here's an overview of key aspects:

1. Sources of Air Pollution in Oil and Gas Industry:
 - ✓ Volatile Organic Compounds (VOCs): Emitted during drilling, storage, and transportation (e.g., benzene, toluene).
 - ✓ Hydrogen Sulfide (H₂S): A toxic gas often found in natural gas and crude oil.
 - ✓ Particulate Matter (PM): Released during flaring, combustion, and equipment operation.

- ✓ Nitrogen Oxides (NO_x) and Sulfur Oxides (SO_x): Emitted from combustion processes.
- ✓ Methane (CH₄): A potent greenhouse gas, also an asphyxiant in high concentrations.
- 2. Occupational Health Hazards:
 - ✓ Respiratory Issues: Chronic exposure to VOCs and PM can lead to asthma, bronchitis, and other lung conditions.
 - ✓ Neurological Effects: Exposure to certain VOCs (like benzene) can affect the nervous system.
 - ✓ Chemical Burns and Eye Irritation: From H₂S and acid gases.
 - ✓ Long-Term Risks: Increased risk of cancers (especially leukemia) from carcinogenic compounds.
- 3. Safety Measures and Controls:
 - ✓ Engineering Controls
 - ✓ Gas detection systems: Fixed and portable sensors for H₂S, CH₄, and VOCs.
 - ✓ Ventilation systems: To dilute and remove contaminated air.
 - ✓ Enclosed systems: Reduce fugitive emissions during processing.
 - ✓ Administrative Controls
 - ✓ Work rotation and exposure limits: To minimize time spent in high-exposure areas.
 - ✓ Air quality monitoring programs: Continuous tracking to ensure safe levels.
 - ✓ Training programs: Educating workers on hazard recognition and emergency response.
 - ✓ Personal Protective Equipment (PPE)
 - ✓ Respirators: NIOSH-approved masks for VOCs and particulates.
 - ✓ Eye and skin protection: Especially in areas with chemical handling.
 - ✓ H₂S monitors: Personal alarms worn by workers.
- 4. Regulations and Standards:
 - ✓ OSHA (Occupational Safety and Health Administration): Sets permissible exposure limits (PELs) for various airborne contaminants.
 - ✓ NIOSH (National Institute for Occupational Safety and Health): Recommends exposure limits and provides safety guidelines.
 - ✓ EPA (Environmental Protection Agency): Regulates air emissions and supports air quality improvement measures.
- 5. Emerging Strategies:
 - ✓ Remote sensing technologies: Drones and infrared cameras for leak detection.
 - ✓ Green chemistry initiatives: Reducing the use of hazardous substances.
 - ✓ Emission-reduction innovations: E.g., vapor recovery units, closed-loop systems.

The main sources of air emissions (continuous or noncontinuous) resulting from activities include: combustion sources from power and heat generation, and

the use of compressors, pumps, and reciprocating engines (boilers, turbines, and other engines); emissions resulting from flaring and venting of hydrocarbons; and fugitive emissions.

Principal pollutants from these sources include nitrogen oxides, sulfur oxides, carbon monoxide, and particulates. Additional pollutants can include: hydrogen sulfide (H₂S); volatile organic compounds (VOC) methane and ethane; benzene, ethyl benzene, toluene, and xylenes (BTEX); glycols; and polycyclic aromatic hydrocarbons (PAHs).

Significant (>100,000 tons CO₂ equivalent per year) greenhouse gas (GHG) emissions from all facilities and support activities should be quantified annually as aggregate emissions in accordance with internationally recognized methodologies and reporting procedures.

All reasonable attempts should be made to maximize energy efficiency and design facilities to minimize energy use. The overall objective should be to reduce air emissions and evaluate cost-effective options for reducing emissions that are technically feasible. Air quality impacts should be estimated by the use of baseline air quality assessments and atmospheric dispersion models to establish potential ground level ambient air concentrations during facility design and operations planning. These studies should ensure that no adverse impacts to human health and the environment result.

Exhaust gas emissions produced by the combustion of gas or liquid fuels in turbines, boilers, compressors, pumps and other engines for power and heat generation, or for water injection or oil and gas export, can be the most significant source of air emissions from facilities. Air emission specifications should be considered during all equipment selection and procurement.

Associated gas brought to the surface with crude oil during oil production is sometimes disposed of at facilities by venting or flaring to the atmosphere. This practice is now widely recognized to be a waste of a valuable resource, as well as a significant source of GHG emissions.

However, flaring or venting are also important safety measures used on oil and gas facilities to ensure gas and other hydrocarbons are safely disposed of in the event of an emergency, power or equipment failure, or other plant upset condition.

Measures should be adopted when considering flaring and venting options for activities.

