SUMMER TRAINING REPORT - 2024

Oil and Natural Gas Corporation Limited
CBM Asset, Bokaro

PROJECT TITLE- OVERVIEW OF CBM AND SRP FAILURE IN CBM ASSETS'S

SUBMITTED BY:

Abhishek Kumar Shah
Admission no.- 22JE0031
B. tech (Petroleum Engineering)
IIT(ISM) Dhanbad, Jharkhand

SUBMITTED TO:

Smt. Anita Yadav
GM(P) Surface Team
ONGC CBM, Bokaro

CERTIFICATE

This is to certify that Mr. ABHISHEK KUMAR SHAH (B. tech, Petroleum Engineering IIT(ISM) Dhanbad, Jharkhand) has successfully completed his summer training in Surface department from May 27th, 2024 to June 26th, 2024.

Apart from the study of various departments in ONGC, the individual attached special focus and projectized the **"OVERVIEW OF CBM AND SRP FAILURE IN CBM ASSEST'S "**Operations, under the guidance of Smt. Anita Yadav – GM(P), ONGC Bokaro.

I wish him all the best and success in his future endeavor.

Anita Yadav
GM(P) Surface
Team
ONGC CBM, Bokaro

ACKNOWLEDGEMENT

A summer training is a golden opportunity for learning and self- development. I consider myself very lucky and honored to have so many wonderful people lead me through in completion of this training.

I wish to express my indebted gratitude and special thanks to my mentor **Anita Yadav, GM(P)** who in spite of being extraordinarily busy with her duties, took time out to hear, guide and keep me on the correct path and allowing me to carry out my industrial project work at their esteemed organization during the training.

I am also obliged to staff members of various departments of ONGC, Bokaro for the precious information provided by them in their respective fields. I am grateful for their cooperation during the project.

-Abhishek Kumar Shah

CONTENT

1. About ONGC

Maharatna ONGC is the largest crude oil and natural gas Company in India contributing around 71 per cent to Indian domestic production. The Oil and Natural Gas Corporation Limited (ONGC) is an Indian central public sector undertaking under the ownership of a Ministry of Petroleum and Natural Gas, Government of India. ONGC was founded on 14 August 1956 by the Government of India. In November 2010, the Government of India conferred the Maharatna status to ONGC.

The Vision of ONGC is to become a global leader in integrated energy business through sustainable growth, knowledge excellence and exemplary governance practices.

ONGC is involved in exploring for and exploiting hydrocarbons in 26 sedimentary basins of India, and owns and operates over 11,000 kilometers of pipelines in the country. Its international subsidiary ONGC Videsh currently has projects in 15 countries. ONGC has discovered 8 out of the 9 producing Indian Basins, adding over 7.15 billion tonnes of In- place Oil & Gas volume of hydrocarbons in Indian basins. The company is also engaged in the development of unconventional resources such as coal bed methane (CBM) and shale gas.

ONGC has been an active participant in the National Gas Hydrate Programes (NGHPs). To promote this a Gas Hydrate Research & Technology Centre (GHRTC) was established on 14 September 2016 at Panvel. ONGC has struck gas hydrate reserves in the deep sea off the Andhra Pradesh coast. The reserves are located in the Krishna-Godavari and the fresh reserves are estimated to be around 134 trillion cubic feet (tcf), about one-third of the gas reserves of the United States, which is the largest producer of natural gas in the world. This is one of the major future targets of ONGC

2. About ONGC CBM Asset

ONGC initiated its Coal Bed Methane (CBM) exploration as an R&D endeavour in 1995 in the Durgapur depression of Raniganj basin. ONGC carried out an evaluation of India's coalfields in 1997 and prioritized the coal basins of India as potential targets for Coal Bed Methane exploration. This foresight of the company yielded fruit when the first R&D well in Jharia flowed Methane in September 1997.

Over the years, Government of India awarded total thirty-three Coal Bed Methane Blocks by various operators of which ONGC was awarded nine acreages. However, with the relinquishment of the Wardha, Satpura, North Karanpura (W), Barmer–Sanchor (BS-3) and South Karanpura Blocks, ONGC presently operates in four CBM acreages.

In view of the enhanced activity, Coal Bed Methane Development Project, ONGC, Bokaro was established in 2007 to carry out focussed and dedicated E&P activity. ONGC has invested Rs. 4,000 crore to develop its four Coal Bed Methane (CBM) gas blocks. Two of the four blocks—in North Karanpura and Bokaro, in Jharkhand—have started production by the second half of 2017-18.

It had won the Bokaro block in the first round of CBM block bidding in the year 2003. Besides this ONGC is also operating the North Karanpura block and Raniganj North CBM block in West Bengal. The Jharia block is estimated to hold 85 billion cubic metres of gas reserves, North Karanpura 62 billion cubic metres, Bokaro 45 billion cubic metres and Raniganj North 43 billion cubic metres. In the view of the mammoth and time-bound task, it has decided to farm-in experienced partners to execute the operations, the process for which is in advanced stages.

ONGC places emphasis on sustainable CBM operations and adheres to environmental regulations and best practices. – The company implements measures to minimize environmental impact during CBM extraction and production. Including the management of produced water and methane emissions.

3. About CBM Asset, Bokaro (SubSurface)

The coal in CBM Asset Bokaro is Sub Bituminous and the rock of the region is of Permo Carboniferous age.

