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Mud Line Suspension System – Key to Success for early Monetization of Shallow Water Fields of Krishna – Godavari Basin of ONGC

*Rakesh*Kapur
Oil and Natural Gas Corporation Limited, E&D Directorate, Dehradun, India

Presenting author, E-mail: kapur_rakesh@ongc.co.in

Summary

Krishna Godavari Basin of ONGC is spread in the vast area in the on-land part as well as in the offshore part, the offshore part of the basin lies in the eastern offshore in the Bay of Bengal and the major plays are Matsyapuri play, Ravva play and Vadaparru play having hydrocarbons.

The Krishna-Godavari Basin is a passive margin basin having two stage evolution i.e. Pranhita-Godavari Graben trending NW-SE superimposed by Pericratonic Cretaceous -Tertiary sediments trending NE-SW direction. During early Cretaceous syn-rift sediments got deposited and during Post Albian, transgressive sequence followed by regressive sediments was deposited (Late Cretaceous period i.e.Campanian to Maastrichtian). The Krishna-Godavari Basin is known for having India's largest natural gas reserves. The KG basin extends more than 50,000 sq.km in the Krishna and Godavari river basins in both onshore and offshore.

First hydrocarbon discovery was made in GS-16 (Ravva field) in Krishna-Godavari shallow water in 1987 which was followed by GS-29 in 1992, GS-15 in 1993 and various oil and gas discoveries continued till date. Most of these discoveries being from discreet isolated reservoirs in Mio-Pliocene. A few of the discoveries were put on production in 1998, being isolated pools, feasibility of development of them could not be possible.

Many discoveries in the shallow water are GS-15-E-1, GS-48-1, GS-KW-1 and GS-69 etc.as shown in Fig-1& 2.Hydrocarbon poolsof small nature could not be monetized. These small pools can't be developed on a standalone basis due to high cost of pipeline and other necessary infrastructure requirements. Due to these requirements, the techno-economics do not become favorable. However with the development of new technologies globally a window of opportunities of monetizing these locked up reserves is possible.

A new technology known as Mud Line Suspension System has been developed for exploiting such type of reservoirs economically. In this, series of hangers, called mudline suspension equipment, provides landing rings and shoulders to transfer the

