# International Journal of
## Engineering Research and Science & Technology

IJERST

www.ijerst.com

*Research Paper*

# SEAM QUALITY AND GAS RESOURCE ESTIMATION IN KULTI BLOCK OF RANIGANJ COAL FIELD WEST BENGAL INDIA

**Deepak Singh Panwar[1]\*, Vinod Kumar Saxena[1],**
**Ajay Kumar Singh[2], Prashant[3] and Anand Mohan Yadav[1]**

*\*Corresponding Author: **Deepak Singh Panwar*** ✉ *deepaksingh.4268@gmail.com*

In this present study an attempt has been made to evaluate the performance of the horizontal wellbores with and without fractures. The performance of both well has been measured by their gas recovery factor. The simulation study reveals that the recovery factor has been improved from 42.14% to 86.13% by fractured well approach with a recoverable resource of 20.89 to 42.70 MCM. It was seen that 51.07% more gas recovery can be possible from this seam.

**Keywords:** CBM, In-situ gas content, Adsorption isotherm, Gas recovery, Simulation, Gas analysis

## INTRODUCTION

CBM gas reservoirs have gained increasing attention in India due to huge availability of coal resources with good gas content. Few decades back coal bed methane considered as uneconomical source for methane production which is now considered as the most favourable and potential resource of methane extraction (Echols, 2001; Kinsland *et al.*, 2003; Scott, 2000a, 2000b; Warwick *et al.*, 2004; Singh, 2002). The gas production is highly affected by fracture system and fracture connectivity. If the cleat system is not properly developed it reduces the gas recovery from reservoirs. The original gas in place is an amount of gas which is present in the reservoir before production being started. It gives us information about deliverability of a CBM reservoir. The abandonment gas content of coal samples helps us to estimate the recovery factor. The recovery factor is a percentage of the gas that can be produced from a CBM reservoir. In this present study an attempt has been made to evaluate the performance of the horizontal wellbores with and without fractures. The

---
[1]  Department of Fuel and Mineral Engineering, Indian School of Mines Dhanbad, Jharkhand 826004.
[2]  Methane Emission and Degasification Department, CIMFR CSIR Dhanbad, Jharkhand 826001.
[3]  Mine Stowing and Filling Department, CIMFR CSIR Dhanbad, Jharkhand 826004.

performance of both well has been measured by their gas recovery factor. For this study several analyses were done like adsorption isotherm study for finding gas adsorption capacity of coal samples, gas composition analysis for finding the exact amount of methane, that can be produced from the reservoir, the gas content study conduct for estimation of actual gas which is present in reservoir and their simulation studies for estimation of gas and water production profile with time.

## LOCATION AND GEOLOGY OF STUDY AREA

The Kulti Coal Block covering an area of about 7.8 sq.km lies in the western part of the Raniganj Coalfield and east of Barakar River. Bounded by the coordinates Latitude N 23⁰42'18''to 23⁰44'02'' and Longitude E 86⁰49'48'' to 86⁰52'14'' this coal block is situated in the Burdwan district of West Bengal, India. Kulti Block is virgin and no mining activity is currently progress in that area. It is surrounded by Mahatadih Raidih (unexploited block of Steel Authority India Limited) in the west and in the North, Begunia (running) and Victoria West (Suspended) mines in the West; Ramnagar (running mine) in further North; and Victoria (closed mine) in the north-eastern part. All the surrounding mines are developed by the board and Pillar method and then SDL or splitting as final operation. The Begunia and Laikdih seams at neighbouring Begunia Colliery are Degree III gassy seams. The geological map of Kulti block is shown in Figure 1.

