

EPRASHEED
signature series

2007 – Issue 4

Brazil oil & gas

Inside



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Drillship in Albacora Leste Field
Photo: Courtesy of Petrobras

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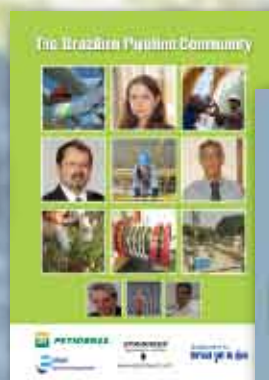
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NOTE FROM THE CEO

Brazil Oil and Gas EP Technology Awards

EPRasheed publications report the latest technological achievements within the Oil & Gas industry. Every so often these achievements justify more than a published report. To recognise these outstanding merits EPRasheed selected the Rio Oil & Gas Conference to present a number of special EP Technology Awards.

1 Marcelino Guedes of Petrobras Transporte received the Brazil Oil and Gas Award for Innovatory Thinking. This was awarded in recognition of the work done by Mr Guedes in helping develop the pipeline technology industry in Brazil and encouraging companies to export technology. Mr Guedes has been instrumental in establishing initiatives such as CTDUT which has become a fundamental link in Brazil's pipeline technology development. This has also helped bring together operators, service companies, universities and government agencies.

2 For their proven track record the Technology Award for an outstanding contribution to drilling and completion was presented to Vetco Gray for its Surface Completion Systems. Welter

Benicio President of Vetco Gray Brazil was presented the award by Monica Placido and Ana Felix.

Having celebrated 100 years, Vetco Gray designs, manufactures, sells and services highly engineered exploration and production equipment for onshore and offshore applications worldwide. Vetco Gray is recognised as the technology leader in each major product group in which it competes.

3 Norwegian Company 'PGS' Receives 4-D Seismic Technology Award. Established since 1991, PGS is a technology focused oilfield service company principally involved in providing geophysical services worldwide. The company provides a broad range of geophysical and reservoir services, including seismic data acquisition, processing and interpretation plus field evaluation.

However, it is the company's 4-D Seismic Technology that secured PGS' Award winning status. EPRasheed recognised the outstanding merits of 4 Dimensional surveys, which allow PGS to evaluate subsurface geophysical conditions that may change over time due to

the depletion and production of reservoir fluids.

The Innovatory Technology Award presentation took place at the PGS stand at Rio Oil and Gas and the award was received by Magne Reiersgard (PGS, President North and South America) and Alex Vartan (Managing Director, PGS do Brasil).

With its headquarters in Oslo, Norway, the company has offices in 22 different countries with larger regional offices in London, Houston and Singapore.

4 For their outstanding R & D work in the EP sector, Petrobras CENPES Well Construction were presented with a Technology award for their work on Liquid Cement Storage. The award was presented to Arnaldo d'Almeida who accepted on behalf of his team which included Cristiane Miranda and Gilson Campos.

EPRasheed Signature Series

EPRasheed believes there is a need to export petroleum technology and a need for a single source of technical material that focuses on key petroleum markets.

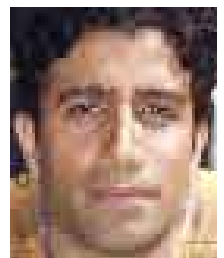
Each of these local markets represent high growth potential in terms of reserves and future production. EPRasheed Signature Series have publications focused on Brazil, Trinidad & Tobago, Norway and Saudi Arabia.

These channels allow oil and service companies to share knowledge and communicate with the wider market. (www.eprasheed.com)

The poster for the Brazil Oil & Gas EP Awards 06 features a central title in large red and white letters. It includes several sections: 'well construction', 'reservoir visualization', 'well-planning', 'categories' (listing seismic, reservoir, production, well planning, etc.), 'gas technologies', 'drilling', and 'subsea'. It also mentions 'presented at: rio oil & gas, 11th Sept' and 'entries July 30th'. The EPRasheed Signature Series logo is visible. The background is a collage of oil and gas related images.

Wajid Rasheed
Wajid Rasheed

Founder EPRasheed
and Brazil Oil and Gas



EP Rasheed Tech

Innovatory Thinking

Petrobras Transporte

Member of the Pipelines Committee of the Brazilian Oil and

Gas Institute (IBP), of the Executive Committee of Asme International's



Marcelino Guedes receives the award from Monica Placido

(American Society of Mechanical Engineers) Pipelines Division and president of the Pipeline Technology Center (CTDut), Marcelino Guedes Ferreira Gomes has worked with Petrobras for 18 years, having worked in the São Sebastião Terminal

(Tébar), in São Paulo; the former Torgua (which originated the Campos Elíseos Terminal), in Rio de Janeiro; and was the coordinator of the Pipeline Technology Program (Produt) of the Research and Development Center Leopoldo Américo M. de Mello (Cenpes). Before becoming part of the board, Marcelino also served as manager for Pipeline and Terminals Technology, and general manager of Transpetro's New Business and Partnerships.