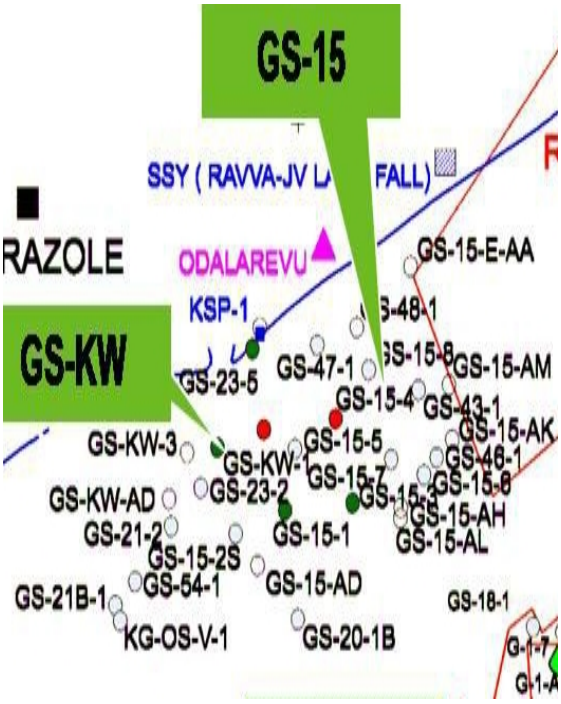

Fig-1 showing small discovered fields, KG offshore, shallow water

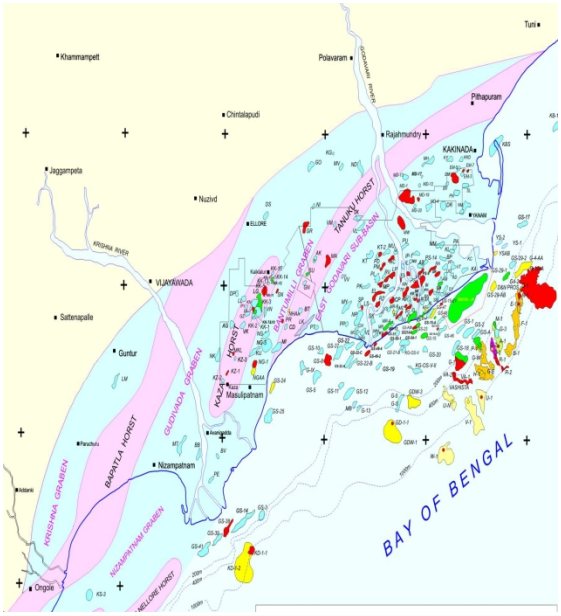

Fig-2Map of shallow water fields in KG offshore

weight of each casing string to the conductor and the sea bed.

This technology is suitable for shallow water areas in the bathymetry (8-45 m). This technique can be applied to either through re-entry in the already drilled wells or provisions can be made for the new wells to be drilled. With this provision the cost of rig for re-installing of mud line suspension system for exploitation or by installing subsea completion system at a later stage can be minimized. In Krishna-Godavari shallow offshore this technique can be utilized for early monetization of the small isolated pools.

Introduction

The basin's characteristic feature is its en-echelon horst and graben system which is filled with a thick pile of sediments of Permian-to-Recent age and emerging as one of India's most promising petroliferous areas. Commercial accumulation of hydrocarbons occurs in sediments from the Permian to as young as the Pliocene. The Pliocenereservoirs are isolated sand bodies within Godavari clays. Miocene-Eocene hydrocarbon accumulations have been in the strati-structural entrapments within different closely spaced fault blocks. This has resulted in different isolated pools.

Krishna Godavari Basin of ONGC consists of many large, medium and small sized fields spread over a large area extending from on-land part falling in the state of Andhra Pradesh and offshore part falling in the Bay of Bengal. Large and medium sized fields are monetized on priority basis whereas small sized fields take time in getting monetized.

Small sized fields are monetized easily and timely if they are in onshore whereas it is of great difficulty to monetize the small fields / pools of hydrocarbons if they are falling in shallow water offshore part. In the present study, discreet hydrocarbon pools in various PMLs blocksin KG shallow offshore basin area are taken care of. The different hydrocarbon fields in the study area are Field A, Field B, Field C, Field D, Field E, Field F, Field G & Field F.

Exploitation Strategy

Production testing results of the drilled wells and available pool maps show that the reservoir units are having limited areal extent. The pay sands are not very thick and in most of the cases are underlain by water. While analyzing the viability for a comprehensive exploitation strategy of these pools i.e. individual oil and gas volumes, taking into account the structural configuration and reservoir continuity, it has been observed that the pools are of scattered nature and hydrocarbons have been accumulated in a wide range of stratigraphic age from Eocene to Plio-Pleistocene. The exploitation strategy is challenging in view of small and discrete nature of hydrocarbon pools. It has been generally observed that oil and gas pools are isolated and very small. Due to discontinuous reservoir sands, small structures/separate fault closures and individual wells drilled so far represent different pools.

These oil and gas pools are widely scattered in these block areas. The small hydrocarbon inplace volumes with bottom water or depletion drive conditions may not permit sustained production for longer period of time. In these conditions, development of each pool needs drilling of a separate well in the shallow water conditions. Exploitation of every pool will require installation of a separate platform and associated necessary production facility. This may adversely affect the economics of field development. Given the nature, size and distribution of hydrocarbons in the study area, economics normally does not support these to exploit on standalone basis. The most probable development may be that of an integrated development concept.

Alternate Method of Exploitation

A new technology known as Mud Line Suspension System has been developed for exploiting such type of reservoirs economically. In this, series of hangers, called mudline suspension equipment, provides landing rings and shoulders to transfer the weight of each casing string to the conductor and the sea bed. This technique can be applied to either through re-entry in the already drilled wells or provisions can be made for the new wells to be drilled. With this provision the cost of rig for re-installing of mud line suspension system for exploitation or by installing subsea completion system at a later stage can be minimized. In Krishna-Godavari shallow offshore this technique can be utilized for early monetization of small isolated pools.

