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Natural Gas A Boon To Environment

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I. INTRODUCTION

Air Pollution is very alarming in Indian cities. Indian economy is growing rapidly with average growth rate of approximately 7% in last two decades. Energy is the key input for economic growth and Indian Energy sector play a vital role in country's Economy. Energy is a key input to the production processes that transform inputs to goods and services contributing to Gross Domestic Product. Increase in GDP along with change in structure of the Indian economy resulted in a significant growth in energy consumption in last three decades and will grow in future also. Energy security and sustainability are interdependent because emissions from energy consumption contributes to climate change in greater extend globally. Energy Mix play vital role in energy security and India's energy mix shows dominance of fossil fuels Coal & Oil with only 6% Natural Gas. Natural gas is the cleanest fossil fuel which emits negligible particulate matters and lowest air pollutants as compare to Coal & Oil. Natural Gas is the fuel of future to achieve the India's ambition of Gas based economy. Globally, Natural gas contributes around 24% in World energy mix as shown in Table-1 and Gujarat state in India have 25% natural gas share in energy mix. Hence, Indian government is also committed to increase the share of natural gas in country's energy mix up to 15% by 2030 and Ministry of Petroleum and Natural Gas intervening with policy reforms in natural gas sector. Globally, natural gas is considered as transition fuel due to its availability, affordability, environment friendliness and ability to support renewable in pick demand time. For India, International market dynamics and country's energy policies are supporting Natural Gas to become fuel of choice in present scenario and address the energy security & climate change in the future. Energy Security is the at most important in line with international security of any country. As India is more depending on energy import from international market, hence there is geopolitics involved in international energy relations causing threat to national security.

In the combustion process, diesel engines produce higher particulate levels, microscopic bits of soot left over. "The greatest danger is with the smallest, so-called "ultrafine" particles, "they get so far into the lungs, they get into the surfaces where oxygen reaches our blood, and almost certainly the particles themselves will reach the blood. These can cause higher rates of stroke and increase heart attacks in people who are most susceptible to disease.

In essence, modern diesel does not have a problem with particulates. 99% of the particles are cleaned up by the filters. They are very effective as long as they are not tampered with. Long-term nitrogen dioxide exposure may decrease lung function, increase the risk of breathing conditions, and exacerbate allergic reactions.

Also provided is a summary of potential biological impacts and products of the atmospheric reaction (secondary pollutants). This summary refers to the biological activity of the pure state of the chemical compounds. At the concentration levels found in diesel exhaust, the biological effects of particular compounds may or may not occur.

Biological Impact of Diesel Emission Components

Emission Component	Atmospheric Reaction Products	Biological Impact
Gas Phase		
Carbon monoxide	-	Highly toxic to humans; blocks oxygen uptake.
Nitrogen oxides	Nitric acid, ozone	Nitrogen dioxide is a respiratory tract irritant and major ozone precursor. Nitric acid contributes to acid rain.
Sulfur dioxide	Sulfuric acid	Respiratory tract irritation. Contributor to acid rain.
Carbon dioxide	-	Major contributor to global warming.
Saturated hydrocarbons (Alkanes, < C_{19})	Aldehydes, alkyl nitrates, ketones	Respiratory tract irritation. Reaction products are ozone precursors (in the presence of NOx).
Unsaturated hydrocarbons (Alkenes < C_5)	Aldehydes, ketones	Respiratory tract irritation. Some alkenes are mutagenic and carcinogenic. Reaction products are ozone precursors (in the presence of NOx).
Formaldehyde	Carbon monoxide, hydroperoxyl radicals	Formaldehyde is a probable human carcinogen and an ozone precursor (in the presence of NOx).
Higher aldehydes (e.g., acrolein)	Peroxyacyl nitrates	Respiratory tract and eye irritation; causes plant damage.
Monocyclic aromatic compounds (e.g. benzene, toluene)	Hydroxylated and hydroxylated-nitro derivatives	Benzene is toxic and carcinogenic in humans. Some reaction products are mutagenic in bacteria (Ames assay).
PAHs (< 5 rings) (e.g. phenanthrene, fluoroanthene)	Nitro-PAHs (<5 rings)	Some of these PAHs and nitro-PAHs are known mutagens and carcinogens.
Nitro-PAHs (2 and 3 rings) (e.g. nitronaphtalenes)	Quinones and hydroxylated-nitro derivatives	Some reaction products are mutagenic in bacteria (Ames assay).
Particulate Phase		
Elemental carbon	-	Nuclei adsorb organic compounds; size permits transport deep into the lungs (alveoli).
Inorganic sulfates	-	Respiratory tract irritation.
Aliphatic hydrocarbons (C_{14}-C_{35})	Little information; possibly aldehydes, ketones, and alkyl nitrates	Unknown.
PAHs (4 rings and more) (e.g., pyrene, benzo(a)pyrene)	Nitro-PAHs (4 rings and more), nitro-PAH lactones	Larger PAHs are major contributors of carcinogens in combustion emissions. Many nitro-PAHs are potent mutagens and carcinogens.
Nitro-PAHs (3 rings and more) (e.g., nitropyrenes)	Hydroxylated-nitro derivatives	Many nitro-PAHs are potent mutagens and carcinogens. Some reaction products are mutagenic in bacteria (Ames assay).