## MATERIALS AND METHODS

### Gas in place Estimation

**Core Analysis:** Coring and core analyses are



Figure 1: The Geological Map of Kulti Block
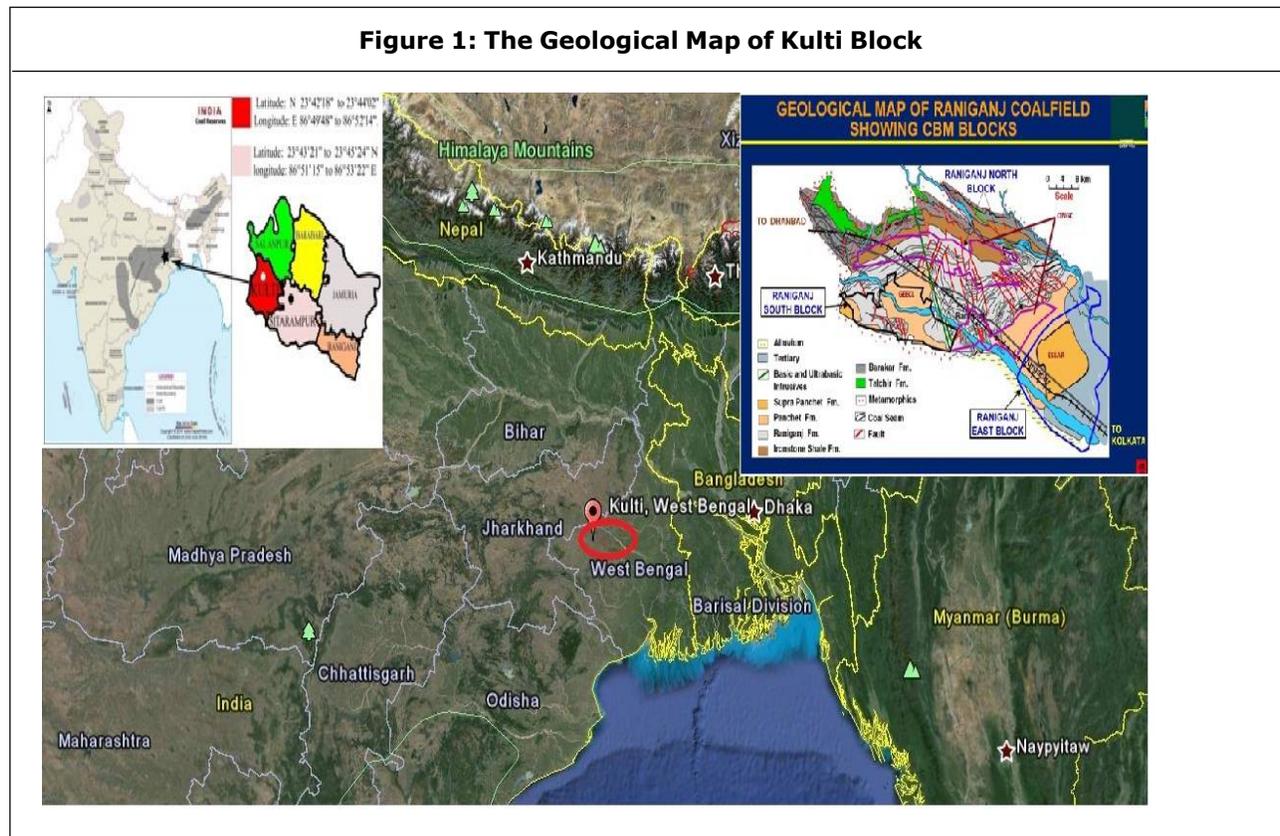
important parameters for estimating an unconventional resource. Core analysis usually related with in-situ gas content and maturity of the coals which leads to a proper evaluation of resource in place.

**Gas Content Estimation:** Canister desorption experiments were employed for determining gas desorption rate and gas content of the coal samples. The in-situ gas content in the coal were estimated by adding lost, measured and residual gas volumes divided by mass of coal sample. The desorption study is performed by sealing coal sample in a canister and measuring the volume of gas evolved from the sample as a function of temperature, time and pressure. The volume of gas which is released from coal sample is measured by displacement of water from a graduated cylinder.

**Adsorption Isotherm Estimation:** The adsorption isotherm study of coal samples was done in the laboratory by adsorption apparatus. The experimental setup used for the volumetric adsorption isotherm consists of water bath which is used to maintain desorption isotherm conditions for the reference and sample bombs, the control panel employed for regulates the flow of gas to the reference and sample cells with monitoring gas pressure. The reference cells are never separated from the system and its purpose is to store a known volume of gas at known pressure and temperature. Sample cells are used to keep the coal samples to determine adsorption isotherm. Estimation of the isotherm involves two-step, first is to determination of dead volume of the system and second evaluation of adsorption isotherm. First, the samples were prepared in the slandered size range and then for equilibrated



