

# Review on Shale gas by using Hydraulic Fracturing in India

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**ABSTRACT:** The paper study aims to find out the shale gas in Indian sedimentary basins. Guar gum plays a crucial role in the fracturing process. Though India accounts for 80% production of the world's total guar cultivation, but still it couldn't take the advantage, as only 10% of the production is used in India and rest 90% gets exported to oil and gas industries in outside countries. Depending on the type of organic matter and maturation level, unconventional hydrocarbons could be shale oil or shale gas or a combination of both. There is a sizeable deposit of shale formations in several sedimentary basins of India with different total organic (TOC) content and maturity history. The Cambay, Krishna-Godavari, Cauvery and Damodar valley are the four major basins of shale gas reservoirs as indicated by considerable thickness of shales; sufficient TOC (2 to 6 wt%) content; and good thermal maturity with vitrinite reflectance of more than 1.0. The Vindhyan, Upper Assam, Pranhita-Godavari and Rajasthan basins are other prospective basins that need to be probed by geo-scientific methods.

**KEYWORDS:** Guar gum, hydraulic fracturing, fracturing fluid, shale gas,

## I. INTRODUCTION

Production of natural gas (NG) from shale formations first occurred when the first gas well was completed in 1821 in Fredonia, New York; however, the low permeability of shale formations posed both technical and economic challenges to large-scale development. Largescale shale gas production started in the Barnett Shale in the 1980s, and by 2006, through advances in drilling technologies and higher NG prices, the success in the Barnett Shale led to rapid expansion into other formations, including the Haynesville, Marcellus, and Fayetteville shales. The development of this resource has generated interest in expanding NG usage in such areas as electricity generation and transportation. It is anticipated that shale gas will provide the largest source of growth in the U.S. natural gas supply through 2035. In 2009, shale gas contributed 16% of the U.S. natural gas supply. By 2035, it is estimated that its contribution will increase to 47% of total U.S. production of natural gas, with this anticipated growth in production raising the natural gas contribution to electricity generation from 23% in 2009 to 25% in 2035 (EIA 2011a).

Hydraulic fracturing is a key technique that has enabled the economic production of natural gas from shale deposits, or *plays*. The development of large-scale shale gas production is changing the U.S. energy market, generating expanded interest in the usage of natural gas in sectors such as electricity generation and transportation. At the same time, there is much uncertainty of the environmental implications of hydraulic fracturing and the rapid expansion of natural gas production from shale plays. The goal of this paper is to explain the technologies involved in shale gas production, the

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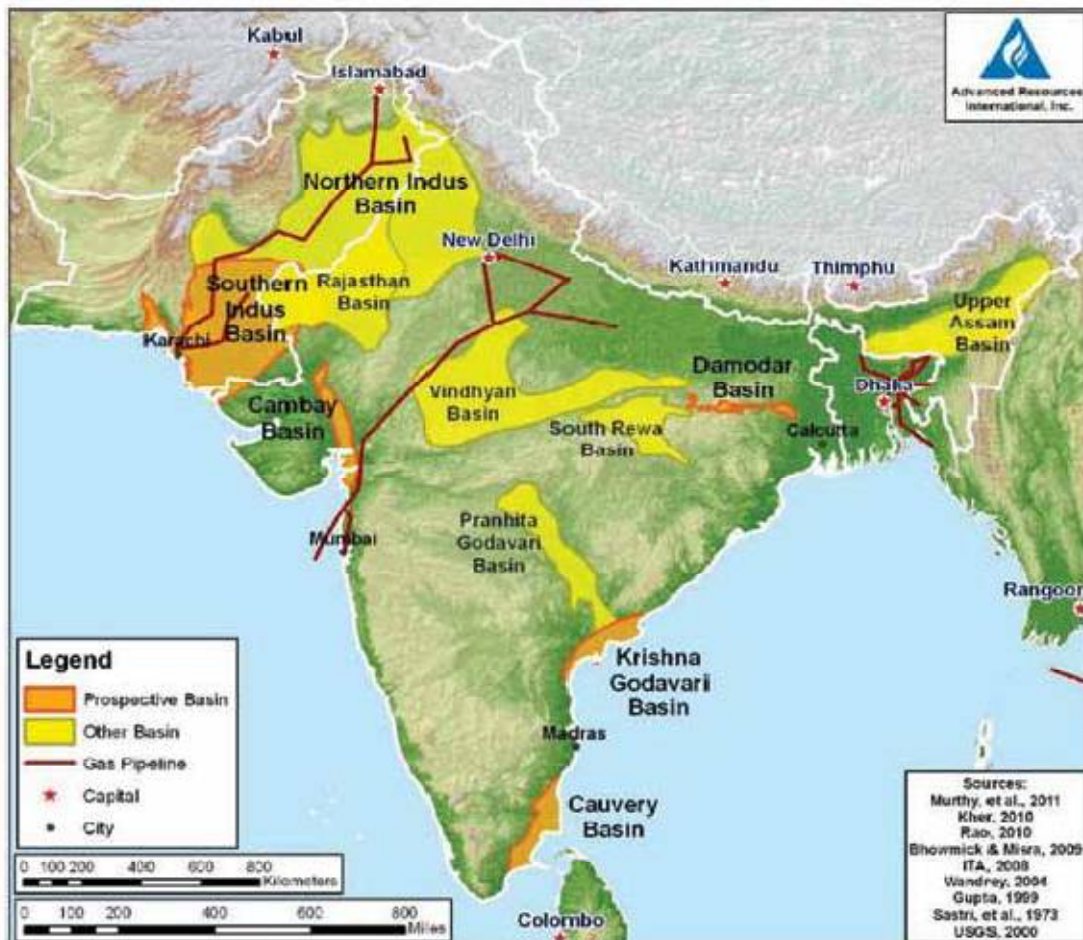
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potential impacts of shale gas production, and the practices and policies currently being developed and implemented to mitigate these impacts.