Table 1

Indian citizens are likely to breathe air with high concentrations of PM2.5 in 2030, even though India would comply with its current policies and regulations on pollution control, the report said. The government launched the National Clean Air Program in January 2019, a five-year plan of action to curb air pollution, build a pan-India air quality monitoring network, and enhance awareness among citizens.

The study also highlighted a marked variance in factors that contribute to state-wide air pollution. Solid fuel, including residential cooking biomass combustion, is the largest contributor in the Indo-Gangetic Plain's major states. Instead, transportation NOx emissions in these two states are major contributors to air pollution.

The Indian Government has tried to take action to address the pollution problem, including the promotion of the use of LPG, CNG and other forms of natural gas, as well as

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renewable energy sources such as wind, solar and thermal. The effects of clean energy are already being noticed cities such as Delhi, Mumbai, Lucknow and Bhopal, which have reported a decrease in Sulphur dioxide levels, which can be attributed to the introduction of cleaner fuel standards and access to LPG, in place of coal, wood, biomass, etc.

The use of diesel and older engines, which also contributed to higher emissions, has been reduced to some extent by promoting compressed natural gas. Over the past few years, CNG has found favor with consumers due to its cost effectiveness.

In residences and factories, the use of natural gas is also aggressively promoted, as it can be piped or supplied in tanks for heating, cooking and running a variety of appliances.

Natural gas causes less environmental damage compared to coal. It consists of methane and results in lower emissions of carbon, it also burns cleaner without leaving any residue. CNG is also credited as being the cleanest burning fuel in the market today. CNG burns cleaner than petroleum-based products because of its lower carbon content. It produces the fewest emissions of all other fuels and contains significantly less pollutants than gasoline. CNG produces 20-30% fewer greenhouse gas emissions and 95% fewer tailpipe emissions than petroleum products. And because CNG fuel systems are completely sealed, CNG vehicles produce no evaporative emissions.

Natural gas releases the lowest carbon dioxide compared to oil and coal when it comes to fossil fuel emission levels. Similarly, in comparison with oil and coal, natural gas has lower emission rates of other pollutants such as sulfur dioxide and nitrogen oxides.

The major laws that can give new impetus for combating pollution is:

- ✓ Petroleum and Natural Gas Regulatory Board Act 2006 (in short PNGRB Act)
- ✓ Petroleum and Mineral Pipelines (Acquisition of Right of User in Land) Act 1962.

The Article 21 of the Indian Constitution ensures the Right to life and liberty includes right to decent way of livelihood. In other words, while going for right to Development, the right to breath clean air free from any pollution is also a paramount right envisaged by the constitution. We need to draw a line and reconcile between the two. Of late, the India's capital city Delhi is considered as GAS CHAMBER for some days owning to the fact that the pollution level was very alarming, and the people were subject to lot of respiratory problems like asthma etc. The duty is casted upon the State to guarantee the wholesome air as envisaged by the framers of the constitution of India in the larger public interest. Article 48A of the constitution also mandates protection of environment. The Bhopal Disaster case, MC. Mehta (Taj Trapezium Matter) vs Union of India are land mark judgments of Apex court towards safeguarding the people from environmental degradation.