Mudline hanger system

The mudline hanger system (shown in **Fig. 3**)consists of the following components:

Mudline hangers:

Each mudline hanger landing shoulder and landing ring centralizes the hanger body, and establishes concentricity around the center line of the well.Concentricity is important when tying the well back to the surface. In addition, each hanger body

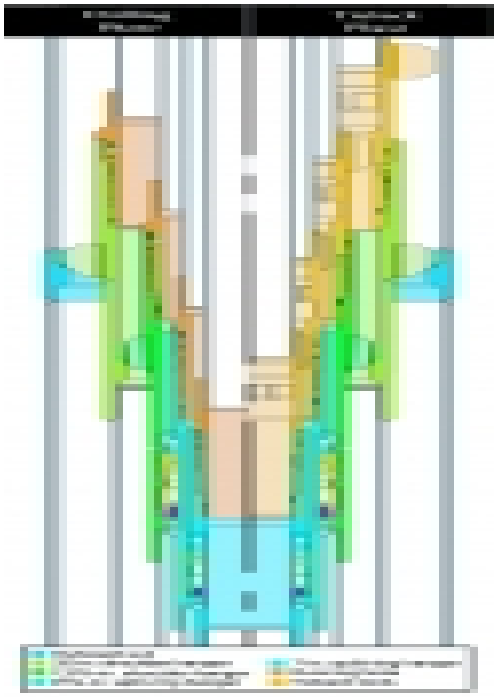

Fig 3

stacks down relative to the previously installed hanger for washout efficiency. Washout efficiency is necessary to clean the annulus area of thepreviously run mudline hanger and running tool as shown in **Fig 4**. This ensures that cement and debris cannot hinder disconnect and retrieval of each casing riser to the rig floor upon abandonment of the well.

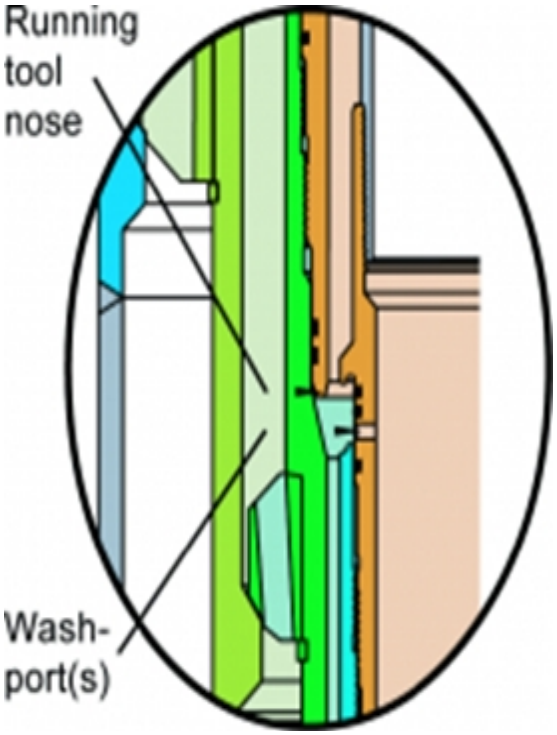

Fig 4

All mudline hangers should stack down to provide washout efficiency. Washout efficiency is supplied by a series of wash ports located in the running tool that (when opened for washing out) are positioned below the running tool attached to the previously run mudline hanger.

Method of installing Mudline hanger

As each hole section is drilled and each casing string and mudline hanger is run, the hanger is positioned in the casing string to land on a landing shoulder inside the mudline hanger that was installed with the previous casing string. Each of the mudline hangers have casing and a mudline hanger running tool made up to it. These running tools are released through right hand rotation to allow disconnect from the well. The threads on the mudline hanger used by the running tool can be used to install temporary abandonment capsinto selected hangers to temporarily suspend drilling operations at the conclusion of the well (shown in **Fig 5**).