**Figure 2: Schematic Diagram of Adsorption System**
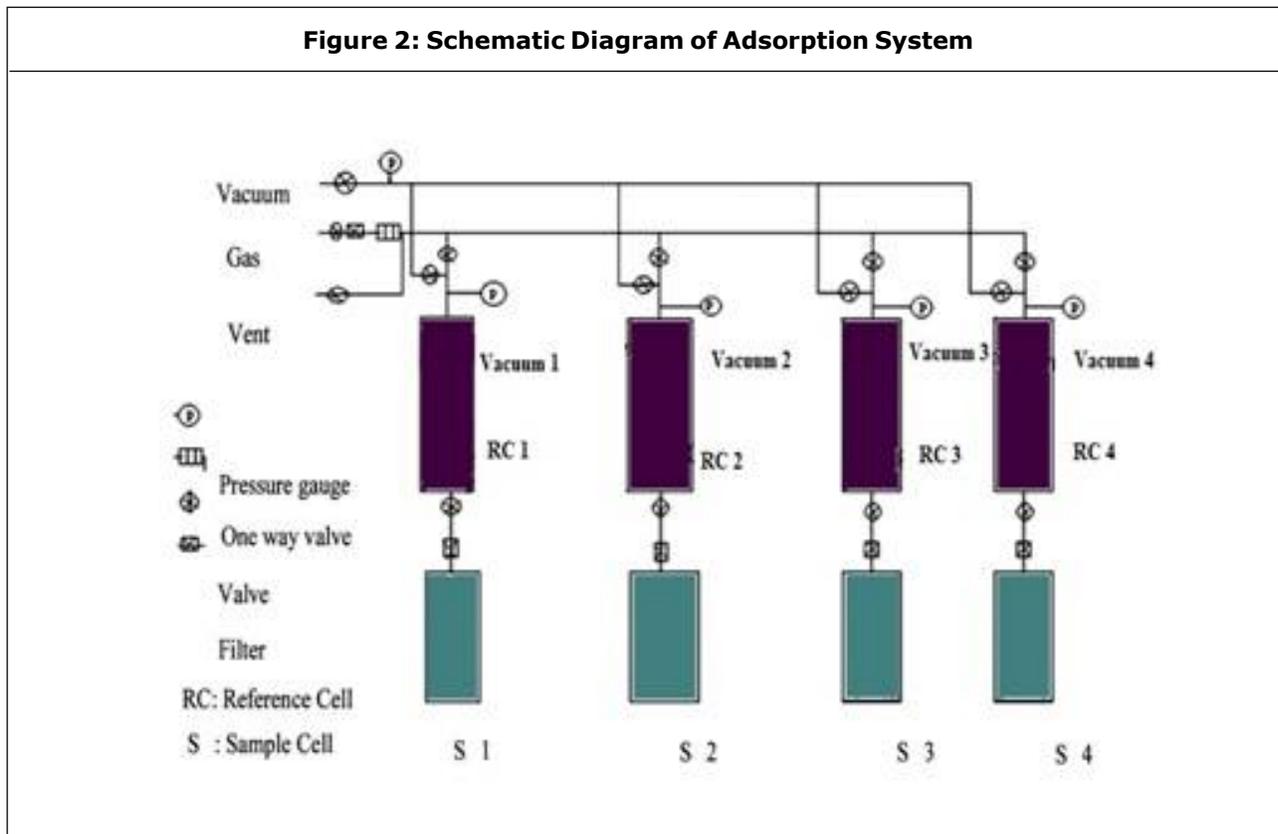
moisture by following ASTM standard. A known sample weight is put into the sample cell than attached to the apparatus. The dead volume is then determined by evacuating and filling the reference cell with helium and allowing it to equilibrate. The helium is than admitted into the sample cell and dead volume is calculated by the drop in pressure. Schematic diagram of adsorption system is presented in Figure 2.

After determination of the dead volume, the apparatus is again evacuated for determination of adsorption isotherm. The adsorbent is added to the reference cell, allowed to equilibrate and then admitted into the sample cell. The amount of gas adsorbed is determined from drop in pressure. The procedure is repeated at increasing pressure steps until the highest pressure is reached.

**Gas Composition Analysis:** Molecular gas compositional analysis was carried out by following the Standards of ASTM D 1945. The gas samples thus, collected at different time intervals were analyzed for molecular compositions on Chemito GC, Model 8610 by using modified Fisher Thermal Conductivity Detector at 400C. The molecular concentrations are reported as percentage on air free basis.