With the increase of population, the transport vehicles using polluting fuels like Diesel etc. have multiplied manifold. The major cause for the air pollution is the vehicular emission and particulate matter. The carbon monoxide emissions from the diesel engines create respiratory problems like asthma, lung cancer etc. more particularly to the children reducing life expectancy. The need of the hour is to convert polluting Diesel vehicles into Green fuel. As on today, the number of CNG vehicles are far less than the polluting diesel vehicles. The reason behind the same is that we do not have adequate CNG stations covering nook and corner of India unlike Petrol Pumps to cater to the needs of the CNG vehicles. With the limited CNG Stations, the CNG vehicles have to stand in queue. Moreover, as the CNG stations are existing only in main cities without any coverage of the CNG stations in outskirts and villages, the user of CNG vehicle is not in a position to go on long travel due to non-availability of filling stations.

However, the PNGRB vide its Notification dated 14.5.2010 stated that the activity of setting up CNG Station can be undertaken only in areas AUTHORISED by the Board. i.e. CNG dispensation can not be done outside any authorized area without the specific permission of the Board.

Hence the need of the hour is to augment the CNG stations in all parts of India by filling up the gaps in the existing Petroleum and Natural Gas Regulatory Board (PNGRB) Policies/Guidelines by relaxing the rules for opening up of free market for setting up of CNG stations in line with Petrol Pumps instead of restricting the business through PNGRB controlled AUTHORISATION to only certain entities which are into City Gas Distribution. In other words, we need to have Customer Friendly Policy to encourage abundant availability of CNG Stations in all part of India with uninterrupted service for optimum utilization of the Green fuel free from any pollution.

II. CONTROLING FLARING OF NATURAL GAS

Flaring is generally used to relieve pressure without simply selling dangerous chemicals to the environment. Flaring often occurs when an oil well is discovered and tested. It may be that gasses are not economical to move or catch during the operation of a well, and so are flared. Throughout chemical processing, it can also occur. Flaring is commonly used in chemical processing to extract waste products or to alleviate emergency pressure. Other common sources of flaring are start-up and shutdown of plants; the list of possible examples is long.

III. BASIC DESCRIPTION OF UNITS FOR FLARING:

The figure below is an example of an industrial plant flare attached to it. The inlet flow for pressure release, combined with a vapor-liquid separation knockout tank, can be seen here, so liquids such as oil and water are not drawn into the flare stack and can be retrieved. The diagram contains an "Alternative Gas Recovery Unit" to recover some of the gas to be flared for use; this may not be enough or may not be sufficient to contain all inlet gas. The inlet gas to be flared in this diagram continues to a flashback seal drum with two essential mechanical features. First, a threshold pressure is needed for fuel inlet gasses to move from the knockout drum to the flashback seal drum. Second, purge gas flow removes any persistent fuel gasses. Both of these features make going

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down the flare stack and into the refinery difficult for any flame, causing destruction. The flare stack has an ignition flame at the top and is designed to eliminate flashback in this situation. Steam injection occurs here to boost the combustion efficiency.

With concerns such as gas composition and pressure, safety, environmental regulations and social effects (noise and light pollution), flares are implemented. The effects of thermal radiation, temperature, wind shear, and combustion efficacy are also considered.

IV. CARBON DIOXIDE FROM FLARING

The flaring of natural gas results in carbon dioxide being released into the atmosphere in the same way as natural gas being burned as a fire. One of the main concerns with the use of flaring, however, is that there is no real use or benefit except to keep people and equipment safe. Although flaring is widely used, flaring rarely results in a significant portion of a country's greenhouse gas emissions, except for a few countries. Globally, flaring accounts for less than 1% of the CO2 produced.

