

## 88. Shale Reserves; A Key Source to Overcome Energy Crisis

Inamullah\*, Abdul Qayoom, Dr. Abdul Razzaque Sahito, Faisal Hussain Memon

Mehran University of Engineering & Technology, Jamshoro, 76062 Pakistan

\*Email Address: inamullahhaneef@hotmail.com

### Abstract

Energy is a key source for development of any country. It is known as the backbone of World's Economy but its crisis may result in doomed the economy of any country around the world. Almighty has blessed with numerous naturally occurring sources like oil, coal, gas and other mineral resources from which the energy is obtained and functionalized through different processes. One of the major source of energy is the shale reservoirs that can be produced to overcome the energy crisis of a country or the world. Various surveys has proved that Pakistan has enormous amount of Shale gas reserves holding second position around the world; almost 586 TCF reserves of gas and 227 bbl tight oil reservoir. The shale reservoir can be extracted through hydraulic fracturing due to his low permeability and inconvenient porosity. The methodology is to pump high pressure water with the sand in perforated formation of shale in order to create channels for increasing effective permeability for economical and maximum production. These days united states of America is on the top of gas producing countries around the world by means of fracking of tight gas reservoirs and Pakistan is facing big shortfall of almost 2 BCF gas per day with the demand of six BCF Gas per day. By having the proper use of technology these energy crisis may be overcome easily and will ultimately results in the reduction of short fall in energy sector.

**Keywords:** Shale reserves, Energy crisis, Oil & Gas Techniques, Hydraulic Fracking

### 1. Overview to World Oil Reserves

World has huge amount of naturally occurring shale reserves that can be produced in order to reduce the shortfall/Energy crisis; quantitatively thirty five thousand seven hundred and eighty two trillion cubic feet (35782TCF) producible reserves. As per division of continent s Asia is on the 2<sup>nd</sup> position around the world having maximum reserves of shale [1].

**Table.1. Technically Recoverable Shale Gas in Place**

Continents	Gas in Place (Tcf)	Technically Recoverable
Africa	6,664	1,391
Asia	6,495	1403
South America	6,390	1431
Europe	4,895	883
North America	4,647	1,118
U.S	4,664	1,161
Austria	2,046	4,37
World	35,782	7,795

The Gas in place describes the gas volume accumulated in rock formation despite of the capability to produce it. The technically recoverable resources describe the gas volume that is considered to be recoverable by the use of current technology.

Asian countries are also enriched in shale reserves including Pakistan and China having enormous reserves of shale as shown in tab-2[2]

**Tab.2 Shale gas in Top-5 Asian Countries**

Countries	Gas In-Place(Tcf)	Technically Recoverable(Tcf)
China	4,746	1,115
Pakistan	586	105
India	584	96

Indonesia	303	46
Turkey	163	24

## 1.2 Types of Unconventional Reservoirs

The whole world is widely dependent of energy for communications, transportations, heating and electric power generation. A large amount of Energy is obtained through burning of fossil fuel.

Following are the main types of unconventional reservoirs

### 1.2.1. Oil shale

#### Definition:

Oil shale is fined-grained sedimentary rocks which are rich in immature organic material called kerogen.

#### Properties:

Oil shale is found at not greater depth that requires a thermal maturity to convert kerogen into oil and gas. Oil shale contains more inert mineral matters than coal like carbonates, silica or even sulphides. 500-400 Kcal/Kg is heating value of oil shale when crushed and burned directly [3].

#### Commercial Use and Economics:

Shale oil recovery has been improved a lot since current oil prices and depletion of the conventional reserves. Average shale oil production cost is greater than 60 \$ /bbl, which is comparatively high.