**Model setup:** The 3-D reservoir model represented by a 254.6*254.6*10 Cartesian grid pattern of 11x11 m mesh geometry was the integral structure for the coal seam characterized through a dual porosity and single permeability model which is constructed in COMET3. Seam wise gas content, permeability, Adsorption isotherm data, porosity and hydrostatic reservoir pressure was input for Simulation study. The average Properties of all the parameters which are used in simulation study is shown in Table 1.

| Table 1: Average Properties of Coal Samples | |
|---|---|
| Parameter | |
| Depth of reservoir, ft | 3808 |
| Reservoir temperature, $^0F$ | 146.30 |
| Reservoir pressure, psi | 1629 |
| Porosity, % | 0.005 |
| Permeability, mD | 3.81 |
| Coal density, gm/cc | 1.35 |
| Thickness Seam (m) | 13 |

# RESULTS AND DISCUSSION

## Estimation of Gas Content

Canister desorption experiments were employed for determining the gas desorption rate and gas content of the coal samples. The in-situ gas content in the coal were estimated by adding lost, measured and residual gas volumes divided by mass of coal sample. The desorption study is performed by sealing coal sample in a canister and measuring the volume of gas evolved from the sample as a function of temperature, time and pressure. The volume of gas which is released from the coal sample is measured by displacement of water from a graduated cylinder. It was found that the lost gas content of coal samples has been found in the range of 0.432 to 0.555 cc/g at STP on as receive basis to dry ash free basis.

The Residual gas of the coal samples from the study area lies between 0.279-0.359 cc/g at STP on as receive basis to dry ash free basis. Similarly, the desorbed gas content values were found to be 6.074-7.808 cc/g at STP on as receive basis to dry ash free basis. Seam wise average gas content of coal samples are given in Table 2.

**Table 2: Seam Wise Average Gas Content of Coal Samples**

| Seam | Average Gas Content($m^3$/t) |
|------|------------------------------|
| Begunia Seam | 5.21 |
| Ramnagar (T) | 7.18 |
| Ramnagar(B) | 8.18 |
| Laikdih(T) | 8.27 |
| Laikdih(B) | 9.16 |

## Original Gas in Place and Recovery Factor

The Estimated gas reserve and recovery factor was calculated from Eq. (2) and Eq. (3), given below:

$$OGIP = \text{Coalzone thickness} \times \text{Area} \times \text{Density} \times \text{Gas content} \quad ...(1)$$

$$\text{Recovery Factor (\%)} = \left[\frac{Gci - Ga}{Gci}\right] \times 100 \quad ... (2)$$

The thickness of the coal seam was 13 m with gas content 8.72 cc/g and 80 acre area, estimated reserve was 49.58 MCM. The recovery factor is 90.25% with a recoverable resource 44.74 MCM.

## Adsorption Isotherm Study

The Langmuir volume shows the gas storage capacity of the coal sample at infinite pressure, and Langmuir pressure is the pressure at which the gas storage capacity of the coal sample is half the Langmuir volume. From experiments, it was seen that the coal is having the higher adsorption capacity. The values are varying from 14.47-16.60 cc/g at moisture equilibrated and dry ash free basis. However, the sample also has sufficient gas content varying from 6.78 to 8.72 cc/g on as receive to dry ash free basis. The reduction of gas in the coal sample shows that there is any fault or fracture present in the area.

The methane adsorption isotherm and Langmuir constant curves are shown in Figure 3 and 4.

## Gas Composition Analysis

The composition of the gas samples which are collected from the field shows that the methane concentration is high and it varies from 97.833 to 97.621% (air-free basis). The huge amount of methane (42.187 MCM) is recovered from the fracture well method. The higher hydrocarbon components ($C_2$+) constituting up to 0.735% with 0.315 MCM of gas resource. The concentration of $CO_2$ varies from 1.145 to 1.354%, which shows that large amounts of $CO_2$ is produced and can be recovered for ECBM recovery prospects. The methane, carbon dioxide and higher hydrocarbon production with time is shown in Figure 5 and 6.

# SIMULATION RESULTS

The simulation study which was carried out by using COMET3 software. The simulation study shows that the recovery factor has been improved from 42.14% to 86.13% by fractured well approach with a recoverable resource of 20.89 to 42.70 MCM. As the simulation values are very close to the experimental values, so this data can be used to predict the future production of the reservoir. The predicted future Cumulative and production rate of the recoverable gas and water has been shown in Figures 7 and 8.

