International Journal of Applied Research 2016; 2(2): 491-493

ISSN Print: 2394-7500
ISSN Online: 2394-5869
Impact Factor: 5.2
IJAR 2016; 2(2): 491-493
www.allresearchjournal.com
Received: 18-12-2015
Accepted: 20-01-2016

PV Ubale
Associate professor,
Department of statistics
G.S.Science, Arts & Commerce College Khamgaon 444303,
Dist. Buldana, Maharashtra, India

DivyeshUbale
M. Tech. (Thermal)
Sardar Patel College of Engineering, Mumbai,
Maharashtra, India

Correspondence
PV Ubale
Associate professor,
Department of statistics
G.S.Science, Arts & Commerce College Khamgaon 444303,
Dist. Buldana Maharashtra India.

Statistical study of natural gas reserves and exploration of shale gas in India

PV Ubale, Divyesh Ubale

Abstract
Growing population in India suggest that demand for energy in this region is likely to increase in the coming years and this situation ultimately means that more natural resources will be utilised to meet growing energy demand. Hence there is need to search for alternative sources of energy. This paper explains the nature of shale gas, the technology for its extraction from underground sources, and its potential for India. Recent shale gas wells are primarily horizontal while older shale gas wells were vertical. Shale gas is produced by hydraulic fracturing and its process and impacts on environment such as methane emissions, groundwater pollution, and increased seismic activities will be studied in this paper. Also focus is on statistical data & figures for use of shale gas.

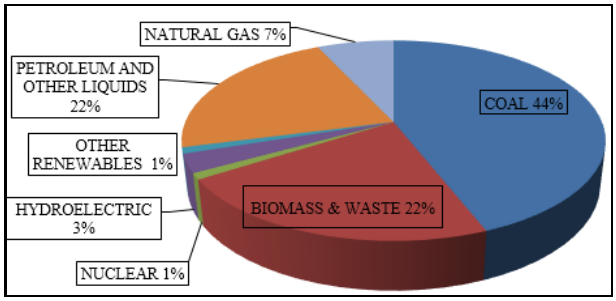
Keywords: Natural gas, Shale gas, Environmental problems, Well casing, CBM, Aquifer, Fracking.

Introduction
Shale gas is becoming an important source of natural gas mainly in US which lead to less dependence on oil imports. This lead to other countries to look forward for using shale gas as an important resource. India is mostly dependant on Coal for power generation. Depletion of fossil fuels in near future lead to search of alternative source of power generation. Government of India has allowed oil companies like ONGC and Oil India limited to explore shale. Six onshore basins namely Cambay, Krishna-Godavari, Cauvery, Assam-Arakan, Ganga and Gondwana are identified for exploration of Shale gas in India. If this is successful Government claims that it will bring down energy import bill of country which was about Rs. 7.83 lakh crore in 2012-13.

But certain environmental concerns have limited use of shale gas as efficient energy source. Process for production of shale gas like hydraulic fracturing has been banned in some areas of countries like France duel to growing environmental concerns. While some other countries like Argentina and China are willing to produce shale gas despite greater environmental risks so as to become more self-sufficient and to meet growing energy demands. India was the fourth-largest energy consumer in the world after China, the United States, and Russia in 2011, and its need for energy supply continues to climb as a result of the country's dynamic economic growth and modernization over the past several years. Figure below shows the total energy consumption in India in 2012. ONGC has been spending Rs 2,000 crore per annum on the exploration of oil and gas in Gujarat and Rajasthan. According to the ENERGY INFORMATION ADMINISTRATION report, India's shale gas reserves equals 96 trillion cubic feet which can supply for 26 years of the country's Gas demand. ONGC estimates India's shale gas reserve in the range of 500 to 2000 trillion cubic meters [ii]. Cambay is one of the basins that have been identified as potentially-bearing shale resources.