Flaring releases large emissions of greenhouse gases into the environment, resulting in no research being done. This is because methane, the primary natural gas component, has a higher potential for global warming than carbon dioxide. This does not suggest, however, that flaring is advantageous, as it would have even less effect to hold the carbon underground. Strategies to eliminate gas flaring include transportation to a market as a gas, conversion to a gas-like liquid fuel, on-site use for heat or electricity, and reinjection into underground strata.

Gas flaring cuts are an attractive option for reducing greenhouse gas emissions because gas is a product that can be sold. The permissibility of flaring, conditions under which flaring is permitted, and reporting requirements vary widely. Russian law requires 95% of the related gas to be used.

V. FLARING IN INDIA

India aims to halve the flaring of natural gas from its oilfields in a year in order to curb energy waste and environmental damage. The upstream regulator, the Directorate General of Hydrocarbons (DGH), has advised oil producers to take swift steps to curb flaring after a recent review of their efforts in this regard. India annually consumes about 850 million standard cubic meters of natural gas, about 2.6% of the total gas it produces.

In conjunction with crude oil, oilfields also contain some natural gas. International attempts to curb flaring have been ongoing for more than a decade, resulting in significant cuts from key manufacturing countries.

Analysts said India's tough flaring measures would help the green cause. This will help make better use of our energy and reduce emissions, distinguished fellow & head of the Observer Research Foundation's Resource Management Centre.

VI. DEVELOPING GAS-TO-LIQUID PROCESSES

How carbon-serious the subsequent fuel is will rely upon how a lot of vitality is required by the reactors and what sort of fuel they use.

FLARE GAS RECOVERY - BY RELIANCE INDUSTRIES LTD. (REFINERY DIVISION)

In order to encourage “Energy Conservation & Environment Protection” in the industrial sector, PCRA has continuously updated its knowledge base through energy audits, experience in these industries and developed case studies for the sharing of experiences by different industrial groups and organizations. The case study described below is one of DGH the changes made by Jamnagar's Reliance refinery to disseminate the information for the benefit of petroleum refineries.

INTRODUCTION

Jamnagar's Reliance refinery is the 3rd largest refinery in the world and India's largest refinery, installed a flare gas recovery system in November 2003 with in-house design and minimal assistance from the Netherlands Shell Global Solution. The aim of flare gas recovery is to reduce the loss of hydrocarbons by recovering flare gas from the main flare device and reuse as fuel gas in process furnaces, gas turbines, HRSGs (Heat Recovery Steam Generators) and auxiliary boilers.

For safety and operational reasons, a flare system is required. A small amount of hydrocarbon gas is kept in the flare device as a purge gas that is continually burned in the flare.

METHODOLOGY FOR REDUCING THE FLARE LOSS

Following methods were considered essential to reduce flare loss.

- ✓ Review the conditions in process equipment’s to minimize flare control valve openings.
- ✓ Identify leaky valves continuously and fix them
- ✓ Consider a flare gas recovery system.

Having worked on the first two methods and minimizing the loss of flare, it became apparent that further reduction of the loss of flare can only be achieved through a suitable and well-designed system for flare gas recovery. The flare gas recovery system is known to operate internationally in some refineries, while at some other locations it does not function properly. From their experience, it became clear that accurate calculation of the flare load was necessary for this system's successful operation.

PROPOSED PROCESS DESCRIPTION

The proposed Flare Gas Recovery System (FGRS) is a skid-mounted package consisting mainly of two compressors which take suction from the flare gas header upstream of the

Liquid Seal Drum, compresses the gas and cools it for re-use in the Refinery Fuel Gas System.

Usually, the flare gas bubbles through the seal drum upstream of the flare stack. In the flare header, the liquid level in the seal drum creates a strong backpressure and thus ensures that air is not drawn into the flare device. In order to provide better suction pressure while avoiding air ingress to the suction of the flare gas recovery compressor, changes are needed to increase the water level in the water seal drum.