India is the fourth largest energy consumer in the world after USA, China and Japan. About 52% of her energy requirement is met by coal, 32% by oil and 6% by natural gas (Sen, 2013). Depletion of fossil fuels (coal, oil and natural gas) and non-discovery of major conventional hydrocarbon resources during the last few decades have prompted us to look for alternate sources of energy for development and sustainable growth of India. The Gas-hydrates, Shale gas and Coal bed methane are considered to be major potential resources of energy for India. The shale gas has stolen the spotlight in recent times after its successful production in USA using the hydraulic fracturing and horizontal drilling (King, 2010).

India has a number of sedimentary basins from Proterozoic to Cenozoic, which contain organic rich shales. By extracting relevant information mostly from a report of the US EIA, World Shale Gas Resources with Advanced Resources International (ARI), we see that some of the Indian basins especially the Cambay, Krishna-Godavari, Cauvery and Damodar Valley have good prospects of shale gas. Several other basins such as the Vindhyan, Upper Assam, Pranhita-Godavari and Rajasthan, though show thermal immaturity, contain measurable thickness of shale with good TOC content.



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## II. HYDRAULIC FRACTURING

**a) Principle:** A hydraulic fracture is formed when a fluid is pumped down the well at high pressures for short periods of time (hours). A proppant, usually sand or other coarse particles carried by the high viscosity fluid, is pumped into the fractures, and the mixture fills the fracture. The viscosity of the mixture must be sufficient at this point in the process to prevent the settling of the proppant particles. The pressure is then released, allowing closure of the fracture onto the fluid/proppant mixture. After the treatment, the proppant remains in the created fracture in the form of permeable pack that serves to keep the fracture open and also provides conductive pathways for hydrocarbons to flow into the wellbore, allowing the production to rise extensively at higher flow rates than otherwise possible.

Recovery of fluid is also as important as its injection and mainly for the completion of one complete cycle. Else, left gel would cause formation damage by decreasing oil and gas production. A successful fracturing treatment must allow oil and gas to easily flow through the fractured zone to the well bore and to the surface.

The effective fracture length doesn't only depend upon fracture length and width but also on good conductivity through the proppant and the formation environment.

Key element in the process- to obtain sufficiently high fluid viscosity at down-hole temperature and pressure to create a fracture in the reservoir and transport as much of intended volume of proppant particles into newly created fracture, as possible, as well as impair the loss of fracturing fluid to the formation during the treatment.

**b) Mechanism:** A hydraulic fracture is formed when fracturing fluid is pumped into the wellbore at a rate which is sufficient to increase pressure down hole which exceeds that of the fracture gradient (pressure gradient) of the rock. The fracture gradient is defined as the pressure increase per unit of the depth due to its density and it is usually measured in pounds per square inch per foot or bars per meter. This can be done by introducing into the injected fluid a proppants like grains of sand, ceramic, or other particulates, which prevent the fractures from closing when the injection is stopped and the pressure of the fluid is reduced. The pressure required to break the formation is dependent on overburden and material toughness. The propped fracture is permeable enough to allow the flow of formation fluids to the well. Formation fluids include gas, oil, salt water, fresh water and fluids introduced to the formation during completion of the well during fracturing.