(www.petrobras.com.br)

4-D Seismic

PGS

Petroleum Geo-Services (PGS) is a leading worldwide geophysical company. PGS provides an extensive range of seismic services and products for the petroleum industry including data acquisition, processing, reservoir analysis and interpretation. The company also possesses the world's most extensive multi-client data library.

Formed in 1991, the company today operates 12 marine streamer vessels including 6 vessels of the unique Ramform class. The company also operates between 7 and 10 Onshore crews and has 15 data processing centers.

Since the start of the company PGS has pioneered the development of multi-streamer marine seismic acquisition, producing increasingly efficient, high-quality 3D seismic data for the industry. The company has also introduced high-density 3D seismic (HD3D) in all environments and developed in-house expertise in geology, geophysics, and reservoir analysis. PGS also provides onshore seismic services where the company has a reputation for using the latest equipment in challenging environments and has an enviable program of sustainable development.

Alex Vartan said, "We thank (EP Rasheed) for the award presented at the Rio Oil and Gas. Events such as this are an important arena in which

to showcase new and innovative technologies for application to the oil and gas industry. In an exploration and development sense, Brazil's basins are maturing and it is only with the application of 4D surveying techniques that the maximum potential for each producing reservoir can be reached. A number of 4D programs are expected to be acquired in 2007 and 2008 and PGS is well positioned to offer its services and experience".

(www.pgs.com)



From left Alex Vartan and Magne Reiersgard of PGS

Technology Awards

Surface Completion System

Vetco Gray

Araken Barreto, Sales and Marketing Manager of Vetco Gray said, "Vetco Gray is grateful to EPRasheed for receiving an award for its Surface Completion Systems Award in Rio Oil and Gas Conference 2006.

We consider this award as recognition of our commitment to providing solutions to customer's needs with high levels of quality and safety.

In Brazil, Vetco Gray is a first class company in providing drilling and completion systems to the offshore industry. In 2006, we also had excellent performance in onshore activities due to our cooperation

with Vetco Gray Argentina, so that we have managed to become the leading supplier in short term. Vetco Gray has a proud tradition of delivering innovative products and establishing industry standard practices in drilling and production technologies built on 100 years of experience in the oil & gas industry.

Over the years, Vetco Gray has introduced such innovations as metal-to-metal sealing technology, designs for safer and cost-saving surface completion systems, development of marine riser

Welter Benicio of Vetco receives the award for his company



systems, deepwater wellhead technology, state-of-the-art control systems, valves and actuators, and high pressure/high temperature production systems for both subsea and surface applications.

We are committed to exceeding expectations through our people, products and values".

(www.vetcogray.com)

Cementing

Petrobras - CENPES



Arnaldo D' Almeida said, "Receiving the EPRasheed Innovatory Technology Award was both very satisfying and fulfilling. It recognizes the importance of our work and its contribution to the Oil Industry.

The EPRasheed award was an external recognition of the R&D conducted by staff at Petrobras research center (CENPES) and this has motivated us to continue our efforts in the R&D of new technology.

The award also highlights the role of CENPES within Petrobras as well

as the wider role of the Petrobras within the international petroleum community.

The liquid storable cement slurry was first used in an intermediate casing string cement application in the 1-MR-1-PR well in Parana. The technology has been used to combat severe lost circulation and offers advantages to Portland cement. Due to its characteristics the liquid storable cement slurry can be injected into the loss zone which allows for gelling and hardening of a cement plug that covers a larger area and therefore is a more effective sealant".



Petrobras EP Executive Manager

EP Feature



Photo: Steferson Faria

By Petrobras Press Office and EPRasheed Staff

Q: *Brazil Oil and Gas* – Which are the major E&P fronts for Petrobras?

A: *Jose Formigli* – The major exploration fronts for Petrobras are deeply-buried siliciclastic and carbonate reservoirs located in deep water settings, containing light oil or natural gas. The main challenge is not only to find new hydrocarbon accumulations, but also to find reservoirs with properties capable of sustaining economic production rates to support deep water development systems. Among the major deep water production fronts are the heavy oil production from poorly-

consolidated, high-permeability sandstones; the natural gas from tight offshore sandstones; and the light oil from heterogeneous, low-permeability carbonates.