The gas stream from the G / L separator is diverted to the Flare Gas Amine Absorber, where the amine gas is treated to eliminate the H2S present in the gas. The Amine Absorber's treated gas goes to the Fuel Gas header.

The Government of India needs to formulate a FLARING OF GAS POLICY to ensure that during the eventuality where the gas needs to be compulsorily flared due to impossibility of storage, the said quantity of FLARING Gas needs to be constructively utilized as a STOP GAS arrangement by taking the said gas in cascades/tankers to the nearby gas utility points. We are not only saving the money avoiding flaring and at the same time, the environment is also kept clean and green.

The above amendment calls for Rs. 10.08 Cr investment and the savings achieved are Rs. 14.0 Cr./annum with a payback period of 9 months.

VII. BRINGING USER FRIENDLY SHALE GAS POLICY

SHALE GAS

It is basically natural gas–mainly methane–found in shale formations, some of which were formed 300-million-to-400-million years ago during the Devonian period in the history of Earth. The shales were deposited at the bottom of relatively enclosed bodies of water as fine silt and clay particles. Primitive plants formed forests on land at about the same time, and the first amphibians made an appearance. Some of the methane formed from the organic matter buried with the sediments fled into sandy rock layers adjacent to the shales, forming relatively easy-to-extract conventional natural gas accumulations.But some of it remained locked in the tight, low-permeability shale layers, becoming shale gas.

INDIA

As reported by the 2015 U.S. EIA report, India has 96 trillion cubic feet of technically recoverable shale gas. In Cambay, Krishna–Godavari, Cauvery, Damodar Valley, Upper Assam, Pranahita–Godavari, Rajasthan, and Vindhya Basins, the recoverable reserves are identified. During October 2013, the Oil and Natural Gas Corporation drilled the first well of exploratory shale gas in Jambusar near Vadodara, Gujarat, Cambay Basin. It is estimated that around 20 TCF shale gas can be recovered from this basin. The country has Coal Bed Methane recoverable 9.9 trillion cubic feet. The CBM is mined from the mines of virgin coal. CBM is currently being manufactured from four blocks–Jharia in Jharkhand, Raniganj East and South in West Bengal and Sohagpur West in Madhya Pradesh. It is estimated that by the end of this year India will be able to produce about 5.5 million standard cubic meters of CBM, which could be about 5 percent of the country's total natural gas production. In Gujarat and Northeast India, tight gas reservoirs have been discovered in Eocene formations. According to the U.S. study, Oil Field Services Company, total tight gas reserves in Cambay amount to 0.55 TCF, of which production is currently not economically viable, but these reserves may be trapped in the future with the new technologies in place.

According to BP Statistical Review of World Energy, India's share of natural gas in primary energy consumption is still around 7%, compared to 28% for oil and 56% for coal. With conventional gas production already declining and the U.S. shale boom, the government has also been forced to search for unconventional energy resources like shale gas / oil.

POLICY GUIDELINES

Soon after the calculation of these estimates, the government announced on October 14, 2013, “Policy Guidelines for the Exploration and Exploitation of Shale Gas and Oil by National Oil Companies under Nomination Regime,” enabling two National Oil Companies (NOCs), namely Oil and Natural Gas Corporation Limited (ONGC) and Oil India Limited (OIL), to conduct shale gas exploration in 50 and 6 blocks, respectively.

These 56 blocks are located in Assam (7 blocks), Arunachal Pradesh (1 block), Gujarat (28 blocks), Rajasthan (1 block), Andhra Pradesh (10 blocks) and Tamil Nadu (9 blocks) states.

While it would take time to launch commercial operations, India's Oil and Natural Gas Corporation (ONHC) struck the first shale gas in a pilot project at Ichhapur in Burdwan, West Bengal. Its drilling began with ConocoPhillips on October 27, 2013, which helped ONGC provide technical assistance in the planning and evaluation phase of the data. In addition, ONGC has spudded one more well in the Cambay Basin area of Gandhar for shale gas and oil exploration.