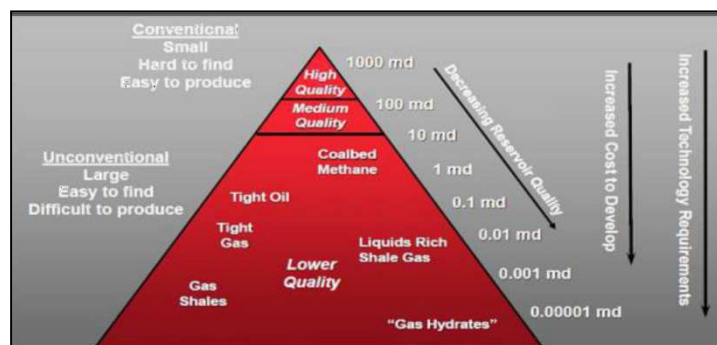


Fig. 1. Types of Unconventional Reservoir

### 1.2.2 Coal-Bed Methane

#### Definition:

Natural Gas that is stored in deeply buried coal seems is known as Coal Bed Methane.

#### Properties:

Coal originates from mines is environmental free. During transformation method biogenic methane is produced. In transformation method coal shrinks results in increase of micro porosity and decrease of coal strength ultimately cause fracture. Coal generally contains CH<sub>4</sub> but CO<sub>2</sub>, N<sub>2</sub>, C<sub>2</sub>H<sub>5</sub>, H<sub>2</sub>S and H<sub>2</sub> can also occurs in them [4]. The quantity of adsorbed gas at a shallow depth is usually higher than the quantity of conventional gas located at the same depth: it depends on the burial, temperature, type of coal, pressure and uplift history.

#### Extraction of Coal Bed Methane:

Coal is basically filled with water during the transformation process coal cleats is depressurized which

consequently amount of gas exceeds critical gas saturation and gas flows to the well bore.

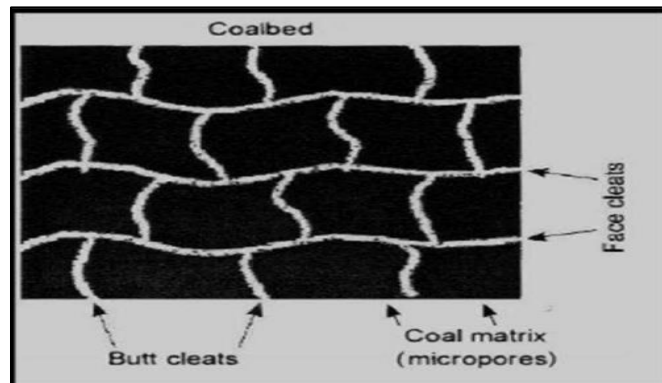


Fig. 2. Reservoir Structure of Coal Bed Methane

### 1.2.3 Tight Gas Sands

Those Reservoirs that have permeability less than 0.1 md is known as tight gas sands. The sands are called tight because these are poor sorted and cemented. Buoyancy forces in tight gas sands do not succeeds due to low permeability jail which cause poor sorting. The permeability jail results in a gas slippage or turbulence flow.

It is estimated there is 7405 Tcf of tight gas is present in the world.

### 1.2.4 Shale Gas

Gas which is produced from shale rocks is known as shale gas. Shale permeability varies between the ranges of micro and nano darcy. Where diffusion flow is dominant in nanodarcy ranges and viscous flow is dominant in microdarcy range, long completion is required. These reservoirs are mostly produced through stimulation job or horizontal drilling [5].

Following are the main properties of shale gas.

- Thick net pay. (Typically 50-600 ft.)
- Porosity is >3 % (typically 2-8%)
- High pressure (overpressure zone)
- TOC is >2 wt. % (typically 1-14%)
- Higher thermal maturity shrinks the in-place organics and creates more pore space for storing gas.
- Favorable in situ stress for fracturing.
- Depth is 1,000-13,000 ft. typically.

## 1.3 Geological Location of Un-conventional Reservoirs in Pakistan

Pakistan's shale oil and gas resources are mostly located in the lower Indus basin region, predominantly in Ranikot and Sembar, mainly in upper Sindh and lower Punjab while a sizeable reserve is also found in KhyberPakhtunkhwa. Prospective basins are Southern Indus Basin and Central Indus Basin along with the important Baluchistan basin and Northern Indus Basin. The following map illustrates the shale gas basins and its potential in Pakistan [6].