For heavy oil, the experience achieved with the 19°API Marlim field, which has already recovered a significant percentage of its original oil, allows Petrobras to move forward to heavier oil fields, such as Jubarte (17°API), Papa-Terra (16°API) and Siri (13°API), the latter in shallow water. These will be some of the most viscous oils at tank conditions ever produced offshore. Nevertheless, several

challenges still need to be overcome in the following areas: oil processing, water management, well drilling and completion, boosting systems and flow assurance. In all of these projects, global cost optimization is mandatory.

Offshore, deep water natural gas production is a completely new front for Petrobras. The main challenges are related to long distance flow assurance, well productivity and remote well workover interventions. Deep water tight gas reservoirs are another important production front. Significant efforts are required

Jose Formigli interview **PART 1**



In the first of a two-part interview Jose Formigli outlines key EP factors for Petrobras

to maximize well productivity, through the use of long horizontals, multilaterals or multi-fractured horizontal wells. An important breakthrough for this type of reservoirs, in deep and ultra-deep waters, would be the development using Dry Completion Units, with a dedicated rig continuously drilling or restoring wells to sustain production.

Q: Brazil Oil and Gas – *What have been the major finds/new reserves booked?*

A: Jose Formigli – During the last four years approximately 2.71 billion barrels of proved oil equivalent reserves have been appropriated,

“During the last four years approximately 2.71 billion barrels of proved oil equivalent reserves have been appropriated, including oil, condensate and natural gas”.

including oil, condensate and natural gas. These reserves include not only newly discovered fields but also new findings in existing fields within the production concession areas of Petrobras in Brazil, according to the ANP/SPE criteria. During the same period, Petrobras has produced 2.49 billion barrels of oil equivalent (boe).

The highlights in terms of additional proven reserves include the discoveries of Jubarte, Cachalote, Baleia Franca,

Papa Terra and Maromba fields in the Campos Basin; Golfinho and Canapu fields in the Espírito Santo Basin; Mexilhão, Tambaú, Uruguá, Pirapitanga, Tamboatá and Carapiá fields in the Santos Basin; and Piranema field in the Sergipe-Alagoas Basin.

New accumulations within the ring fence of production concessions have been found mainly in the Albacora, Marlim Leste and Espadarte fields in the Campos Basin.

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BJ

BJ BRAZIL'S FIRST INTELLIGENT WELL COMPLETION

By Frederico Carvalho, BJ Brazil

BJ Services completed a 3 zone intelligent well in an onshore field for Petrobras. This is the first intelligent completion that BJ Brazil has performed in this promising market. The well was completed in three production zones and is located in the Carmopolis field, north of Aracaju city (capital of the state of Sergipe). This field already has seven intelligent wells, all being monitored with a supervisory office inside Petrobras' Base in Carmopolis City.

The software provided gives Petrobras the ability to manage and control the three zones independently. All data are transmitted through radio from the Petrobras system to the supervisory center. Petrobras' IT lay-out enables Petrobras engineers to monitor the well through the internet from anywhere in the world.

This type of intelligent well uses sensors that are linked through fiber optics and hydraulic controllable

valves. The downhole sensors and optic system can read data such as pressure and temperature from each zone and from the lift equipment, allowing the operator to intervene in any of the production zones.

The intelligent completion package enables the operator (Petrobras) to monitor, control, and model the production zones for production optimization using real time. In practice, the operator can quickly identify any production decrease (or pressure decrease for water management) and can close one or more valves remotely without having to perform a costly workover intervention.

BJ Services is currently working on the development of a variable multi position choke valve to be field tested in an offshore well in the Campos Basin. BJ Services plans to supply a complete intelligent completion system including downhole intelligent

completion packers, multi position valves, downhole electronic gauges and other accessories. The application of BJ's Multi position valve embraces:

- Optimization of Injector wells ;
- Production enhancement, extending well lifetime;
- Production and cost optimization of wells equipped with ESPs;
- Others;

The completion of these wells maximizes BJ Services expertise and qualifies BJ Services Smart Solutions as an option for future projects in Brazil and abroad.



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PETROBRAS EP EXECUTIVE MANAGER JOSE FORMIGLI INTERVIEW



Besides the new fields, Petrobras appropriated more 0.073 billion barrels of oil equivalent of proved reserves from new pools inside the ring fences (Baleia Azul, Golfinho and Mexilhão) according to ANP/SPE criteria.

Q: Brazil Oil and Gas – What is Petrobras' Reserves to Production ratio?