Of the 50 wells for which ONGC has to identify and submit proposals, it has recently decided to drill 17 assessment wells to evaluate the nominated blocks of shale gas / oil potential in Cambay (11 wells), Krishna-Godavari (5 wells) and Cauvery Basin (1 well). These 17 wells ' estimated cost is pegged at Rs 625 crores.

In addition, ONGC also has other companies in both private and public sector undertakings that have initiated cooperation with the U.S., including investments in their shale play and LNG terminal stakeholders.

VIII. CHALLENGES

WATER CHALLENGE

But despite the efforts, which remains primarily on a pilot basis, India has to face the main challenge of having two precious resources available, namely water and land, which are needed in abundance to make shale gas business happen.

The problem of water stress is prevalent in all these places, such as Cambay, Gondwana, and Krishna-Godavari and the Indo-Gangetic plains, where shale gas reserves exist. India would prefer to initially work out waterless fracking techniques while discovering deposits of shale at the same time.

On the other hand, this will prompt India to strengthen its infrastructure for natural gas, including regassified LNG terminals, floating terminals, and a network of natural gas pipelines.

LAND CHALLENGE

Besides water, land is another challenge for the production of new shale gas, or real access to the subsoil where the minerals reside. In the U.S., underground resources are owned by landowners who happily provide a signing bonus and royalties for access to exploration and production. Therefore, there is absolutely no incentive for landowners.

In addition, acquiring land for fracking in India is a contentious issue due to a shortage of available land and densely populated areas such as Damodar Valley and Gangetic Basin, where shale gas prospects are present.

IX. WATER AND HYDRAULIC FRACKING: COMPLEXITIES AND CONFRONTATION

Since water laws in India are still premature, a water-intensive process of extraction of natural gas will certainly hurt the rights of the community to water. The Directorate-General for Hydrocarbons states that the extraction of shale gas requires approximately 5 to 9 million liters of water, but does not indicate whether this is one-time use or whether it has to be repeated several times during the lifetime of the well, nor does it indicate the expected gas output per well, so that estimates can be made for water per unit of gas. In a nation where «thirst» is still a cause of thousands of deaths, this amount of water is huge.

A project promoter must maintain a distance of 600 meters between aquifers and fracture zones to avoid contamination as per industry standards.

The Indian water legal regime is far away to make such specific observations, as aquifers are not defined in any of the Indian environmental regulatory or legal regime leading to a free pass for unregulated mixing of shale fluid and aquifers. Moreover, the landless have no right to groundwater, and accordingly peasants and tribal communities who have no ownership rights over land have no right on groundwater. Under high pressure, a combination of water, chemicals and sand is pumped underground to crack the surface, allowing oil and gas to flow. When the pressure used for injecting the mixture is removed, some of the fluid returns to the surface during the so-called “flow back” phase. Usually this period lasts two weeks. Return flows start as the well pumps oil and gas. The characteristics of ‘flow-back water’ due to the liquid pumped into shale fluid are different from the usual waste water and the related issues of ‘flow-back water’ disposal and leakage are different.

X. THE WAY AHEAD

India's goal is to begin exploring shale gas by 2020, and the government is developing a set of policies and directives to achieve this goal. Between 2012 and 2018, by enabling project promoters to simultaneously exploit conventional and unconventional shale gas resources in a region, the government provided business policy support.

A recent policy has also allowed a project advocate to explore shale gas in areas predominantly allocated to conventional gases. The speed of these “facility to do business” policies, however, may conflict with existing public policies that may raise concerns regarding water rationing, contamination and access to water resources by communities.

Given the exclusive existence of shale gas drilling issues, the government has left these problems to be solved through common environmental clearance procedures that do not even have a specific environmental clearance manual for unconventional hydrocarbons, including shale gas.

Also, the draft policy of the ministry and the guidelines of the DGH did not specifically address the issues raised by the fracking operations proposed.

Before the fracking process is implemented, the government must establish a domain-specific environmental clearance process that takes into account

- ✓ the proximity of shale wells to nearby aquifers,
- ✓ precautionary measures to prevent contaminated water from entering groundwater resources, and;
- ✓ a technical solution to the flowback water issue, specifically legislative categorization.

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