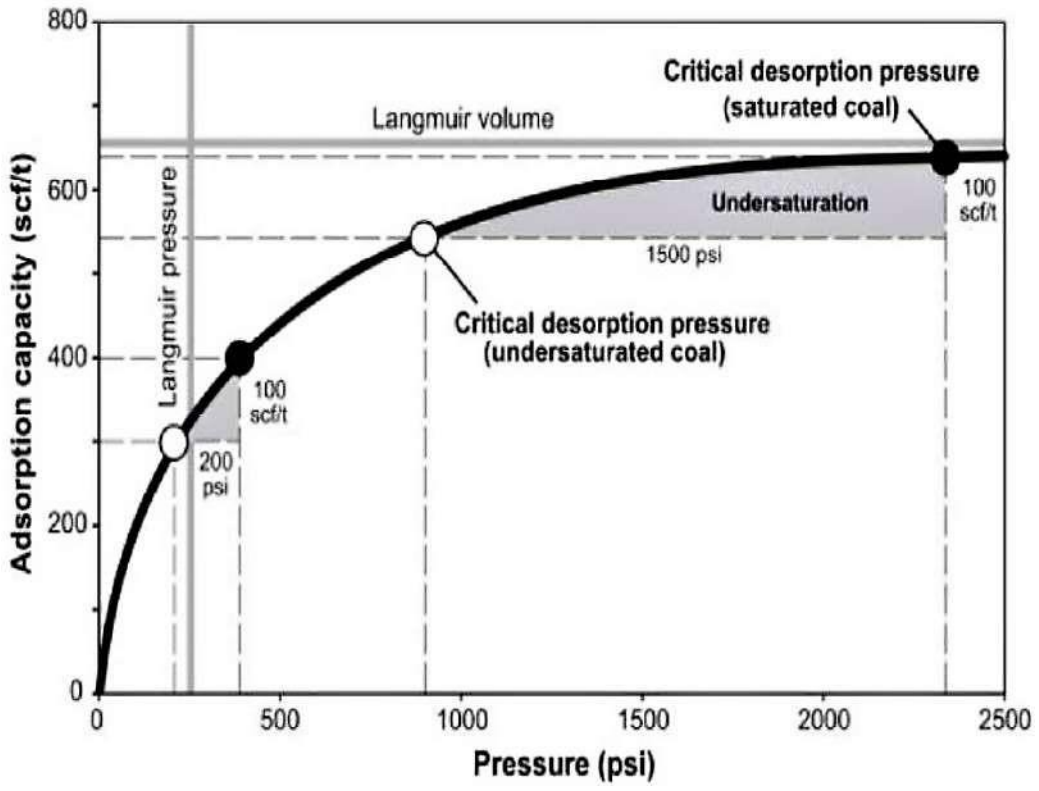
- CBM Asset Bokaro is found to have 26 coal seams over Bokaro and Jharia regions.
- Out of these, 5 seams in the Bokaro block and 2 Seams in the Jharia block are estimated to produce natural gas economically and hence are termed objective seams.
- The 5 objective seams of the Bokaro block are Kargali Top, Kargali Bottom, Bermo, Karo-IX&X, Karo-VIII. Karo-VIII is estimated to be the most productive seam of the Bokaro Block.
- The Jharia Block has 2 objective seams that are XV and XIV-A.
- The Bokaro block is divided into 2 patches according to drainage area. Patch-A has a drainage area of 80 acres and Patch-B has a drainage area of 40 acres.
- Currently, the Bokaro Block is in the Development phase and almost 141 wells are drilled to cover the complete prospect.

4. Coal Bed Methane (CBM)

Coal Bed Methane (CBM) refers to the natural gas that is adsorbed on the surface of the coal seams. It is a form of unconventional natural gas that is extracted from coal deposits.

The formation of CBM occurs during the process of coalification, where organic material (such as plant matter) is subjected to heat and pressure over millions of years, converting it into coal. As coal forms, methane is generated and gets adsorbed onto the coal matrix, occupying the pore spaces within the coal seams.

The extraction of CBM involves reducing the pressure within the coal seam, allowing the methane to desorb from the coal matrix and flow to the wellbore.

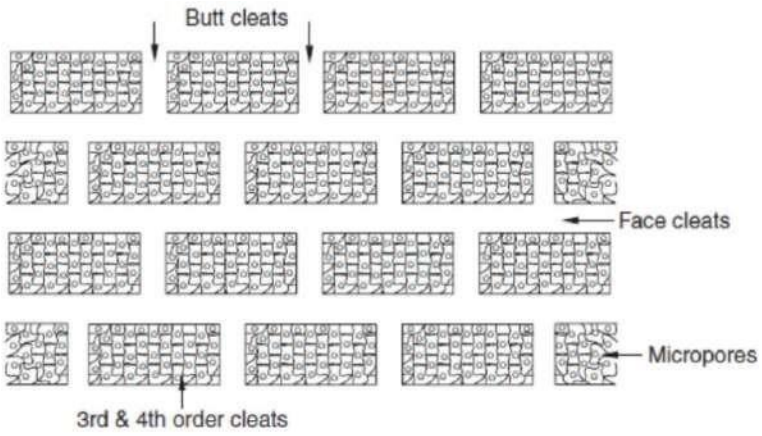


Langamuir Adsorption Isotherm Curve

Around 95–98% of the gas in coal seams is adsorbed on the pore structure of the coal. If we observe the given curve, the amount particles adsorbed per unit area decreases with decrease in pressure. Hence a decreased reservoir pressure is desired for transportation of Methane gas from surface of seams through desorption technique.