Continuous venting of associated gas is not considered current good practice and should be avoided. The associated gas stream should be routed to an efficient flare system, although continuous flaring of gas should be avoided if feasible alternatives are available. Before flaring is adopted, feasible alternatives for the use of the gas should be evaluated to the maximum extent possible and integrated into production design.

Alternative options may include gas utilization for on-site energy needs, export of the gas to a neighboring facility or to market, gas injection for reservoir pressure maintenance, enhanced recovery using gas lift, or gas for instrumentation. An assessment of alternatives should be adequately documented and recorded. If none of the alternative options are currently feasible, then measures to minimize

flare volumes should be evaluated and flaring should be considered as an interim solution, with the elimination of continuous production associated gas flaring as the preferred goal.

If flaring is necessary, continuous improvement of flaring through implementation of best practices and new technologies should be demonstrated. The following pollution prevention and control measures should be considered for gas flaring:

- Implementation of source gas reduction measures to the maximum extent possible;
- Use of efficient flare tips, and optimization of the size and number of burning nozzles;
- Maximizing flare combustion efficiency by controlling and optimizing flare fuel / air stream flow rates to ensure the correct ratio of assist stream to flare stream;
- Minimizing flaring from purges and pilots, without compromising safety, through measures including installation of purge gas reduction devices, flare gas recovery units, inert purge gas, soft seat valve technology where appropriate, and installation of conservation pilots;
- Minimizing risk of pilot blow-out by ensuring sufficient exit velocity and providing wind guards;
- Use of a reliable pilot ignition system;
- Installation of high integrity instrument pressure protection systems, where appropriate, to reduce over pressure events and avoid or reduce flaring situations;
- Minimizing liquid carry-over and entrainment in the gas flare stream with a suitable liquid separation system;
- Minimizing flame lift off and / or flame lick;
- Operating flare to control odor and visible smoke emissions (no visible black smoke);
- Locating flare at a safe distance from local communities and the workforce including workforce accommodation units;
- Implementation of burner maintenance and replacement programs to ensure continuous maximum flare efficiency;
- Metering flare gas.

In the event of an emergency or equipment breakdown, or plant upset conditions, excess gas should not be vented but should be sent to an efficient flare gas system. Emergency venting may be necessary under specific field conditions where flaring of the gas stream is not possible, or where a flare gas system is not available, such as a lack of sufficient hydrocarbon content in the gas stream to support combustion or a lack of sufficient gas pressure to allow it to enter the flare system. Justification for excluding a gas flaring system should be fully documented before an emergency gas venting facility is considered.

To minimize flaring events as a result of equipment breakdowns and plant upsets, plant reliability should be high (>95 percent) and provision should be made for equipment sparing and plant turn down protocols.

Flaring volumes for new facilities should be estimated during the initial commissioning period so that fixed volume flaring targets can be developed. The volumes of gas flared for all flaring events should be recorded and reported.

Fugitive emissions at facilities may be associated with cold vents, leaking pipes and tubing, valves, connections, flanges, packings, open-ended lines, pump seals, compressor seals, pressure relief valves, tanks or open pits / containments, and hydrocarbon loading and unloading operations.

Methods for controlling and reducing fugitive emissions should be considered and implemented in the design, operation, and maintenance of facilities. The selection of appropriate valves, flanges, fittings, seals, and packings should consider safety and suitability requirements as well as their capacity to reduce gas leaks and fugitive emissions. Additionally, leak detection and repair programs should be implemented. Vapor control units should be installed, as needed, for hydrocarbon loading and unloading operations. Use of open vents in tank roofs should be avoided by installing pressure relief valves. Vapor control units should be installed, as needed, for the loading and unloading of ship tankers. Vapor processing systems may consist of different units, such as carbon adsorption, refrigeration, thermal oxidation, and lean oil absorption units.

Toxic air monitoring involves the use of specialized equipment to detect and measure the concentration of hazardous substances in the air. These monitors can identify various toxic gasses and volatile organic compounds (VOCs) that pose significant risks to human health and safety.

In the oil and gas industry, toxic air monitors are indispensable tools for ensuring the safety of workers, protecting the environment, and maintaining operational efficiency. They are used extensively across various stages of oil and gas exploration, production, refining, and transportation.

Here's how toxic air monitors are used in different applications within the industry:

- ❖ **Drilling Rigs.** Toxic air monitors detect harmful gasses like hydrogen sulfide (H_2S) and benzene during drilling operations. Early detection of these gasses is crucial for preventing health hazards and ensuring the safety of workers on the rig.

- ❖ **Production Facilities.** Continuous monitoring of toxic air contaminants in production areas helps detect leaks and prevent accidental releases. This ensures that production processes remain safe and efficient, protecting workers and equipment from exposure to harmful substances.

