

Coal Mine Methane Flaring: Technology and Case Studies

Updated January 2021



Introduction

Worldwide, coal mines produced an estimated 967 million metric tons of carbon dioxide in 2015, about 8 percent of the world's anthropogenic methane emissions.¹ Methane emitted from coal mines presents a critical safety hazard for mine workers, especially at underground mines, and is an important source of greenhouse gas (GHG) emissions.

Technology is readily available to recover and use methane, the major component of natural gas, from coal mines. For instance, gas removed in advance of mining, known as "drained gas," is often very high quality (i.e., high concentrations of methane with low impurities) that can be used in typical natural gas applications such as pipeline injection and power generation, and as boiler fuel.

Although utilization of coal mine methane (CMM) is the most effective use of this resource, it may not be economically practical to do so in every case. In some instances where end uses are not economic or available, the destruction of methane through enclosed flaring may be the most appropriate option for reducing GHG emissions and mitigating CMM-related mine hazards. Flaring CMM may serve as an intermediary stage for achieving emissions reductions prior to, or in combination with, the operation of a full-scale CMM utilization project.

This document presents information related to CMM flaring. For more information on CMM utilization, see the CMOP [Coal Mine Methane Recovery Primer](#).

Disclaimer: U.S. EPA is providing this information for educational purposes only and does not endorse or support any specific technology or project.

About the Coalbed Methane Outreach Program

Since 1994, the Environmental Protection Agency's (EPA's) Coalbed Methane Outreach Program (CMOP) has worked cooperatively with the coal mining industry in the United States and other major coal producing countries to reduce CMM emissions.

Learn more at: www.epa.gov/cmop

Contact CMOP at:
www.epa.gov/cmop/forms/contact_us_about_coal_methane_outreach_program



Exhibit 1. Enclosed flares have been used by the coal industry at underground coal mines for over 20 years

- Flares have been deployed at underground coal mines since the 1990s.
- As of 2021, the Global Methane Initiative's (GMI's) International CMM Project List identifies nearly 30 global CMM projects where flaring has been practiced.
- Flaring projects are operational in seven countries, including the leading four countries in terms of global CMM emissions: China, the United States, Russia, and Australia.

¹ U.S. EPA. 2019. *Global Non-CO₂ Greenhouse Gas Emission Projections & Mitigation 2015–2050*. EPA-430-R-19-010. Available: https://www.epa.gov/sites/production/files/2019-09/documents/epa_non-co2_greenhouse_gases_rpt-epa430r19010.pdf.

Planning for Flaring CMM

When methane utilization projects are not economically viable, flaring CMM can be an effective strategy for reducing GHGs and mitigating CMM-related mine hazards. Conditions in which flaring could be an appropriate strategy for a mine include:

- Gas is stranded at remote wellhead locations.
- Logistic or economic issues exist with transporting the gas.
- Mine operators are interested in an initial GHG mitigation option prior to operation of an energy recovery facility.
- Mine operators are interested in using enclosed flares alongside methane utilization projects, enabling them to mitigate methane emissions that exceed the capacity of the utilization equipment or during project downtimes.

Compared to many energy recovery projects, enclosed flares offer the potential advantage of shorter planning, design, and installation schedules. They also typically have much lower capital and operating costs (e.g., the capital cost of a typical CMM flaring project can be just 5–10 percent of the cost of a CMM electricity generation project).² However, revenue sources for flaring projects are limited to GHG emissions reductions markets.

Flaring Technology

The technology for flaring projects is well-established and widely practiced. There are two general designs: open or “candle stick” flares, and enclosed or “ground” flares. Early projects utilized **open flares** because they were common in the oil and gas industry. However, **enclosed flares** are now the industry standard because they are designed with the important safeguards that are required at underground coal mines such as detonation and flame arrestors, temperature sensors, and real-time monitoring. The safety risks of enclosed flares are comparable to those of a CMM-fired boiler. In addition, enclosed flares typically have higher destruction efficiencies. The costs associated with enclosed flares are generally two or three times higher than for open flares.

CMM Flaring Case Studies

West Ridge Mine (Utah, United States of America)

The flare at the West Ridge Mine was installed after the coal mine was abandoned in 2016. Global Carbon Strategies, the project developer, commissioned the project in March 2018. Mine methane from the site’s gob wells is considered stranded gas, since it is located more than five miles from the nearest electricity infrastructure. Using 2 methane-fueled extraction units, the project recovers methane from 3 gob wells via a 10-inch-diameter gathering pipeline. The abandoned mine methane is sent to an enclosed flare manufactured by Perennial Energy, which has a capacity of 72 million British thermal units/hour. The flare has successfully operated over a wide range of methane concentrations, from 25 to 70 percent. The West Ridge project is especially notable because it safely operates at a remote site located above 7,000 feet in elevation and without access to grid-based electric power. Also, mine methane is used to generate the onsite power for monitoring equipment and communications.



Exhibit 2. West Ridge Mine Flare
(Courtesy of Global Carbon Strategies)

² See CMOP’s CMM Project Cash Flow Model to generate example costs. U.S. EPA. 2019. *CMM Cash Flow Model*. Available: <https://www.epa.gov/cmop/cmm-cash-flow-model>.

MIMOSA Mines (Mexico)

Minera del Norte S.A. de C.V. (MIMOSA), a leading coal company in Mexico and a subsidiary of Grupo Acerero del Norte (GAN), began operating the first CMM flares at active coal mines in Mexico in October 2013. The MIMOSA flaring project was registered as a Clean Development Mechanism project, and destroyed mine methane from gas drainage systems at two of its mines in northern Mexico: Mine VII (Sabinas Basin) and Esmeralda Mine (electric power generation project in the Saltillo Basin). The projects operated successfully for about seven years through 2019. They were decommissioned by MIMOSA in 2020 following closing of the mines.

The flares, manufactured by Biogas Technology Ltd., are sited at fixed locations (i.e., they are not portable) and are enclosed flares with a combined air throughput capacity of 4,000 normal cubic meters (Nm³)/hour (two 2,000 Nm³/hour units).



Exhibit 3. MIMOSA Mine Flare, Mexico
(Courtesy of M. Santillan Gonzales, GAN)

Duerping Mine (Shanxi Province, China)

The Duerping Mine, operated by Xishan Coal & Electricity Company, a subsidiary of Shanxi Coking Coal Co. Ltd., is located in the mountains just west of the City of Taiyuan in China's Shanxi Province. Since 2008, the site has operated a 5,000 cubic meter/hour enclosed flare.

The flare was initially used as an interim emissions reduction option before 12 megawatts of gas gensets were installed. Now the flare destroys drained gas volumes in excess of those utilized by the gensets, or gases with concentrations less than the permitted minimum (currently 30 percent) but higher than 25 percent. Approximately 20 percent of the drained gas is expected to be flared.



Exhibit 4. Duerping Mine Flare, Shanxi Province, China
(Courtesy of Sindicatum Sustainable Resources)

Resources

To learn more about flaring CMM, please consult the following resources:

- U.S. EPA CMOP: www.epa.gov/cmop
- GMI Coal Sector webpage: www.globalmethane.org/coal/index.aspx
- International CMM Project List: www.epa.gov/sites/production/files/2016-05/coalprojectlist.xlsx
- United Nations Economic Commission for Europe "Best Practice Guidance for Effective Methane Drainage and Use in Coal Mines":
www.unece.org/fileadmin/DAM/energy/se/pdfs/cmm/pub/BestPractGuide_MethDrain_es31.pdf