Cleat System and Natural Fracturing:

The network of natural fractures and cleats in a coal determines to a large extent the mechanical properties of the coal and the permeability of the coal.



Water Content:

Water is stored in coals in two ways. Bound water in the coal matrix and free water in the coal cleat system are some of the ways in which water gets trapped in coal seams. Matrix bound water is not mobile and has not been shown to significantly affect methane recovery from coal.

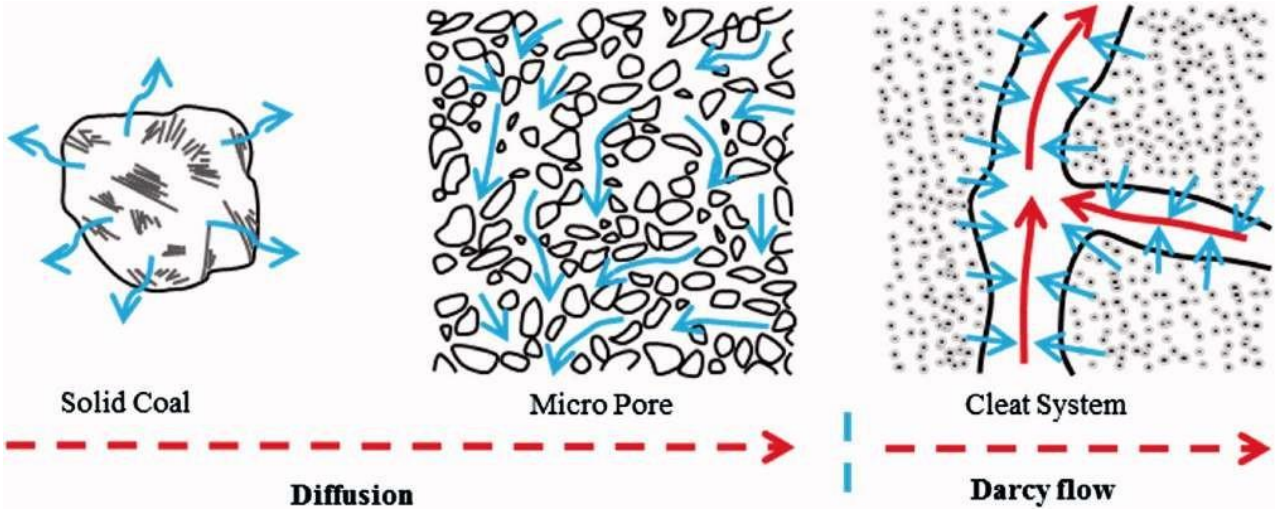
Gas content:

Gas Content is the amount of gas that actually is stored in a coal sample.
It is measured in scf/ton.

Transport Mechanism:

Methane molecules detach from the micropore surfaces of the coal matrix and enter the cleat system where they exist as free gas through the process of desorption.

They get transferred into the Cleat system through diffusion. In the cleat network the gas flows following the Darcy Law.


Solid Coal
Micro Pore
Cleat System
Diffusion
Darcy flow

5. SRP Failure in CBM Asset's

5.1 Introduction:

Sucker Rod Pumps (SRPs) are crucial for the extraction of Coal Bed Methane (CBM) in the petroleum industry. These pumps lift water and gas from coal seams to the surface. Failures in SRPs can disrupt production, increase operational costs, and pose safety risks. This report examines the causes, impacts, and mitigation strategies for SRP failures in CBM assets within the petroleum industry.

5.2 Causes of SRP Failure in CBM Assets:

1. Mechanical Wear and Tear:

Component Degradation: Continuous operation leads to wear of pump components such as rods, plungers, and tubing.

Corrosion: Exposure to water, gas, and other corrosive elements can degrade metal parts over time.

2. Operational Issues:

Incorrect Pump Settings: Inappropriate stroke length, speed, or depth settings can cause excessive stress on the pump.

Fluid Dynamics: Variations in fluid properties like viscosity and gas content can impact pump performance.

3. Environmental Factors:

Abrasive Particles: Presence of sand and other particulates can cause abrasion and erosion of pump components.

Temperature and Pressure Variations: Fluctuations in temperature and pressure can lead to mechanical stress and failure.

4. Maintenance and Monitoring Deficiencies:

Inadequate Maintenance: Lack of regular maintenance and inspections can lead to undetected wear and imminent failures.

Insufficient Monitoring: Poor monitoring of pump performance and conditions can result in late detection of issues.

5. Design and Installation Errors:

Improper Design: Pumps not designed for specific well conditions may fail prematurely.

Incorrect Installation: Errors during installation can lead to misalignment, resulting in mechanical stress and wear.

5.3 Impact of SRP Failure:

1. Operational Downtime:

Production Interruptions: Unplanned failures cause production stoppages, leading to significant downtime.

Extended Repair Times: Unexpected failures can result in longer repair times, further delaying production.

2. Increased Maintenance Costs:

Emergency Repairs: Higher costs associated with emergency repairs and replacements.

Frequent Part Replacements: Increased frequency of replacing worn-out components adds to maintenance expenses.

3. Safety Risks:

Accidents and Injuries: Mechanical failures can pose safety hazards to personnel working on-site.