- ❖ **Refineries.** In refineries, toxic air monitoring systems are essential for detecting a variety of hazardous gasses, including VOCs and hydrogen sulfide. These systems ensure safe processing operations by providing real-time alerts to prevent potential hazards and exposure to toxic substances.

- ❖ **Pipeline Monitoring.** Toxic air monitors are used to detect leaks of hazardous gasses along pipelines, preventing explosions and environmental contamination. Monitoring pipelines helps maintain the integrity of the transportation infrastructure and ensures the safety of surrounding areas.

❖ **Storage Tanks.** Monitoring the area around storage tanks for toxic gas leaks is crucial to prevent fire hazards and ensure containment. Toxic air monitors help maintain the safety and integrity of storage facilities, protecting both workers and the environment.

❖ **Confined Space Entry.** Portable and personal toxic air monitors are essential for ensuring the safety of workers entering confined spaces such as tanks, vessels, and underground storage areas. These monitors provide real-time monitoring of air quality, ensuring safe working conditions in hazardous environments.

❖ **Maintenance & Spot-Checks.** During maintenance activities, portable toxic air monitors are used for spot-checks to ensure that air quality remains within safe limits. This is particularly important in areas where concentrations of toxic gasses might fluctuate due to maintenance work.

The RAE Systems MultiRAE Lite is a versatile and reliable multi-gas detector widely used in the oil and gas industry to ensure worker safety and operational efficiency.

Here are its key features and benefits:

- **Multi-Gas Detection Capabilities.** The MultiRAE Lite can simultaneously monitor up to five gasses, including oxygen (O₂), hydrogen sulfide (H₂S), carbon monoxide (CO), volatile organic compounds (VOCs), and combustible gasses (LEL).

- **Versatility.** Suitable for a broad spectrum of applications in the oil and gas sector. Immediate

- **Alerts.** Delivers real-time data and alarms if gas levels exceed safety thresholds, allowing for prompt action in hazardous situations.

- **Visual, Audible & Vibrating Alarms.** Ensure alerts are noticeable, even in noisy or low-visibility environments.

- **Data Logging.** Records data for subsequent review and analysis, aiding in compliance and reporting.

- **Wireless Communication.** Certain models feature wireless capabilities for remote monitoring and integration with central safety systems.

- **Durable Design.** Engineered to endure harsh industrial conditions, guaranteeing reliable performance.

- **Compact & Lightweight.** Easy to transport and use, making it perfect for personal safety and portable monitoring.

- **User-Friendly Interface.** Intuitive design allows for simple operation, requiring minimal training for workers.

- **Extended Battery Life.** Long-lasting battery ensures uninterrupted operation during lengthy shifts or extended use.

Toxic air monitors are indispensable tools in the oil and gas industry, providing critical safety and operational benefits by monitoring and detecting hazardous airborne contaminants.

Whether you are a service provider or asset owner, understanding the applications and benefits of toxic air monitors can lead to safer, more efficient, and compliant operations.

By integrating toxic air monitoring technology into daily operations, the oil and gas industry can achieve greater safety, efficiency, and environmental stewardship.

REFERENCE

1. U.S. Environmental Protection Agency (EPA). (2012). Oil and natural gas sector: New source performance standards and national emission standards for hazardous air pollutants reviews (EPA–HQ–OAR–2010–0505). Washington, DC: U.S. Environmental Protection Agency. 112 pages.

Available at: <https://www.epa.gov>

2. Occupational Safety and Health Administration (OSHA). (2023). Hydrogen sulfide release: Fatal facts (OSHA Fact Sheet No. 4204). Washington, DC: U.S. Department of Labor. 2 pages.

Available at: <https://www.osha.gov>

3. National Institute for Occupational Safety and Health (NIOSH). (2012). Worker exposure to silica during hydraulic fracturing: Hazard alert. Atlanta, GA: Centers for Disease Control and Prevention. 6 pages.

Available at: <https://stacks.cdc.gov/view/cdc/39918>

4. Esswein, E. J., Kiefer, M., & Snawder, J. (2016). Occupational health and safety aspects of oil and gas extraction. In B. D. Goldstein et al. (Eds.), *Environmental and Occupational Health in Oil and Gas Development* (pp. 93–105). Springer. 13 pages.

https://doi.org/10.1007/978-3-319-23874-4_6

5. Witter, R. Z., Tenney, L., Clark, S., & Newman, L. S. (2014). Occupational exposures in the oil and gas extraction industry: State of the science and research recommendations. *American Journal of Industrial Medicine*, 57(7), 847–856. 10 pages. <https://doi.org/10.1002/ajim.22316>