**c) Well Drill:** Conventional or low-volume hydraulic fracturing which is being used to stimulate high-permeability reservoirs to frac a single well can be distinguished from unconventional or high-volume hydraulic fracturing which is being used in the completion of tight gas and shale gas wells, this is because unconventional wells are deeper and require higher pressures than conventional vertical wells. In addition to hydraulic fracturing of vertical wells, it is also performed in horizontal wells. This technique is known as 'well stimulation' when performed in already highly permeable reservoirs such as sandstone-based wells.

**d) Factors for selection:** There has been a great evolution in the use of fracturing fluids over past five decades and still continue to evolve. For the selection of fracturing fluid for a specific well, there is a necessity for understanding of the properties of the fluid and detailed modification in the fluid properties to accomplish desired effects.

Factors for selection of fracturing fluids:

- Low leak-off rate,
- Ability to carry the propping agent,
- Low pumping friction loss,
- Easy to remove from the formation,
- Compatible with the natural formation fluids,
- Minimum damage to the formation permeability,
- Break back to a low viscosity fluid for clean up after the treatment.

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## III. PROSPECTS IN INDIA

According to estimates by EIA, India has 63 trillion cubic feet (tcf) of recoverable shale gas reserves. However, there has been a recent downward revision in the estimates. India's shale reserve estimates pale in comparison to global standards, however limited exploration has been carried out so far. It is quite possible that similar to the US, India's shale gas reserve potential could be upgraded with further exploratory drilling. The Cambay, Krishna Godavari, Cauvery and the Damodar Valley are the most prospective sedimentary basins for carrying out shale gas activities in the country. The Cambay basin in Gujarat is the largest basin in the country, spread across 20,000 gross square miles, with a prospective area of 1,940 square miles. Around 20 tcf of gas has been classified as technically recoverable reserves in the basin. It is estimated that the Krishna Godavari basin, located in eastern India, holds the largest shale gas reserves in the country. It extends over 7,800 square miles in gross area, with a prospective area of around 4,340 square miles. The basin encloses a series of organically rich shales, containing around 27 tcf of technically recoverable gas. Figures shows the results of text detection from an image and inpainting by using exemplar based Inpainting algorithm. Figs. 2, 3, 4 (a) shows the original image. (b) is the image obtained by applying first set of criteria. All objects whose area greater than 10000 and filled area greater than 8000 are eliminated and major axis lengths are in between 20 to 3000 are considered to be text. Still, some small non-text objects are detected.

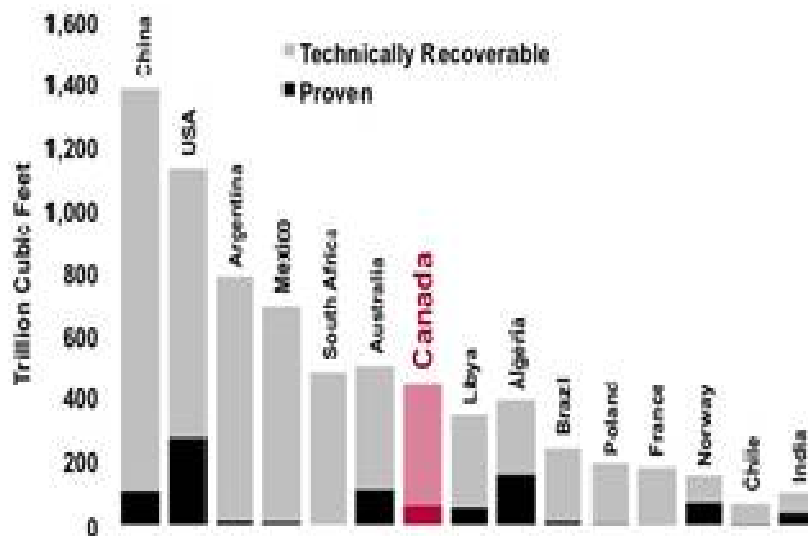


Fig.1 illustrates global shale reserves in trillion cubic feet of various countries. It gives the idea about both technically recoverable and proven shale reserves

**Demand of shale gas in India:** India's natural gas market continues to be in a state of deficit, with demand far exceeding the supplies. In FY12, around 38% of the gas demand was unmet. As a result, the dependence on 'liquefied natural gas' (LNG) imports has increased and there has been an underutilization of gas-consuming industries, particularly in the power and fertilizer sectors. For instance, the average 'plant load factor' (PLF) of gas-based power plants has declined from 66% in FY11 to 59% in FY12. Additionally, the existing gas-based units have to rely on expensive alternative fuels such as naphtha, diesel, furnace oil and LNG to meet demand. Therefore, promotion of hydraulic fracturing (gas recovery technologies) needs to be done along with its further advancement and growth in Indian energy sector, supplying the market with new source of energy.