## Coal and Gas Resource in Kulti Coal Block

Average gas content of coal seams was then computed. Seam-wise coal reserves were also estimated using coal seams thickness and block area. Gas reserves were then computed by multiplying the coal reserves and average gas content. Seam-wise coal reserve and estimated gas resource are summarized in Table 3.

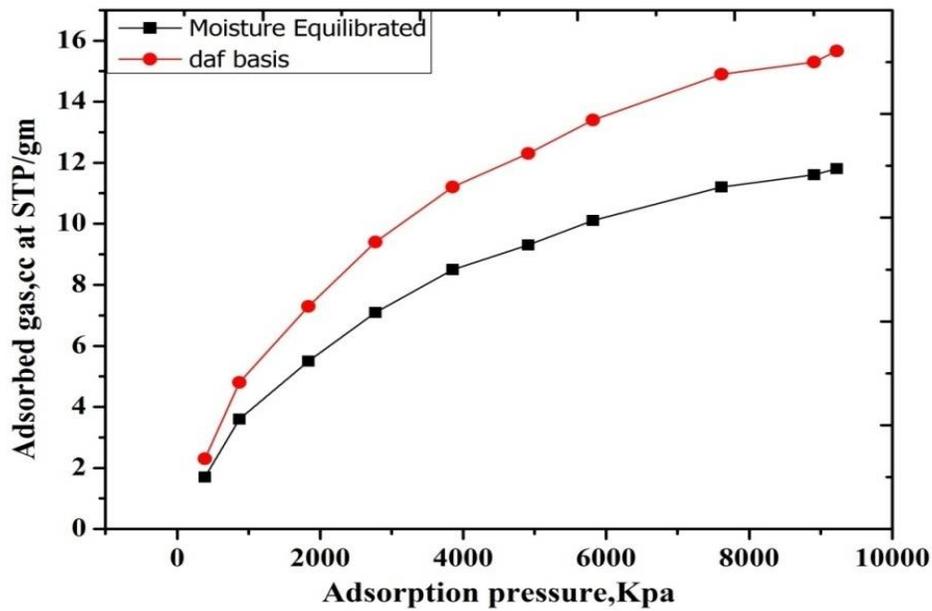**Figure 3: Methane Adsorption Isotherm Curve of Coal Sample**



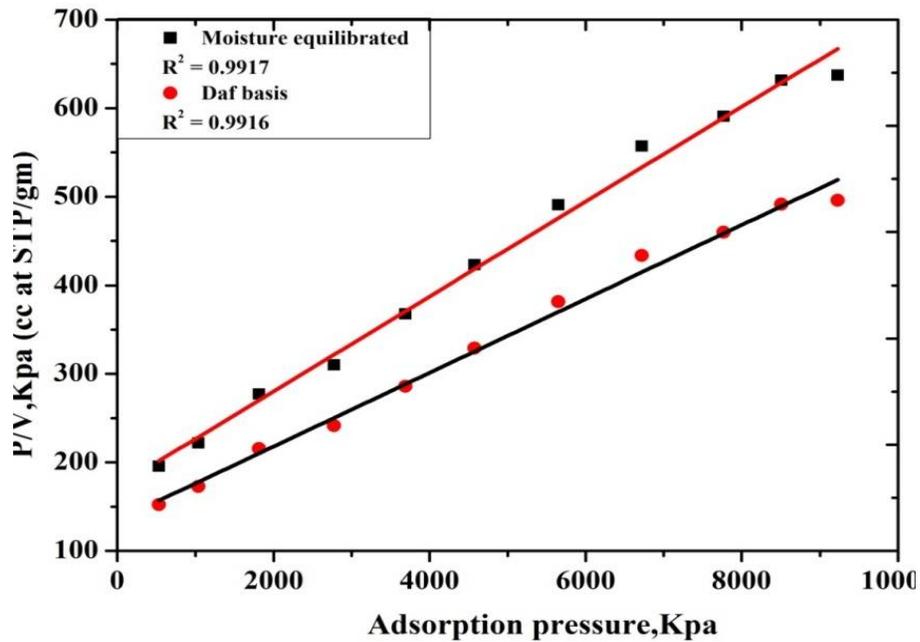**Figure 4: Langmuir Constant Curves of Coal Sample**