A: Jose Formigli – In the last four years the R/P ratio (relation between proved reserve at the end of the year and the net production of the year) has been kept around 20 years. For 2006, our R/P domestic ratio was 19.5 years according to the SPE criteria.

Q: Brazil Oil and Gas – What challenges are presented by E&P knowledge management?

A: Jose Formigli – The need to manage knowledge in organizations has increasingly become a key success factor in the so called “knowledge economy”. Organizations around the globe are developing knowledge management (KM) projects and strategies to harvest knowledge, thus remaining competitive and innovative. Much of the KM research effort has been focused on finding effective ways of managing knowledge through social and managerial approaches. Since knowledge resides in humans, human centered techniques are necessary for its management. 🕯

In December 2006 Petrobras declared the commerciality of 20 new fields which 10 of them appropriated 0.15 billion barrels of oil equivalent of proved reserves (Araracanga, Tangará, Maromba, Camarupim, Catuá, Saíra, Seriema, Tabuaíá, Jaçaná and Pintassilgo).



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Well Plan

Well planning is the process of creating a blueprint for constructing oil and gas wells. This article takes a behind the scenes look at the key components of well planning and their interaction.

The first of 3 articles based on excerpts from the book Hydrocarbon

By Wajid Rasheed

The Well Plan – a book-like bundle of engineering and legal documents – covers all aspects of designing, drilling and completing a given oil and gas well.

Large operators may refer to this as the ‘pre-drill package’ (purists may argue about the exact usage of terms but they both refer to the same thing). Smaller oil companies will simply refer to the documents as the well plan. This should be distinguished from the well profile which only describes the proposed architecture and sizes of the well.

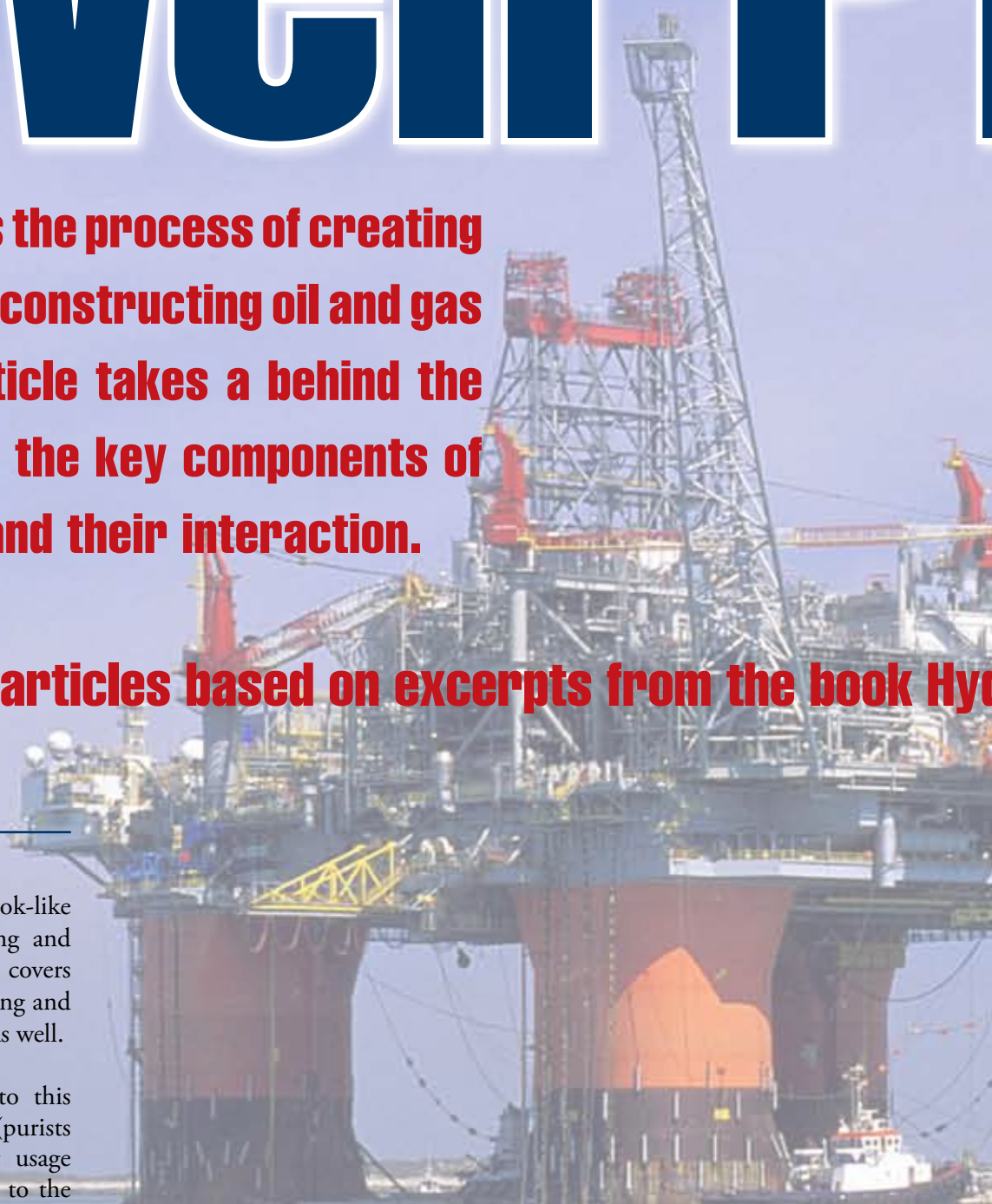
We have already seen how raw seismic info is processed into geological data. After, poring over this data bright spots and prospects are identified.