Environmental Hazards: Failures can lead to leaks and spills, causing environmental contamination.

4. Reduced Efficiency:

Lower Production Rates: Inefficient pump operation reduces methane extraction rates.

Increased Energy Consumption: Faulty pumps may require more energy to operate, increasing operational costs.

5.4 Case Studies and Examples:

1. CBM Wells in the Appalachian Basin:

Incident: SRP failures due to improper settings and abrasive particles in the fluid.

Impact: Production downtime of several days and significant repair costs.

2. Australian CBM Operations:

Incident: Corrosion-induced failure of sucker rods in multiple wells.

Impact: Environmental contamination and increased maintenance expenditures.

3. Powder River Basin CBM Fields:

Incident: Temperature fluctuations causing mechanical stress and pump failure.

Impact: Extended repair times and reduced methane production efficiency.

5.5 Mitigation Strategies:

1. Regular Maintenance:

Scheduled Inspections: Implement regular inspections and maintenance schedules to detect and address wear and tear early.

Preventive Maintenance: Use preventive maintenance strategies to replace components before they fail.

2. Enhanced Monitoring:

Real-time Monitoring: Utilize real-time monitoring systems to track pump performance and detect anomalies.

Data Analytics: Apply data analytics to predict potential failures and schedule proactive maintenance.

3. Improved Design and Materials:

Durable Materials: Use corrosion-resistant and wear-resistant materials for pump components.

Customized Designs: Design pumps specifically for the unique conditions of each CBM well.

4. Proper Installation and Settings:

Accurate Installation: Ensure proper installation practices to avoid misalignment and mechanical stress.

Optimized Settings: Adjust pump settings according to well conditions to minimize operational stress.

5. Environmental Controls:

Filtration Systems: Install filtration systems to remove abrasive particles from the fluid.

Temperature Control: Implement measures to manage temperature and pressure variations to reduce mechanical stress.

5.6 Conclusion:

Sucker Rod Pump failures in CBM assets can have significant operational, financial, and safety impacts. By understanding the causes and implementing effective mitigation strategies, petroleum companies can reduce the risk of SRP failures, enhance the efficiency of CBM extraction, and ensure the safety and reliability of their operations. Regular maintenance, enhanced monitoring, improved design and materials, proper installation, and environmental controls are critical to mitigating the risks associated with SRP failures in CBM assets.

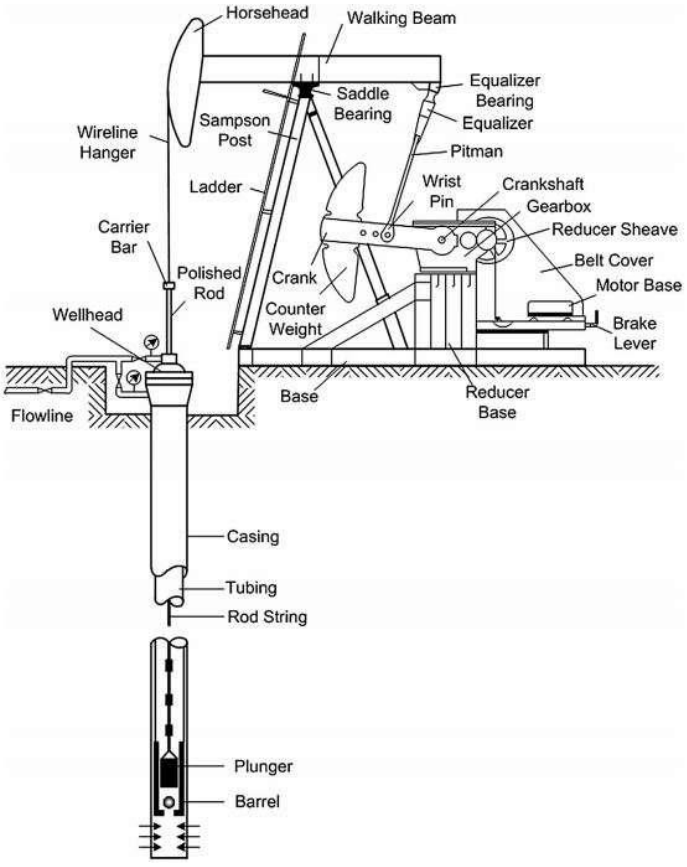
6. Advantages and Disadvantages of SRP

Advantages of Sucker Rod Lifts:

1. Easy for personnel to operate to pump oil, water, and/or gas.
2. Mechanically simple.
3. Surface unit may be changed to other wells with minimum cost.
4. Can pump a well down to very low pressure.

Disadvantages of Sucker Rod Lifts:

1. Pulling unit needed to service downhole equipment.
2. High levels of solids in CBM wells, such as coal fines or formation sands, can cause abrasion.
3. In high-gas wells, the presence of gas can interfere with the pump efficiency and cause gas locking issues, reducing the pump's performance.
4. Solids production from the well is a problem
5. Surface stuffing-box leaks can cause pollution.