Shale gas recovery process
Coal bed methane (CBM) is extracted from coal beds which are an unconventional gas and it occurs much closer to the land surface than other similar gases. However, shale rock is found at a depth of 3,000 metres below the surface. The shale gas is located in the rocks of very low permeability and cannot escape to the surface as easily as Conventional Natural gas. Firstly, the land is drilled vertically up to a considerable distance. Shale gas is being explored by a method popularly known as hydraulic fracturing. This process involves the injection of water and sand into a shale formation and this leads to generation of fractures or cracks in the target rock formation. The sand or holds the fractures open so that the gas in the shale can

flow to the wellbore and in this way it is produced. Efficiency of fracture process is improved by adding small amount of additives in water and sand which are known as fluid or fracture fluids. This process creates passageways through which the natural gas, previously trapped in the shale rock, can now flow. During the fracturing process, companies monitor in real-time the rock response and well pressure, enabling them to ensure the safety of operations.



Source: eia June 26, 2014

Fig 1: Total energy consumption in India in 2012

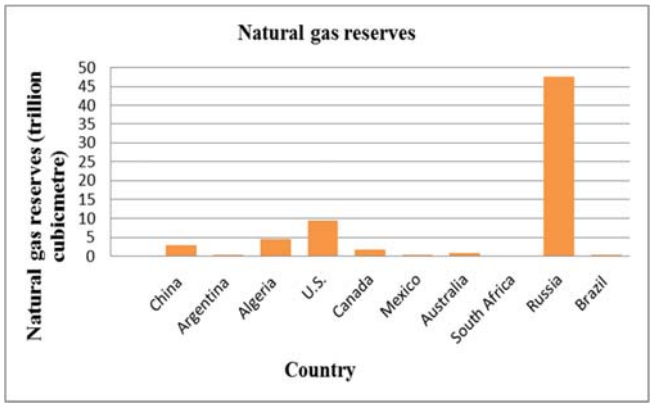


Fig 2: Natural gas reserves of top 10 countries [1]

This graph shows the top 10 countries in the world with respect to natural gas reserves with potential to recover shale gas.

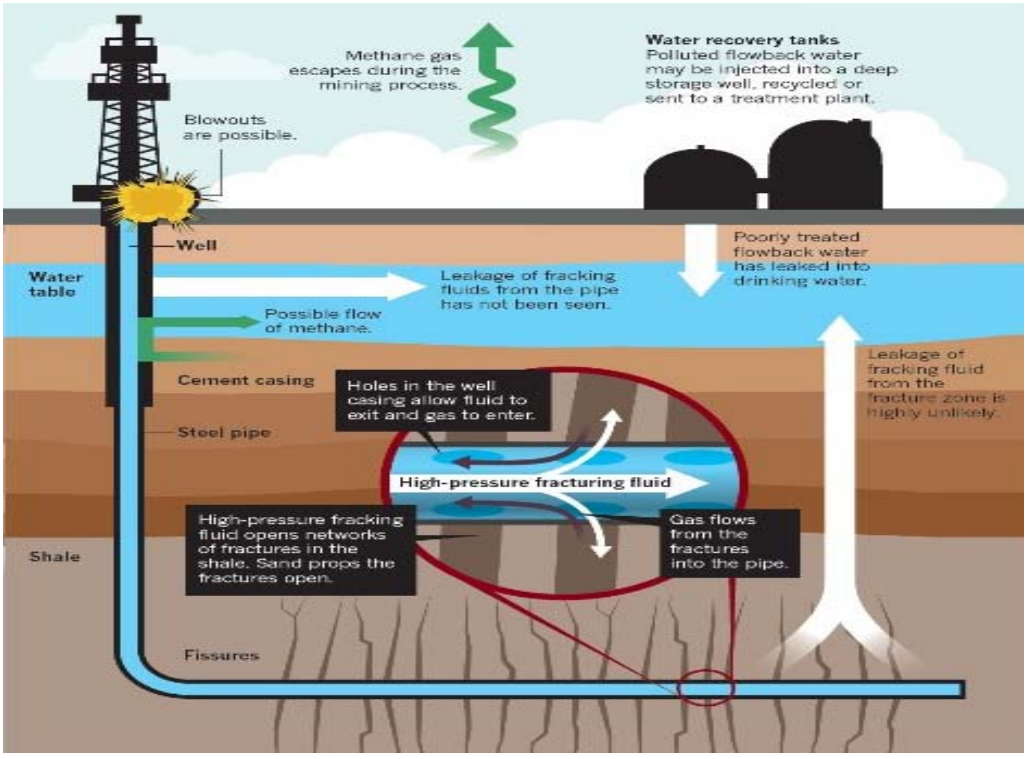


Fig 3: Shale gas exploration [i]