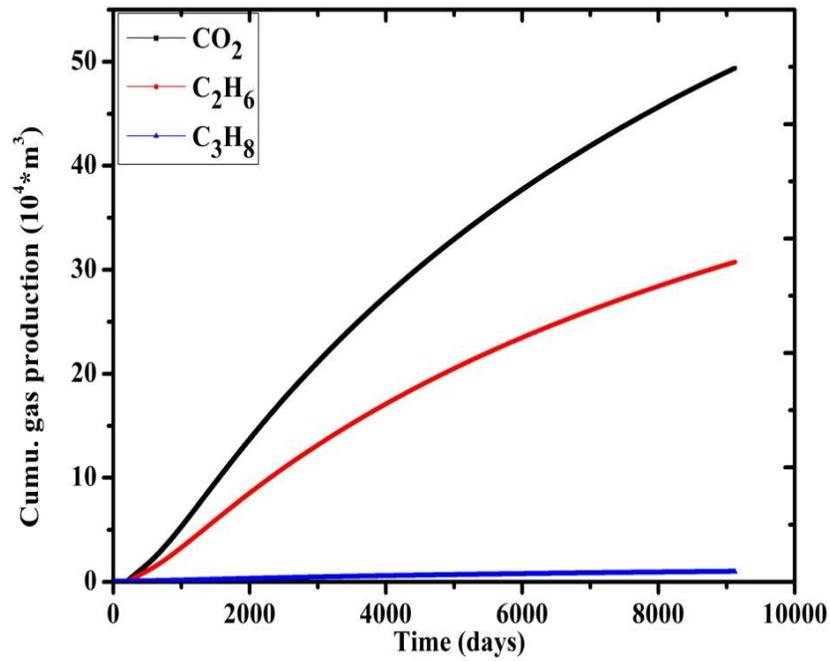**Figure 5: Cumulative Carbon Dioxide and Hydrocarbon Production With Time**
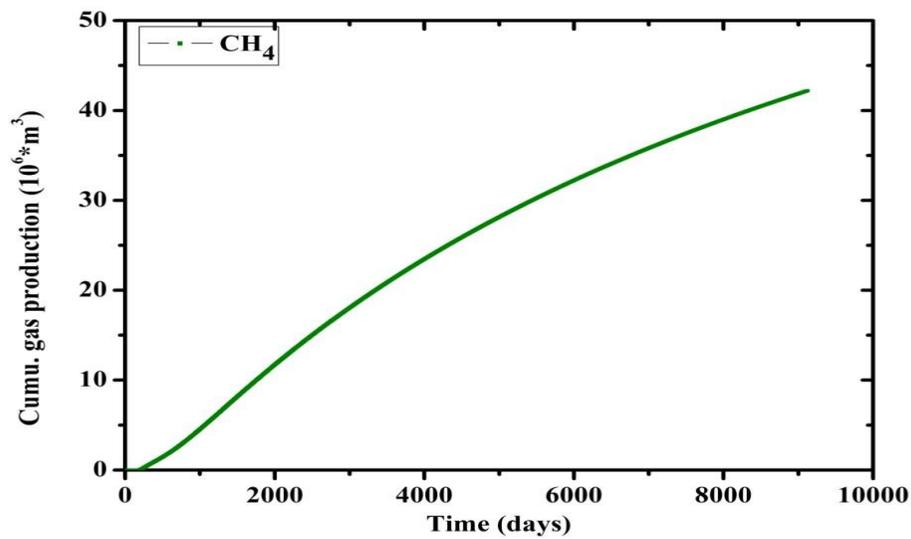