However, a prospect must be converted into a well-plan. Prospects are oil and gas reserves, (destinations), well plans are reaching reserves (access) – a way to reach the oil and gas.

“Prospects are oil and gas reserves, (destinations), well plans are reaching reserves (access) – a way to reach the oil and gas”.

Faster, better, cheaper

Picture this: Six months before spudding a deepwater wildcat, the drilling team members are scratching their heads. Which rig will they contract? Will shallow water flow affect the casing scheme? Will they keep the fragile balance between pore pressure fracture gradient and



PART 1

Planned

DWOP is the process of analyzing each step of the well construction process to generate ideas for improving performance and reducing cost.

Procarbon Highway

this concept in greater detail in due course. However, for now it is important to define the technical limit for each activity, or minimum time required to complete each task in a perfect world. It serves as a theoretical value only and can never be achieved as an actual target. Next, a realistic target based on the best past performance is established, which becomes the performance benchmark for the well.

DWOP is the process of analyzing each step of the well construction process to generate ideas for improving performance and reducing cost.

Blueprint

Getting to the blueprint stage requires various scenarios to be enacted (DWOP) and huge volumes of information to be analyzed and formatted. Well planning is a very broad concept that encompasses:

- the management of phased well construction service and supply processes to meet a desired timeline and objective;
- commercial aspects of contracts and pricing for well services and equipment;
- financial cover in terms of insurance and liabilities;
- legal conditions such as compliance with regulatory framework and outlining limits of responsibilities;

- design and operational aspects that cover detailed engineering drawings of well construction;

- health and safety considerations;

- environmental protection;

- political/cultural/linguistic aspects of operations.

There can be as many as a 100 different regulatory conditions and as many service and supply companies on a single well project. Subsequent issues will look in depth at regulatory issues such as permit to drill, supply and services procurement such as rig type, services contracts and well types but for now we shall look at the main features of well planning and accompanying risk and the engineering aspect of a vertical exploratory well.

Essential Info

A well plan has essential information such as well number, location, block, partners, and the level of confidentiality will dictate if it is tight-hole (confidential). It will include the well objectives, Surface location, longitude, latitude, Eastings and Northings.

It will also contain well information such as water depths in the case of offshore wells, MD measured depth, TVD, azimuth, spud date and critical dates such as first oil or seasonal or environmental factors that may affect operations. 

mud weight? Which drilling fluid will they use in high-pressure zones? And will they deliver a well that flows, on time and within budget?

One way of managing budgets (as well as risk and uncertainty) is the Drilling Well Optimization Process (DWOP), also known as Drill the Well On Paper. We will look at

Casing Drilling Technology

Jorge Sanguino, TESCO Corporation, João Carlos Ribeiro Plácido, Petrobras

This process developed by TESCO eliminates the conventional drillstring by using the casing string to transmit mechanical and hydraulic energy to the bit. Statistics on safety have demonstrated that drillpipe and conventional casing handling are major cause of accidents associated to drilling a well. The Casing Drilling® process requires fewer people on the rig floor and less pipe handling than conventional rotary drilling, resulting in a safer drilling process. It also eliminates unscheduled events that result from tripping the drill string, such as swabbing, formation sloughing and swelling.

Retrofitting an existing rig with Casing Drilling® equipment is easy to do and does not interfere with its use for conventional drilling. As a dual-purpose rig, it can be used on a wider range of wells, increasing contract opportunities. For long term projects, Casing Drilling® fit per purpose rigs can be manufactured, resulting in smaller and lighter rigs due to the use of Range III masts, no setback required, less fuel use, and less loads to move, consequently less horsepower is needed, resulting in a less environmental impact process and hence less capital investment.