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**Environmental Impact:** Hydraulic fracturing has raised environmental concerns and is challenging the adequacy of existing regulatory regimes. These concerns have included ground water contamination, risks to air quality, migration of gases and hydraulic fracturing chemicals to the surface, mishandling of waste, and the health effects of all these, as well as its contribution to raised atmospheric CO<sub>2</sub> levels by enabling the extraction of previously-sequestered hydrocarbons. Because hydraulic fracturing originated in the United States, its history is more extensive there than in other regions. Most environmental impact studies have therefore taken place there.

**Benefits:** Guar gum, being a natural product is non-pollutant to water and soil, thus can be used as a substituent to chemicals due to its suitable fluid properties. The air emissions from hydraulic fracturing are related to methane leaks originating from wells, and emissions from the diesel or natural gas powered equipment such as compressors, drilling rigs, pumps etc. [40] Also transportation of necessary water volume for hydraulic fracturing, if done by trucks, can cause high volumes of air emissions, especially particulate matter emissions

Hydraulic fracturing has been seen as one of the key methods of extracting unconventional oil and gas resources. According to the International Energy Agency (IEA), in India, the remaining technically recoverable resources of shale gas are estimated to the tune of 63 tcf . As a rule, formations of these resources have lower permeability than conventional gas formations. Therefore, depending on the geological characteristics of the formation, specific technologies (such as hydraulic fracturing) are required. Although other methods exist to extract these resources, such as conventional drilling or horizontal drilling, hydraulic fracturing is one of the key methods making their extraction technically viable. Significance of the extraction of unconventional hydrocarbons lies also in the fact that these resources are less concentrated than conventional oil and gas resources.

**Export scenario of guar gum:** India is the major exporter of guar gum to the world (as shown in Figure 2 ). It exports various forms of Guar products to a large number of countries. The country has exported 7, 07,326.42 MT of guar gum to the world for the worth of Rs.16, 523.83 crores during the year 2015-16.

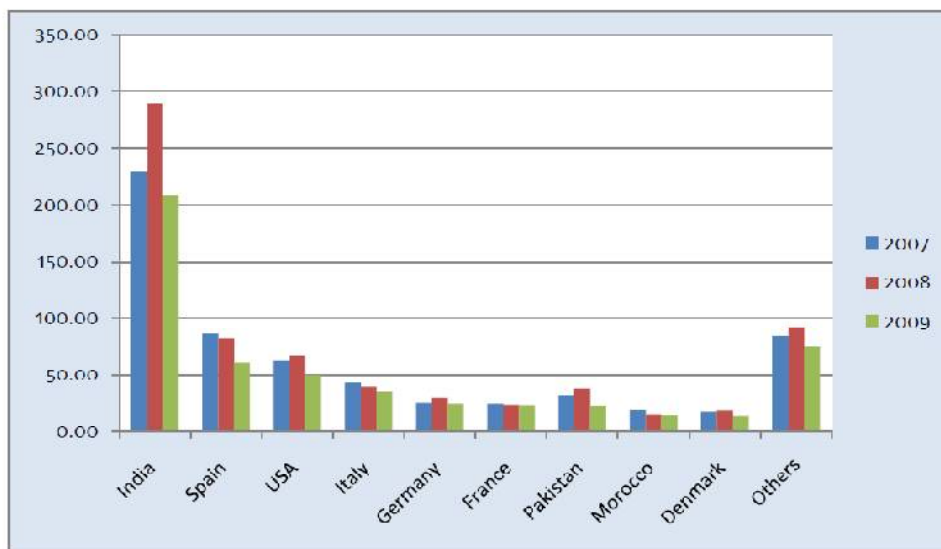


Fig.2 Major Exporting Countries of Guar gum.



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## IV. CONCLUSION

India is the largest producer of guar. With the advent and development of hydraulic fracturing technology, India can use guar as an eco-friendly fracturing fluid that might help taking a giant leap in the energy sector. This will ease burden of India regarding the import of energy fuels from foreign countries. The shale reserve can also be further accessed to deeper extent. And guar, being a leguminous plant, if grown repeatedly in Indian soil, will enrich the soil for harvesting different types of crops. The high clay content in the shale reservoir posing threat to effect hydro fracturing and reservoir monitoring at nanoscale are to be taken care for viable production of shale gas. So the Oil & Gas industries have to come forward to develop a systematic approach for Thus, it is recommended to promote the hydraulic fracturing technology and its associated benefits in Indian mines context and to access the deeper deposits of shale reserves of India.

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