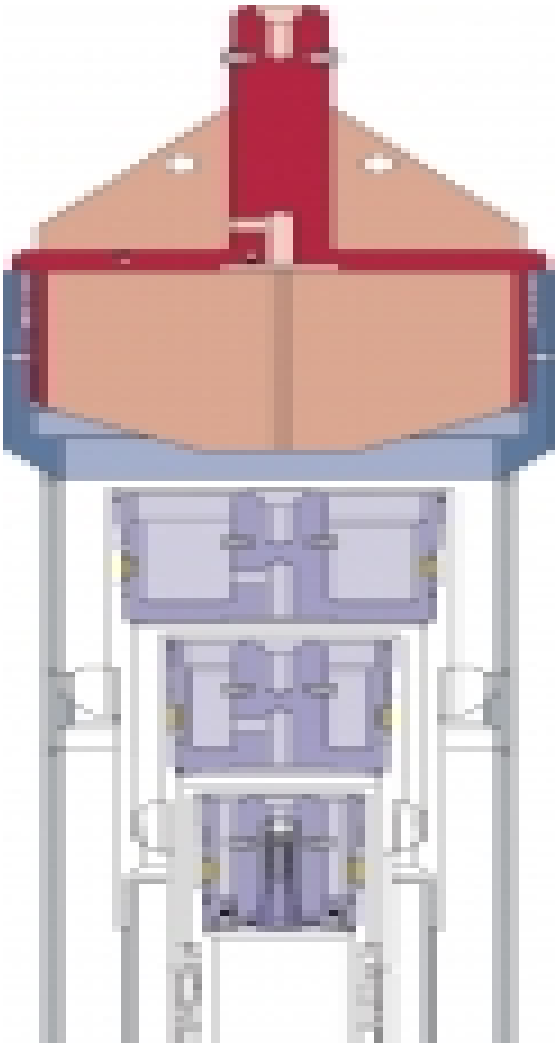

Fig 5

Different Well Heads in Mudline Hangers

The main difference between the wellheads used in the land drilling applications and the jack-up drilling applications (with mudline) is the slip and seal assembly as shown in **Fig 6**. Because in jack-up drilling wellheads, all the weight of the well now sits at the seabed. In this case the seal assembly which is normally used in on-land drilling well heads i.e. weight-set-slip-and-seal assembly is not used. Instead of that, a mechanical set in which the seal is energized by hand is used. In this case, cap screws are made up with a wrench against an upper compression plate on the slip-and-seal assembly to energize the elastomeric seal.

Fig 6

Different Uses of Mudline Hangers Assembly

- **Mudline hanger assembly can be used for temporarily abandoning the well:**

  Well can be abandoned temporarily (disconnected) with the help of mudline suspension system. When the well is drilled up-to target depth, well can be disconnected from the drilling with the help of mudline hanger system. When this is carried out, the conductor casing is normally cut approximately 5 to 6 ftabove the mudline and retrieved to the surface. Each casing string is disconnected from the mudline suspension hangar. All the casings are retrieved to the rig floor in the reverse order of the drilling process. These cut casings are threaded with temporary abandonment caps or stab-in temporary abandonment caps. In both the cases, these can be made-up into the threaded running profile of the mudline hanger as shown previously in Fig-5. Such type of treaded running profiles are installed in selected mudline hangers before the drilling vessel finishes and leaves the location. The temporary abandonment caps can be retrieved with the same tool that has installed them.

- **Reconnecting to the well:**

  The mudline suspension system also incorporates tieback tools to reconnect the mudline hanger to the surface for reentry and /or completion. These tieback tools can be of two types. One type is threaded and the other is of stab-in type as shown in Fig 7. The tieback threaded tools are different from the running tools. The difference between the two is that the threaded tieback tools makeup their own dedicated right hand make up threaded profile. The stab-in tieback tool offers a simple, weight-set, rotation-lock design that provides an easy way to tie the well back to the surface. The surface well-head system is installed and the well is completed similarly to the method used on land drilling operations.