The main reasons to use this technique are to reduce trip time, eliminate well conditioning time before running casing into the well, overcome troublesome formations with well instability and loss circulation problems, and improve well control.

A pilot hole is drilled using a conventional bit and an underreamer enlarges the well diameter. The BHA is attached to a DLA (Drill Lock Assembly), which connects the BHA

to a profile nipple immediately above the casing shoe joint. The BHA can be tripped with wireline, coiled tubing or drill pipe. When the BHA is run into the well, spring-loaded dogs in the DLA stop the tool at the proper depth to lock it to the profile nipple. The locking process is accomplished by shifting a sleeve downward to positively extend lock dogs into recesses in the profile nipple.

Any type of BHA can be used, depending on the operation. For vertical wells, the BHA may consist of a pilot bit, stabilizers, and underreamer. For directional wells, the BHA would include a downhole motor and MWD (or LWD). A casing connection must have adequate torque capacity to withstand drilling loads. A torque ring increases casing torque connection capacity.

The experience Casing Drilling® system in Brazil consists of three tests, which covered a wide range of complexity, from very simple vertical wells to high angle directional wells.

The first Casing Drilling® test in Brazil was conducted by Petrobras in the Pilar field on June 2003. Casing Drilling® was used to drill and case the 13-3/8" and 9-5/8" intervals. The 9-5/8" casing was used to directionally drill to 30 degrees.

The second Casing Drilling® test was conducted, also in 2003, in the offshore Curimã field, Northeast of Brazil, using a jack-up rig. The test objective was to drill in the 13-3/8" surface casing to overcome the troublesome fractured limestone formation. When drilled conventionally, this zone experiences total loss circulation, impairing

the casing running operation. The technique Casing Drilling® presented potential for drilling loss circulation zones, in fractured limestone formation.

In the third test, in November 2004, a 9-5/8" directional Casing Drilling® system was used to drill through a troublesome section in an onshore Petrobras well, also in Northeast Brazil. Previous attempts to drill horizontal wells in the Aracas field were unsuccessful in penetrating through the over pressured Taua shale to set casing in the under pressured Agua Grande pay zone. Mud weights adequate to keep this shale from collapsing caused massive lost circulation at the top of the Agua Grande. Sliding mode required the casing to be "rocked" in order to slide effectively. This test demonstrated that 9-5/8" casing can be used to drill directional wells with adequate directional control and competitive drilling rate.

After all these tests, the Casing Drilling® system has shown great potential to overcome troublesome zones. After these trials, it was observed some points could be improved. The system was modified and tested in USA by Conoco Phillips. The tool is being prepared to be sent back to Brazil, where a new test will be performed this year in an onshore field located in the Northeast of Brazil.



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Deepwater Feature Drilling and Completion

Rosana Lomba spoke exclusively with Brazil Oil and Gas on the latest in the world of drilling and completion fluids.



By EPRasheed Staff

Q: Brazil Oil and Gas – *What challenges do deep and ultra deepwaters create for fluid design?*

A: Rosana Lomba – Deep and ultra deep water drilling projects generate a series of complex technological problems. In order to minimize borehole problems and increase well productivity many different aspects of drilling fluid design and additives must be considered. In these circumstances the chemical and physical properties of drilling fluids may determine the success of a drilling operation. Technological problems are related to low seabed temperatures, highly unconsolidated formations, low fracture pressures, shallow water and shallow gas flows, and narrow operational margin between pore pressure and fracture create. Therefore, a number of carefully designed drilling fluids need to be developed to overcome technological problems and

guarantee operational success. Also as the number of depleted reservoirs increases so do the demands for aqueous and/or non-aqueous light weighted drilling fluids as an alternative to aerated fluids.

Q: Brazil Oil and Gas – *What is the purpose of non water based or non-aqueous systems?*

A: Rosana Lomba – Non-aqueous drilling fluids are water-in-oil emulsions. Different base oils may be used to formulate the system. Internal olefins, normal and iso paraffins, ester and ether are commonly used base oils. The internal phase is a brine of low water activity to ensure chemical stabilization of shales. The emulsion is stabilized by a surfactant that keeps the water droplets from coalescence. Wetting agents are added to the system to oil-wet the solids. Fluid loss control additives,

viscosifiers and weighting agents are other components of the system.