**Figure 6: Cumulative Methane Productions With Time**

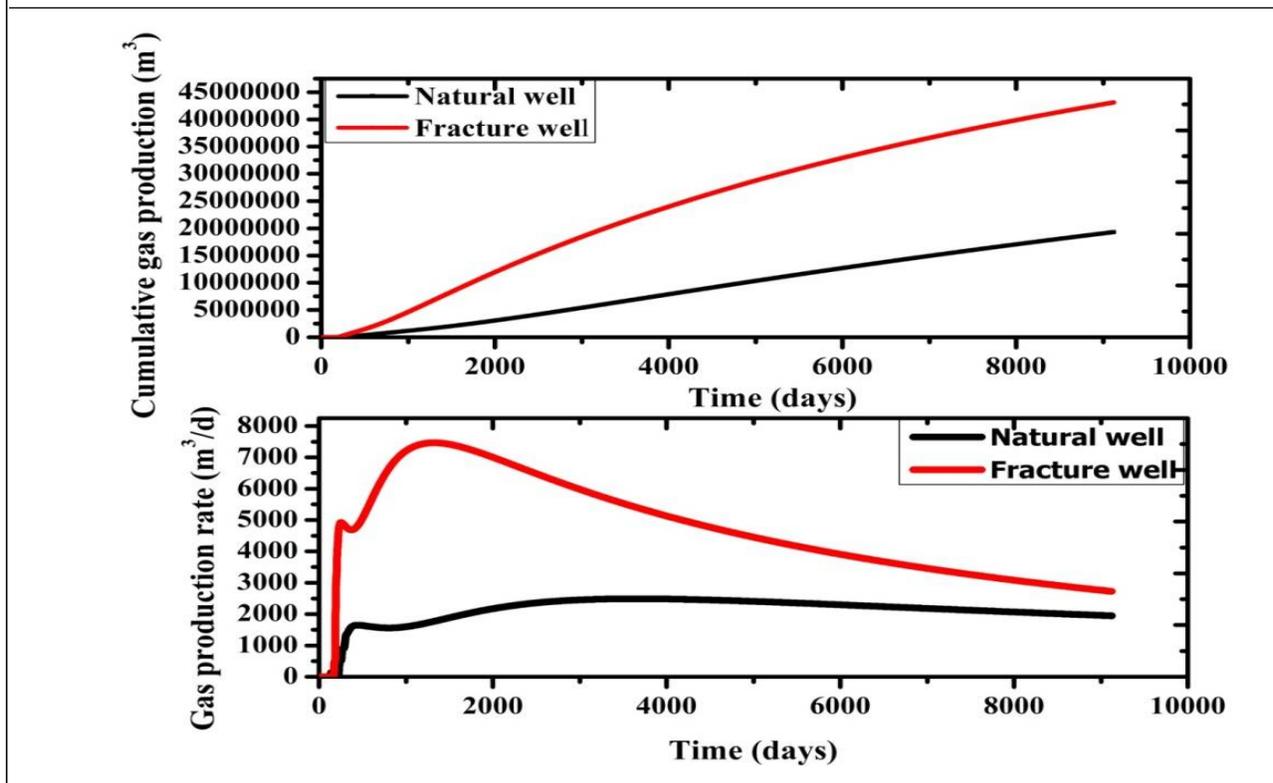**Figure 7: Cumulative and Production Rate of Gas With Time**



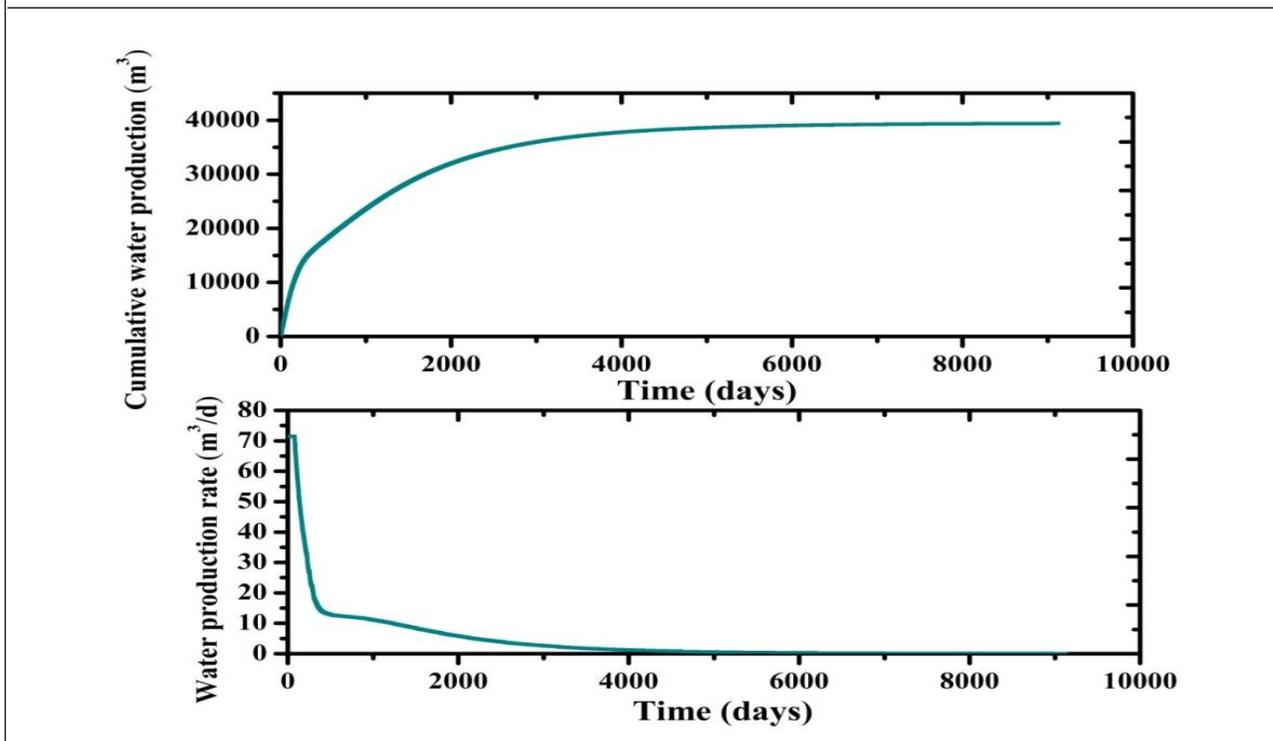**Figure 8: Cumulative and Production Rate of Water With Time**