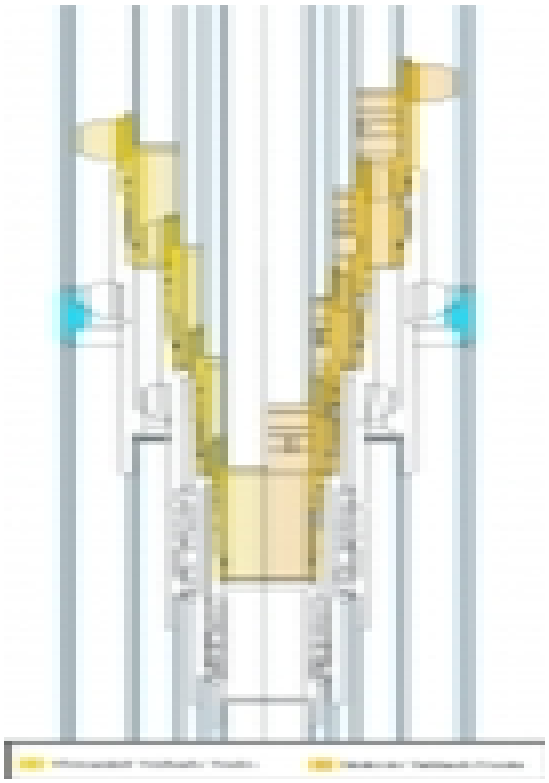

Fig 7

The mudline suspension system has been designed to accommodate tying the well back to the surface for surface completion and it also can be adapted for a subsea production tree. A tieback tubing head can be installed to the mudline suspension system at the seabed, and a subsea tree can be installed on this tubing head.

In Exploratory or Development Wells

Mudline suspension system should be used both in exploratory as well as development wells. It should be used in exploratory wells also because of the well is a hydrocarbon well and the pool is small, mudline hanger can be detached from the drilling rig and can be reconnected again when the exploitation system will be in line with the pipeline/tanker system.

In this case, there will be no need to deploy a rig again for subsea completion and other necessary completion procedures to put the well on production. In case it is not a hydrocarbon well, mudline hanger system can be retrieved back while abandoning the well.

It should be used in development wells also. If there is a smart completion, zone transfer can be done by control systems and no need to deploy the rig to carry out the zone transfer from one sand to other. In that case, no need to remove the mudline hanger suspension.

PrecedenceWorld Over

The standard mudline suspension systems used in Brazil are 30x20x13 3/8x9 5/8 and 30x20x10 3/4x7" casing programs. Both systems are stack up type, and the 30" casing is normally left with a connector pin, 1.5 m, above the mudline.

Field Use

This technique has not been used so far in India. ONGC has approved to use this technique in three wells A, B & C of Krishna Godavari shallow water wells (already proven hydrocarbons) with an approximate cost of Rs 300 Crores. The NPV is 268 and IRR is 61.23% at a gas rate of US$4.75 per MMBTU. The calculations have been done by taking $ rate =Rs. 55/-. The oil rate per barrel has been taken as per guidelines of the competent authorities. This includes cost of drilling rig for installing mudline hanger suspension system, equipment and all umbilical control lines. This approval has not still been executed in the field.

Commercialization

On the basis of successful execution of this technique in the above three wells A, B & C, more and more wells will be drilled with mudline suspension hangers.

Results and Discussions

Mudline suspension hanger system is not used in India by any company so far but in it is being used by Petrobras in some shallow water wells by using two basic systems for completion. One system is used to complete mudline suspension wells and the other is used to complete well head systems. Only the mudline system has an integral completion head, while the completion trees for both systems are nearly identical.The evolution of these trees has resulted in a system based on standard tree components. In most cases, blocks, valves, down-hole sensor stabs, crossover loops and adaptions to be run with hydraulic tools. The versalality of these systems has given much greater flexibility in completion scheduling andreaction to unexpected well conditions.

Mudline suspension systems are used in Brazil for both exploratory and field development. Petrobras had many exploratory wells over marginal fields that had been abandoned. In order to increase the production and develop these marginal fields resulted in the design of an economic mudline completion system. Thesystem developed is both versatile and economic, has the operational advantages of reduced diverintervention time, and is capable of being completed immediately after drilling.

Uniqueness

- No requirement of drilling rig in offshore, which is a very costly affair, to put the well on production.
- Well can be abandoned in between by releasing the drilling rig.
- Well can again be reconnected for further drilling.

Conclusions

Mudline suspension system is a robust technique for putting small pools of hydrocarbons on production immediately after discovery and completion of evacuation system.
In the current case, the techno economics is carried out at the oil and gas rates specified by the Company's Board.However if we consider our proposals at the current rates, even then the proposals are in the favorable regime. In ONGC, India, this technique is in pilot stage. Only scheme is approved for three already hydrocarbon discovered wells. Once the technique will be proved successful on pilot stage, it can be implemented on large commercial pace and more

and more marginal in nature small offshore pools can be monetized to enhance the oil and gas production.

References

1. SPE paper on mudline suspension hanger system.