7.Field Development Phases in CBM Asset

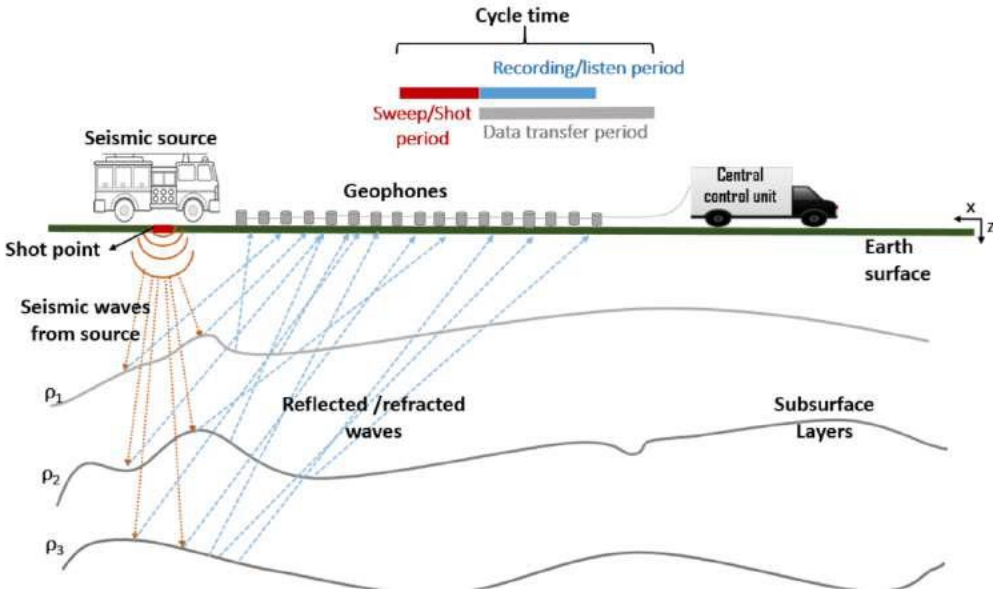
Exploration and Planning Phase:

Seismic Survey

Geophones are placed in a predetermined pattern on the surface, either in a linear array or as a grid. They are connected to recording equipment that captures the seismic data.

The explosive charges in the shot holes are detonated in controlled sequence.
The resulting explosions generate seismic waves that propagate through the ground in all directions.

Geophysicists analyse the processed data to interpret the subsurface geology, identify potential hydrocarbon reservoirs



Core Hole Drilling:

Core hole drilling is a method used to obtain physical samples of soil, or other geological formations from beneath the Earth's surface. The core sample is taken to laboratory for the analysis of porosity, permeability, maturity, and gas content estimation.

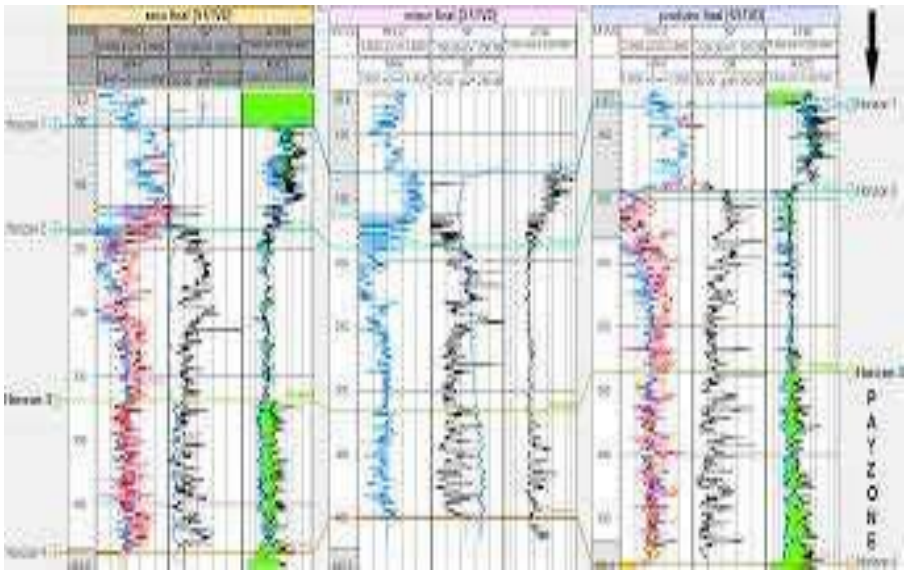
Well Logging:

It involves the measurement and recording of various physical properties of rock formations and fluids encountered while drilling a well. This gives an idea about the number of coal seams, their thickness and depth.

Well Correlation and Contour Mapping:

Well correlation involves comparing and matching the rock layers encountered in different wells to establish stratigraphic relationships and create a coherent geological framework. Geologists analyse well logs, including gamma ray, resistivity, and sonic logs, along with core samples and seismic data, to correlate formations between wells.

Contour Mapping involves creating contour lines that connect points of elevation hence giving proper field plan on which depths in the field are to be drilled for extracting a methane gas.



Development Phase:

Drilling:

Once the field planning is done, the drilling of Development wells are started.

Wells of a maximum of 1600 m depth are drilled in the CBM Asset Bokaro with proper casing and cementing techniques.

2 Casing Policy is followed in the asset that means only Surface Casing and Production Casing are used.

The surface casing and cementing prevents the pollution of groundwater by the formation fluids.

Hydraulic Fracturing:

Hydraulic fracturing, commonly known as "fracking," is a technique used in Coalbed Methane (CBM) operations to enhance gas production from coal seams.

Fracturing fluid, consisting of water, sand (proppant), and additives, is injected into the coal seam at high pressure. The fluid injection creates fractures or fissures in the coal seam, extending the permeability and enhancing gas flow.