**Table 3: Seam-wise Coal Reserve and Estimated gas Resource**

| Seam | Coal Resource (Mt) | Gas Resource (MCM) |
|------|--------------------|--------------------|
| Begunia Seam | 20.83 | 108.52 |
| Ramnagar (T) | 15.97 | 114.66 |
| Ramnagar(B) | 16.66 | 136.28 |
| Laikdih(T) | 32.24 | 266.62 |
| Laikdih(B) | 124.93 | 1144.36 |
| Total | 210.63 | 1770.44 |

It is observed that about 210 million tonnes of coal reserve is available in the Kulti Block. Total gas resource in the Kulti Block is estimated as 1.77 BCM. Laikdih group of seams contain the major share of coal and gas.

## CONCLUSION

Deep seated coal seams in block are best suited for CBM production because of less feasibility of coal mining. The simulation study reveals that the recovery factor has been improved from 42.14% to 86.13% by fractured well approach with a recoverable resource of 20.89 to 42.70 MCM. It was seen that 51.07% more gas recovery can be possible from this seam. The gas analysis data shows that large quantity of $CO_2$ also recovered from well. The dual benefit approach of this mechanism of carbon capture from gas cleaning plant only help in reducing the transportation cost of CO2 but also added advantage in the enhance gas recovery in block.

## REFERENCES

1. Diamond W P and Levine J R (1981), "Direct method determination of the gas content of coal: procedures and results", No. RI-8515.

2. Echols J B (2001), "The producibility of coalbed methane from Wilcox coals in Louisiana", *Gulf Coast Assoc. Geol. Soc. Trans.*, Vol. 51, pp. 75–84.

3. Kinsland G L, Zeosky J E, Smith G B and Schneider R V (2003), "Integrated exploration scheme for lower Wilcox coalbed methane in central Louisiana", *Gulf Coast Assoc. Geol. Soc. Trans.*, Vol. 53, pp. 398–409.

4. Laxminarayana C and Crosdale P J (2002), "Controls on methane sorption capacity of Indian coals", *AAPG bulletin*, Vol. 86, No. 2, pp. 201-212.

5. Scott A R (2000a), "The pre-quaternary history of re", *Palaeogeogr., Palaeoclimatol., Palaeoecol,* Vol. 164, pp. 281–329.

6. Scott A R (2000b), "Coalbed methane potential in Texas", *Gulf Coast Assoc. Geol. Soc. Trans.*, Vol. 50, pp. 509–526.

7. Singh U P (2002), "Progress of coal bed methane in India", In: Proceedings, North American Coal Bed Methane Forum, Star City, WV: North American Coal bed Methane Forum, Chapter 15.

8. Warwick P D, Breland Jr., F C, Ratchford M E and Hackley P C (2004), "Gas resource potential of Cretaceous and Paleogene coals of the Gulf of Mexico Coastal Plain" (including a review of the activity in the Appalachian and Warriorbasins).