Q: Brazil Oil and Gas – *What can you tell us about Lightweight and Non Invasive Fluids in Deepwater applications?*

A: Rosana Lomba – The particular drilling scenario characterized by the occurrence of a narrow operational margin between pore pressure and fracture has been commonly associated with some drilling problems, such as loss of circulation and well control events. The use of lightweight fluids introduces the possibility of being able to successfully drill ultra deep-water wells, which has a significant impact in the exploratory activity. In addition, some deep-water reservoirs are already depleted and there is a demand for light weight fluids capable of avoiding circulation losses and minimizing formation damage.

on Fluids

Biography

Rosana Fatima Teixeira Lomba is a Technical Consultant in the Wellbore Engineering Technology Sector in PETROBRAS R&D Center located at Rio de Janeiro, Brazil. Since she joined the Company in 1985, she has been the coordinator of major research projects involving drilling and completion fluids technology and shale stability. Presently, she is the coordinator of a project on the design of fluids for drilling, evaluation and completion of long horizontal section wells in offshore heavy oil environments. She holds a Ph.D. degree in Petroleum Engineering from the University of Texas at Austin (1998), a MS degree in Mechanical Engineering (1994) and a BS degree in Chemical Engineering (1982) both from the Federal University of Rio de Janeiro. She is a member of SPE. (rlomba@petrobras.com.br)



 The image shows an industrial scene with a large offshore oil rig in the background and a large storage tank in the foreground. The scene is set against a blue sky and water. The image is framed within a blue background that also contains the text "Goma xantana" and "Tecnologia brasileira, qualidade internacional."

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LOMBA

From those operational perspectives, currently, the development efforts are focused on two different topics: (1) the development of a dual gradient drilling (DGD) system based on lightweight fluids; and (2) the formulation of non-invasive drilling fluids.

Q: Brazil Oil and Gas – How has the Dual Gradient Drilling System developed?

A: Rosana Lomba – In the last few years, the industry has been addressing the use of lightweight fluids with great interest. Technology reviews and the development of equipment, materials and computer simulators through several joint industry projects and independent research groups are under way. One of the most beneficial ways of using the lightweight fluids technology in a deep-water operation consists of providing an effective approach for managing the challenges associated with the narrow operational margin between the curves of pore pressure and formation fracture. Considering those operational circumstances, the use of a DGD system introduces the possibility of being able to drill successful deep water and ultra deep-water wells.

For achieving the DGD condition, the industry has been focusing on the development of systems based on two distinct conceptual approaches: (1) the use of lightweight fluids, which is the main focus of the present development efforts, and (2)

"The role differs from mechanical lifting systems, as the use of lightweight fluids for achieving a dual gradient condition consists of diluting the mud returns at the seafloor by injecting gas or hollow spheres".

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mechanical lifting, which consists of a pumping system to lift the mud from the seafloor up to the surface.

Q: Brazil Oil and Gas – What is the application of lightweight fluids in DGD?

A: Rosana Lomba – The role differs from mechanical lifting systems, as the use of lightweight fluids for achieving a dual gradient condition consists of diluting the mud returns at the seafloor by injecting gas or hollow spheres. As those materials have low density, they are good options to decrease the density of the drilling fluids. From the point of injection upward to the surface, the density of the drilling fluid will be less than the effective mud density below the seafloor.

Q: Brazil Oil and Gas – What challenges does that present?

A: Rosana Lomba – The DGD condition requires that the mud flowing through the riser exerts the equivalent hydrostatic pressure of the seawater on the seafloor. So, the diluting material must be added at a proper concentration to decrease the density of the drilling fluid to a value such that fulfills this DGD

requirement. Besides injecting the diluting material, it is also necessary to separate it from the drilling fluid at surface. After this separation, the drilling fluid is processed in order to maintain the proper physical and chemical properties, and is pumped back to the well through the drill string. If the hollow spheres are used as the diluting material, which generate an incompressible lightweight fluid, they will be reused after being extracted at surface. However, despite all recognized advantages of a dual gradient drilling system based on this diluting material, this innovative drilling process requires new pieces of equipment and operational procedures that are still being developed.

Q: Brazil Oil and Gas – What is the principal behind the gas-lift DGD?

A: Rosana Lomba – The gas-lifted riser DGD system, which consists of injecting gas at BOP level to reduce the marine riser annular density down to the seawater density, requires much less development efforts than the hollow sphere system to be implemented in the field because of the improvements already introduced by the underbalanced drilling technology over the last

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DRILLING AND COMPLETION FLUIDS

few years. The primary idea is to combine nitrogen injection with a high-pressure concentric casing riser, which reduces the internal diameter of the riser and, consequently, the pumping volumetric requirements. The annular space between the outer riser and internal casing is filled with seawater to prevent collapse of the outer marine riser. A high-pressure rotating control head (RCH) located at the top of the concentric riser seals the annular space and the return stream is directed to an automated 3-phase separator, which enables the continuous separation of the mixture components for re-circulation, sampling, storage, flaring or disposal.

