

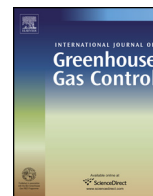


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Review

A review of global gas flaring and venting and impact on the environment: Case study of Iran

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ABSTRACT

After a brief review of the global gas flaring and venting in oil industries including the emission of air pollutants and greenhouse gases and the amount of energy resources wasted, the focus is on Iran as a major oil producing and the world's third largest gas flaring country. Gas flaring is also practiced in natural gas industries, petroleum refining and petrochemical plants, although the level of emission is very low compared with emissions from oil production. The historical emission of these gases globally and Iran specifically, geographic location of emission sources, composition of gases, environmental impacts of gas flaring and the current and future projects to mitigate emissions are evaluated and discussed. Emission factor, an indication of efficiency in oil production, varies widely among oil production sites around the world, from near zero to more than 50 standard cubic meters of flare gas per barrel of oil produced with an average value of about 5. Iran's emission factor has fluctuated from around 1 to more than 16 according to the data of 1980–2012 with higher emission factors for offshore oil production. Data also show an increasing trend during 2010–2012 which could be due to the several technical reasons in oil productions as well as economic sanctions imposed on Iran. In addition, there is a great amount of uncertainty and discrepancies among various data sources in the emission factors due to the lack of actual measurements of the volume and composition of flare gas and the uncertainties in the data sources. This requires regulatory measures, investment by oil companies and international collaboration. The economic and technological constraints in implementing or delaying the gas flare reduction projects are evaluated and addressed, with successful case studies and best practices reviewed. In particular, the techno-economic constraints in implementing gas flaring reduction projects caused by international sanctions on Iran are analyzed. It is shown that despite the great loss of energy resources due to gas flaring, its adverse impacts on the local and global environment and the availability of the technologies to reduce emissions, flaring is still practiced in many parts of the world, which can be avoided if the necessary regulatory policies and measures are established at national levels and international collaboration can facilitate the investment by providing the required finance and technologies. At present the international activities to implement gas flaring project activities under the Clean Development Mechanism (CDM) of the Kyoto Protocol of the United Nations Framework Convention on Climate Change (UNFCCC) are very limited, but could be very effective in reducing emissions, if implemented. Due to the global demand and continued use of oil and gas in the next decades, there is an urgent need for reducing gas flaring emissions. This is not only the responsibility of the oil and gas companies, but also the responsibility of the national governments and the global community.

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1. Introduction

Since the inception of oil exploration, drilling and production in the world more than one and a half century ago, gas flaring and venting has been practiced as a method to dispose of the gases associated with petroleum, mostly for safety, operational and economic reasons. The environmental awareness and concerns as well as the issue of sustainability on gas flaring have been raised only in the past few decades.

Under the high-pressure condition in underground reservoirs, light hydrocarbons and other impurities are dissolved or dispersed in the heavier hydrocarbon compounds (crude oil). When this high pressure is reduced to the atmospheric condition at the well head in the surface facilities, the dissolved gases and other impurities are separated from liquids and released that are called the *associated gases*, flared or vented to the atmosphere.

It should be noted that in addition to gas flaring and venting in oil production facilities (*associated gas*), in all oil and natural gas refineries as well as in petrochemical plants, there is always some amount of gases collected from various processes and sent to flare in tall stacks mostly for safety reasons or process operational considerations such as startups or shutdowns or process disruptions. This is called the *non-associated gas* that contains flammable and hazardous materials from pressure relief valves, process equipment

and shutdown operations. As it will be shown in Section 10.2, the contribution of this type of flaring is relatively very small compared with the *associated gas* flaring in oil production, however, the *associated gas* flaring and venting, is the focal area of this article.

There are several reasons for gas flaring and venting in oil production including:

- Lack of infrastructure to collect, treat, transport and utilize the associated gases;
- The production site is remote from the market demand (such as offshore sites);
- The small volume of the gas and its fluctuation, which make the design of facilities more uncertain and therefore uneconomical investment;
- Impurities in the gas that require hard and expensive treatment methods (such as highly acidic gases);
- Safety and operational reasons;

Flaring wastes a valuable energy resource with great adverse environmental impacts and economic losses. According to GE Energy report (Farina, 2010) gas flaring is: (1) a multi-billion dollar waste; (2) a local environmental tragedy; (3) a global environmental issue; and (4) an energy problem that can be solved. As will

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