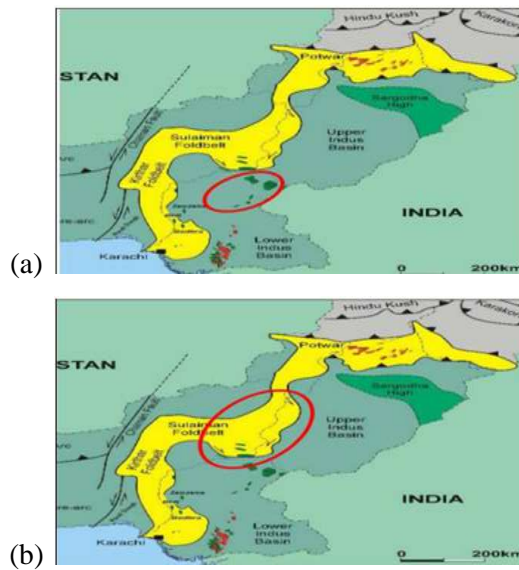


Fig. 3. Geological Illustration of Shale Reserves (a) Middle Indus Pakistan (b) Suleiman FB (Pakistan).

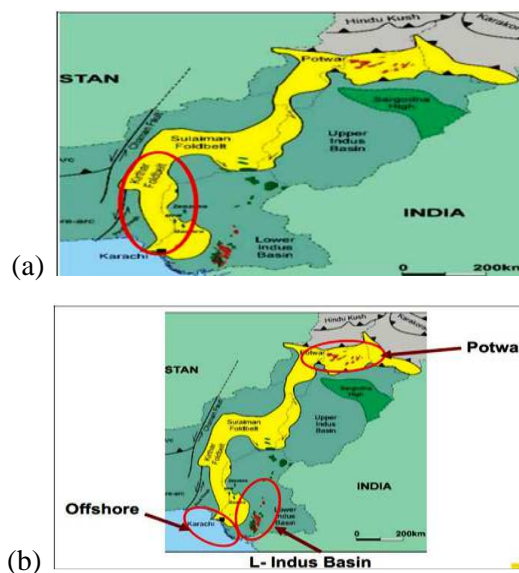


Fig. 4. Geological Illustration of Shale Reserves (a) Kirthar Area of Pakistan (b) Other regions (Pakistan)

## 2. Strategies for Production of Shale Reserves.

The key technique is Hydraulic fracturing to produce these naturally occurring resources, through applying the same technology the porosity and permeability of the reservoir can be increased in order to extract it out at the surface and utilize it as a energy source[7].

### 2.1 Hydraulic Fracking; A Key Technique

A process of stimulation by which the fractures are created in huge amount in the rock mechanically results in the flow of natural gas from these trapped reservoirs to the surface. The production rate can be increased also results in the production of total gas accumulated from the required shale [8].

- The well is drilled vertically to the aquifer and the surface casing is installed in order to isolate the ground water.
- The well is continuously drilled up again to the kick of point, after that it is deviated for drilling

horizontally in shale formation up to the targeted depth of trapped reservoir.

- By reaching the targeted depth the drill sting may be removed and the cement and annulus is cased.
- After that lowered the perforation gun in order to create perforation channels at short distance.
- High pressure fracturing fluid is pumped into the well results in creating the fractures.
- The fracking plugs are installed to create fractures in the entire formation of shale reservoir.

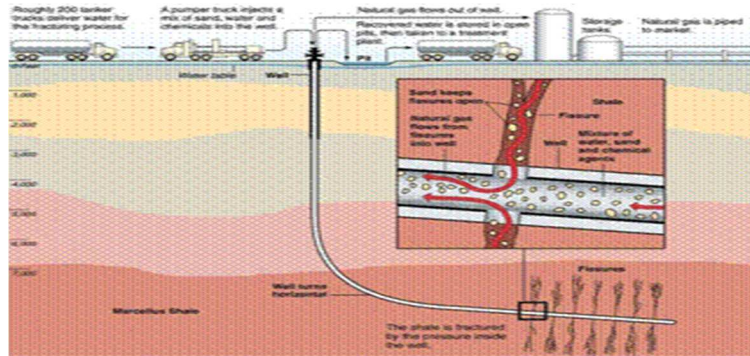


Fig 5. Hydraulic Fracking

## 2.2 Fracking Fluid Composition

The fluid is significantly composed of chemicals along with water like propane, retarder, accelerator and fraction reducer etc. The typical composition is as under in figure