Workover Services:

These can include activities such as repairing or replacing damaged or corroded equipment, cleaning out or removing obstructions from the wellbore, or treating and stimulating the coal seams to improve gas flow.

Well Completion and Production Phase:

Completion Equipment Installation:

After perforation and stimulation, completion equipment is installed to facilitate gas production. This typically includes production tubing, packers, and downhole pumps or artificial lift systems.

The artificial lift systems include the down hole pumps such as Progressive Capacity Pumps and the Sucker Rod Pumps that create suction to pull out the water and conduct dewatering and later remove gas during gas break.

Surface Facilities:

Alongside well completion, surface facilities are established to handle the produced gas. GCS Khudgadda is the surface facility for the CBM Asset Bokaro where Gas from all the wells is collected and made suitable for transportation to refineries.

The KOD helps in first hand separation of gas, the compressors are utilized to increase the flowing pressure of gas, and the dehydration and CO_2 removal unit helps to purify the gas according to consumer standards. All these methods are also necessary to decrease the dew point of gas to below 0 deg. celsius.

Production and Monitoring:

The production rate and pressure are monitored regularly to optimize production and ensure the well is performing as expected.

The amount of gas produced and the calorific value of the gas decides the pricing of the product which ultimately calculates the wealth of the Company.

8.Well Logging

The continuous recording of a geophysical parameter along a borehole produces a well log. The value of the measurement is plotted continuously against depth in the well.

Types of Logging:
Open-Hole Logging
Cased-Hole Logging

In the CBM Asset Bokaro, Open-Hole Logging is done mostly.

Types of Open-Hole Logging

1. Gamma Ray Log:
Measures the Gamma ray emission from different rock formations. All formations have characteristic gamma ray emission, so using the chart it can be assumed the characteristic of formation in that region.

2.Resistivity Log:
It determines the resistivity of the formation. Due to formation damage (fluid invasion) there is an alteration in the resistivity of the formation.
So, this log helps us to flag formation damage as well. Resistivity at different width of the formation is measured in the log.

3. Neutron Log:
It indicates the porosity of the formation. HC and Water are present in the pores.
So, higher scattering means more pores, which indicates higher porosity.

4. Density Log:
It indicates the density of the formation. If the scattering is higher then due to colliding with molecules which means there will be less reflected back, so low receiver and hence high density.

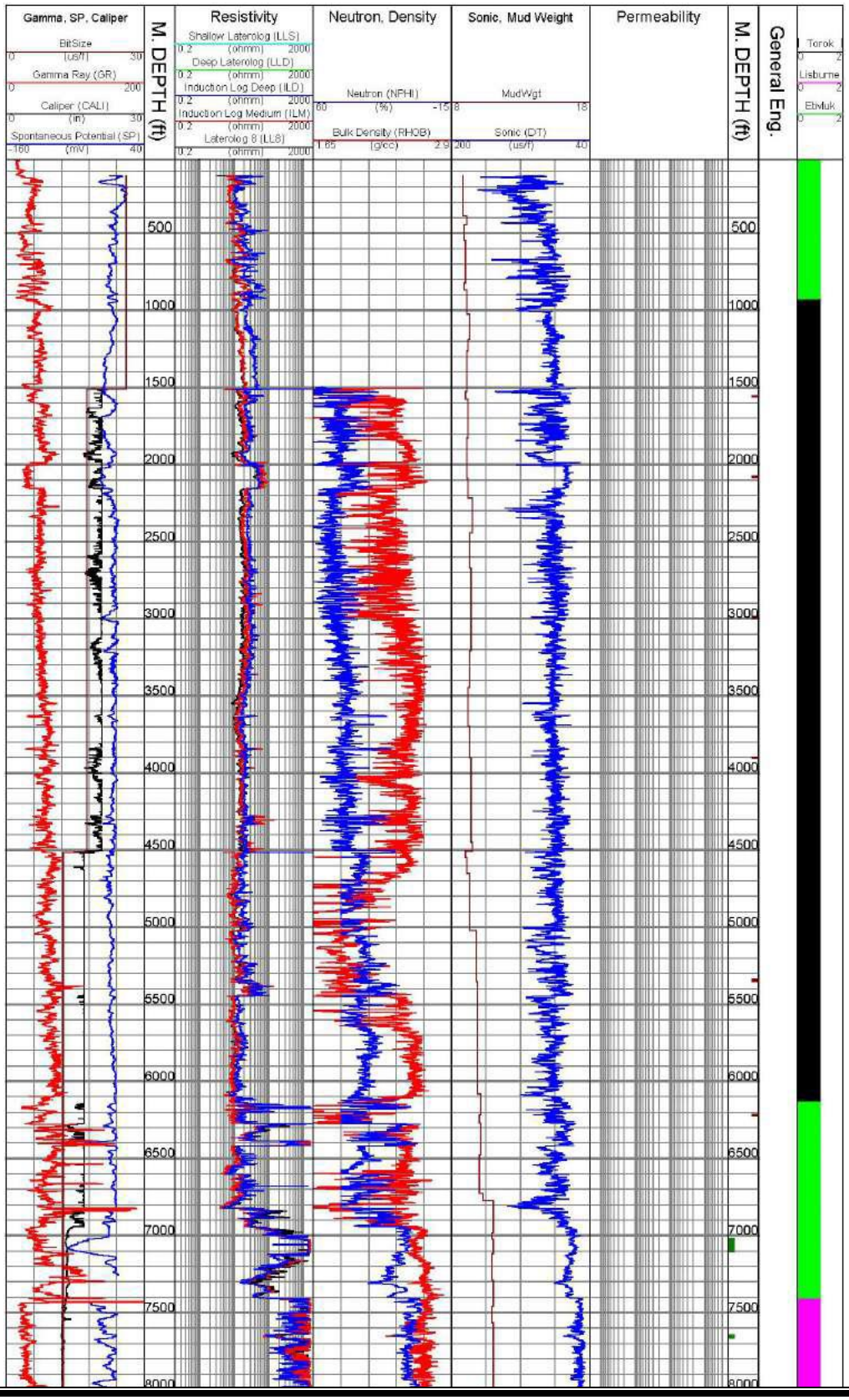
5. Calliper Log:
Measures Bore-hole diameter. Indicates well caves, mud cake formation or any other kind of discrepancy in the well diameter.