Well Casing

Hydraulic fracturing takes place around one to three kilometres below the surface. Drilling operation done vertically downwards for shale gas formation can penetrate the water table. The proper casing of shale gas wells is very much essential so as to ensure safety of operations [iii]. The casing process keeps the well open and protects the earth, similar to the efforts to protect groundwater. These safety techniques constitute construction of multiple barrier layers of steel and cement to isolate the well from groundwater:

1) Conductor casing: This type of casing is installed before the arrival of the drilling rig and is installed so as to prevent the top section of the well from collapsing.
2) Surface casing: It is generally up to 500m underground. This type of casing helps to stabilise the wellbore also it is used to protect groundwater deposits so as not to cause any contamination by potential gas leakage.
3) Intermediate casing: This type of casing is placed between the surface and production cases. This type of casing ensures that there will be no leakage path from the shale reservoir up to the aquifer and also the cement layer protects the casing from corrosion which is very important function.
4) Production casing: This type of casing is situated very deep and is the last casing. It constitutes the path from the surface of the well to the gas-producing shale formation.

This multiple layered design is very much essential so that if any one of the casings ruptures, nothing would go outside the wellbore thus ensuring safety. Also all wells are pressure-tested before hydraulic fracturing takes place at the actual site.

Environmental problems caused by shale gas production:
While the environmental safety of shale gas production is still under study there are many health and safety concerns which cause environmentalists to strongly oppose project related to hydraulic fracturing technology and water usage.

1) Contamination of groundwater and generation of waste water
Groundwater is mainly contaminated due to failures associated with vertical drilling and hydraulic fracturing technique especially in areas which are densely populated where ground water is very much needed for activities such as drinking, agriculture and industrial use. Huge amount of water is needed for industrial use. Ground water contamination is higher when natural gas is produced from shale sandstones. This is done mainly by hydraulic fracturing which generates huge amount of pressure and injects water at high pressure with added chemicals. In this case it is difficult to stop contamination of groundwater which leads to strong opposition to this technique by environmentalists.

2) Emissions of methane and Greenhouse gas
Greenhouse gases emission takes place in following two categories:(i) When shale gas is burned carbon dioxide (CO_2) is produced and also methane gets leaked out which is harmful to health and (ii) As shale gas is transported after extraction so the emission during transportation also creates harmful effects. Methane emissions from shale gas are comparatively higher when compared to natural gas reserves.

3) Increased seismic activity
Hydraulic fracturing technique occurs at high pressure and deep inside ground. Due to this some earthquakes have been observed in such exploration areas where there have been no earthquakes earlier in that area. This lead to fear among people residing in nearby areas which lead to strong opposition to such kind of exploration activities.
The government has drafted policy regarding exploration of shale gas and has given some provisions such as there should be mandatory rainwater harvesting plan in the area where exploration of shale gas takes place, which leads to minimization of the extent to which water will be required and requirement and demand will be balanced. It further states that mostly river, rain or groundwater should be utilized for fracking. This water should be recycled and reused so as to make the process efficient leading to less groundwater depletion.

Conclusion
Shale gas is definitely going to be a useful additional energy resource for India. But the challenge lies in making it sustainable and safe. The main limitation is that the process requires about 3 to 4 million gallons of fresh water which our country cannot afford in a water scarce condition. Also the environmental impacts caused due to exploration of shale gas has gained opposition from environmental activists. Along with the shale gas, many toxic chemicals are also released which cannot be disposed at once. Land acquisition for the drilling purpose is also a problem. Efficient techniques of exploration in near future can produce good results and will balance the energy demand with the use of shale gas.

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