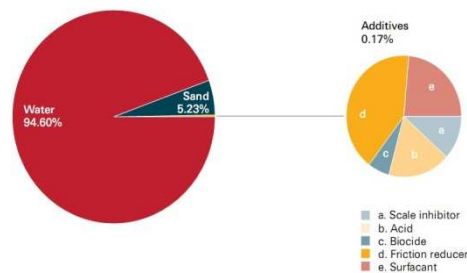


Fig 6. Composition of Fracking Fluid

## 2.3 Fracking Effect on Shale Reservoir & Recovery

The only method that enables the formation to produce is Hydraulic Fracking, whose main effects are:

- Fracking ultimately increases the shale permeability up to 1mili Darcy or greater.
- The fractures that are created through propane allow the seal reservoir oil/gas volume to rush in towards wellbore.
- Un-procurable gas up to 40-60% can be produced through hydraulic fracking

## 3.1 Economical Effect of Shale Gas Production

Generally the development of natural gas is viewed as a preferred option for energy to oil, coal and a key to employment and development of rural areas, economy and in interest of various investors. The high production will ultimately affect the cost of gas supplied in fewer amounts. Large amount of shale gas reservoirs leads to improvement in the economy of state and also the entire world as well [9].

## 4.1 Operational Problems & Remedies.

Very Huge amount of water and chemicals are required to inject into the wellbore for creating fractures.

When the formation is fractured the waste water is removed and store in open pits that is harmful to the environment [10]. It is significantly treated either for reuse or dispose off. Only 0.17 % of fracking liquid is comprised of chemicals and the rest is sand; pointed out by the companies associated with energy.

The fracking procedure and the act of infusing wastewater into profound wells lead to earthquakes at small intensity. The earthquake from fracking is too little to be a safety concern. More than one hundred earthquakes of small intensity were recorded, a notable number for a town that has never been the epicentre of seismic movement. The reason for the earthquake, which didn't impact critical.

## 5 Results & Conclusions

### 5.1 Results

- USA is the stand out nation, who is creating the shale gas stores. We should perceive how shale gas reservoir helps the USA.
- Unusual shale gas reservoir, powers our economy, conveys heat and energy to more than 60 million U.S. homes and gives our country a perfect smouldering, household vitality source.
- In the course of recent years, the mix of hydraulic fracking and horizontal drilling and have opened the guarantee of characteristic gas in shale gas reservoir in the intermountain West and shale all through the central and eastern U.S and have prompted a natural gas boom in a several territories of the nation.
- Among the principal targets was the Barnett shale store in northern Texas. As an after effect of hydraulic fracturing and horizontal drilling the Barnett Shale now creates more than 7 percent of America's natural gas, enough to energize 20 million homes for each year. Now operators are capable of drilling underneath Fortress Worth from miles outside as far as possible with directional drilling.
- Changes in innovation and use of science have added to a 8 percent increase in U.S. natural gas generation somewhere around 2007 and 2008, 30 percent increase in U.S. naturally occurring gas creation somewhere around 2010 and 2013 through improvement of shale.

### 5.2 Conclusion

Creation of shale gas reservoir will add to increment production rate, it is utilized for producing the power. World has and 7,795 TCF which are producible, 1 Tcf of naturally occurring gas is sufficient for heating 15 million homes or provide fuel to 12 million natural gas-let go vehicles for the period of one year [9]. Additionally Pakistan is likewise pregnant with the shale store of 105 Tcf, which will defeat the gas deficit and illuminate the Pakistan. Generation of shale stores can surmount the vitality emergency and additionally make the new openings for work and businesses to boosting the economy of world.

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