Properties to identify the presence of Coal:

Low Gamma (< 90-100 API)

High Resistivity (> 500 Ωm)

Low Density (1.4-1.5 gm/cc)



9. Drilling

Drilling is an essential component of petroleum engineering, as it involves the creation of boreholes beneath the Earth's surface to extract oil and gas reserves.

Types of Wells Drilled Based on the purpose and objective of the well

Exploration Wells: Exploration wells, also known as wildcat wells, are drilled in unexplored or frontier areas to search for new oil and gas reserves.

Appraisal Wells: Appraisal wells are drilled to further evaluate the discovered hydrocarbon resources after an initial exploration well. The objective is to gather additional data about the reservoir, such as its size, productivity, and reservoir properties, to estimate reserves and plan field development strategies.

Delineation well: It is a well drilled in a known hydrocarbon reservoir to further assess its extent, characteristics, and commercial potential.

Development Wells: Development wells are drilled in established oil or gas fields to extract known reserves and increase production. These wells are strategically located within the field based on geological and reservoir data to maximize hydrocarbon recovery.

Injection Wells: Injection wells are used to inject fluids into the reservoir for various purposes such as maintain reservoir pressure, enhance oil recovery, or dispose of produced water.

Re-entry Wells: Re-entry wells involve re-entering an existing wellbore for various reasons, such as side tracking the well, conducting workover operations, or drilling additional branches from the original wellbore.

Abandonment Wells: Abandonment wells, also referred to as plug and abandon (P&A) wells, are wells that are permanently sealed and taken out of production. These wells are properly plugged and sealed to ensure the integrity of the wellbore and prevent any environmental or safety concerns.

10. Work Over Services

Work over services is a team formulated to act as a doctor for the well.
Work over services supervise the flow back post fracturing and clear the well so that equipment for dewatering be commissioned successfully.

Fishing Operation

The Technique of removing equipment or parts of equipment which have become disengaged from the drilling tools or stuck in bore hole is called fishing. Hence the term fishing applies to all operations concerned with the retrieving all unwanted objects from bore hole.

KINDS OF FISH

(1) Tubular Type Fish: Tubular equipments such as drill pipes, casing pipes.

(2) Non-Tubular Type Fish: Small or big materials stuck or freely fallen in the well.

RULES OF FISHING

The general rules applied to all fishing job to be prepared for fishing operations are-

1. Planning of fishing jobs carefully
2. To make decision for operation correctly
3. To know the fishing tools and equipments with their correct uses
4. To know the operation thoroughly
5. To learn all details (back history of accident)
6. Developing a plan of action
7. Trained personnel (Operators and fishing Master, Expert) are required
8. Operation

11. Well Stimulation Services

The work conducted by this department is mainly Enhanced recovery jobs through hydraulic fracturing and acid jobs.

Pre- Requisite for HF Jobs:

Completion Data

- Tubing and Casing specifications (Size, Grade, ppf etc.)
- Wellhead Pressure Rating

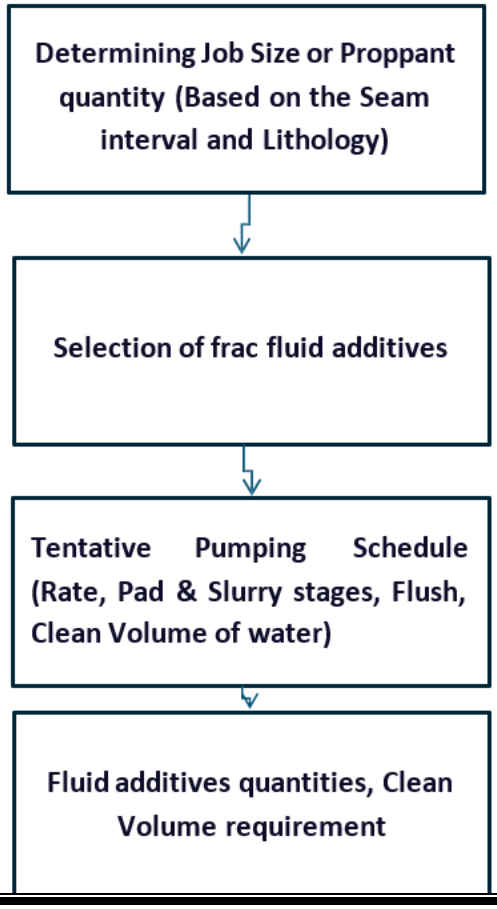
Reservoir & Geological Data

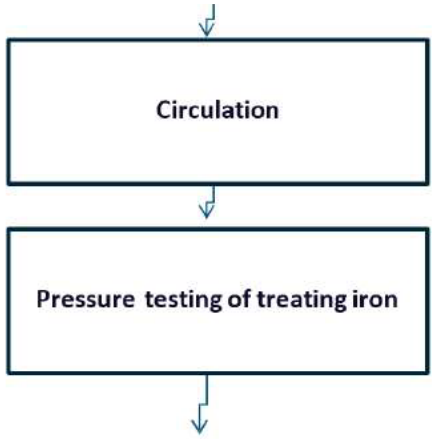
- Perforation data (Interval, density , spf)
- Seam Interval
- Lithology
- Reservoir Temperature, Permeability, Injectivity & Stress Envelope

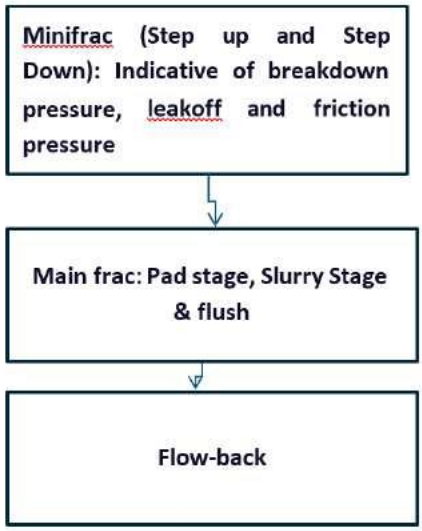
Rock Mechanical Properties

- Young's modulus
- Poisson's Ratio

Stages for Job Design




Circulation
Pressure testing of treating iron


Minifrac (Step up and Step Down): Indicative of breakdown pressure, leakoff and friction pressure
Main frac: Pad stage, Slurry Stage & flush
Flow-back

12. Well Stimulation and Testing

Dewatering of the coal seams is carried out to attain critical desorption pressure so that methane oozes out from the coal seam to the surface.
Water drawn out is treated properly and quality check/treatment is done as per existing norms before discharging them.

Equipment for dewatering of CBM reservoir are:
Sucker rod pump
Progressive cavity pump

Applications

Use of a PCP system should be evaluated for situations that are:

- High-viscosity oil wells
- High-sand-cut wells
- Low-productivity wells
- Gassy wells
- Directional- and horizontal-well applications
- Hostile fluid conditions
- High-speed operations
- Coalbed-methane and water-source wells
- Elevated-temperature applications

Use of a SRP system should be evaluated for situations that are:

- Water production rate in the well should be almost constant and not more than 40 scmd
- Solid content in the well should be less and water content should be very high
- Low gas interference should be observed in the well.

13. Surface Unit

This department is mainly responsible for production of gas at the surface level. There were several set-ups apart from rig. Talking about the well-site facilities, they are same for all the types of all completion.

Some important installation at Jharia field, Prabatpur are as follows:

1. **Separator :-** There are two types of separator we have seen in this Bokaro asset. Separates the methane gas, coming from the gas valve of the well head, from the moisture. From here, the gas is sent to main gas-lines for transportation. And the water separated is sent to storage tank and then pumped to main waterline.

2. **Group Gathering Station (GGS) :-** The surface production team are responsible for monitoring and optimizing of oil and gas flowing from each producing wells to local collecting stations called GGS(group gathering station) by regulating the production beans for individual wells.

3. **Early Production System (EPS) :-** It provide real-time production data for appraising reservoir performance before more-expensive long-term facilities are installed.

14. Fire Services

Fire is the rapid oxidation of a material (the fuel) in the exothermic chemical process of combustion, releasing heat, light, and various reaction products.

Fire Triangle:

For a fire, three elements must be present simultaneously:

– Combustible material. (Solid, liquid, gas)

– Supply of air that is necessary for the combustion process.

– Introduction of ignition source. (Flame, spark, static electricity, heat).

Fire Extinguisher

1st Class Fire Protection
01603 742741
enquiries@1stclassfireprotectionnorfolk.co.uk

Fire Extinguisher Type

Fire Type		Powder	Foam	CO^2	Water	Wet Chemical
CLASS A	**Solids** (e.g. wood, plastic, paper)	✓	✓	✗	✓	✗
CLASS B	**Flammable Liquids** (e.g. solvents, paint, fuels)	✓	✓	✓	✗	✗
CLASS C	**Gases** (e.g. butane, propane, LPG)	✓	✗	✗	✗	✗
CLASS D	**Metals** (e.g. lithium, magnesium)	✓	✗	✗	✗	✗
ELECTRICAL	**Equipment** (e.g. computers, servers, TVs)	✓	✗	✓	✗	✗
CLASS F	**Cooking Oils** (e.g. cooking fat, olive oil)	✗	✗	✗	✗	✓
Some examples of businesses that may need this extinguisher		Outdoor locations, garages, welding workshops, forecourts.	Schools, offices, hotels, shops, hospitals, apartments.	Offices, server rooms.	Schools, hospitals, shops, apartment blocks.	Kitchens, canteens, restaurants.

15. References

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8. https://www.mdpi.com/1424-8220/21/15/517

thank you

Respected Mentor,

Thank you so much for for your support and guidance throughout the Summer Training at ONGC. I am also grateful to all departmental heads for sharing their knowledge, which has significantly contributed to my professional growth.

Abhishek Kumar Shah