The gas-lifted riser DGD system involves the use of a closed and pressurized circulating system. In floating rigs, the key point consists

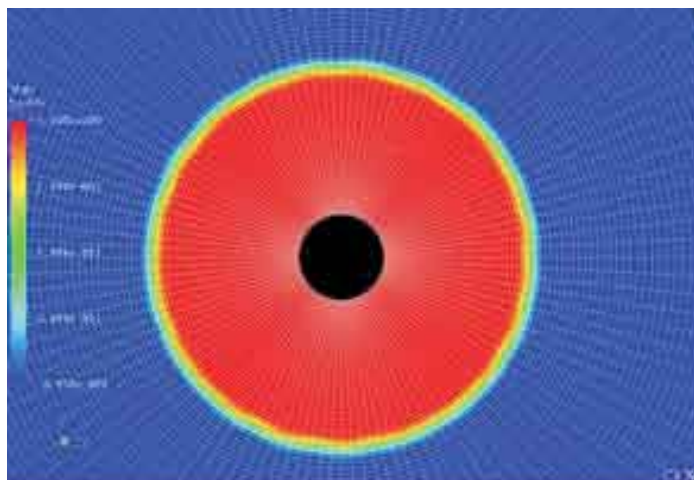
besides the concentric riser concept, another very promising alternative is being developed to overcome it, the surface BOP. This alternative will not only solve the difficulties associated with the strength of the conventional drilling riser but also combine perfectly with the slender well concept, presenting a significant potential for reducing overall drilling costs.

Q: *Brazil Oil and Gas* – How has Non Invasive Fluid technology developed?

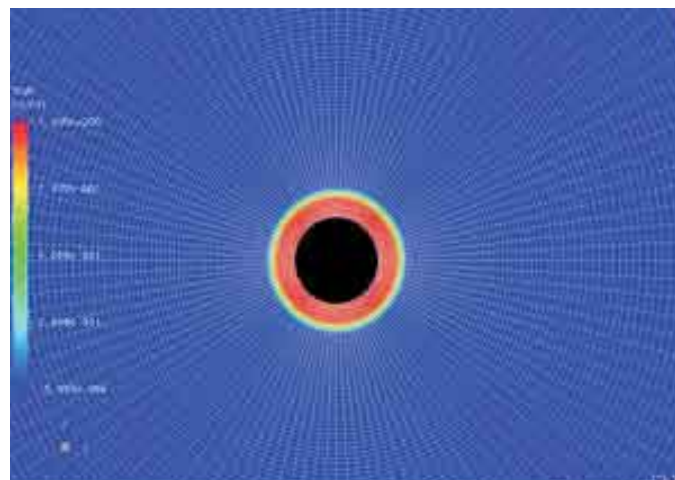
A: *Rosana Lomba* – Filtration control is a major criterion for fluids design. Avoiding fluid losses and minimizing formation damage depend on the minimum interaction between drilling fluids and the drilled rock. The adequacy of the drilling fluid to reach these goals is

pore plugging and minimize fluid penetration. Also, specific polymers are used that reduce fluid invasion due to surface chemistry and viscosity effects. The development of less invasive non-damaging fluid formulations requires the knowledge of filtration mechanisms of solids containing polymeric solutions in porous media.

The research has been carried out in different ways: the search for the understanding of the relative importance of factors contributing to filtration, the evaluation of solid additives to prevent loss of circulation, the evaluation of polymers to minimize fluid invasion into porous media and the development and evaluation of non invasive fluid formulations. Theoretical and experimental studies on static and dynamic filtration of



Invasion profile at 800 psi – Darcy



Invasion profile at 800 psi – Viscoelastic

of defining the best location for the rotating piece of equipment that holds pressure. This issue is critical, but, based on previous experiences, to place the Rotating Control Head (RCH) at the top of the inner riser is supposed to be the best option for this particular application, which is a choice that has many similarities to the one already implemented in the field. The low strength of the conventional drilling riser in terms of holding internal pressure and collapse is an important aspect to be considered in this analysis. However,

normally evaluated by the execution of conventional static and dynamic filtration experiments.

Fluid invasion into productive zones has been widely recognized as detrimental to well productivity. Filtrate and solids invasion can cause irreversible formation damage and permeability reduction. Drilling fluids are formulated to avoid excessive fluid penetration into productive zones. Non-damaging acid-soluble solids (for example, calcium carbonate) are usually added to drill-in fluids in order to promote

water based drilling fluids have been carried out to evaluate the effects of fluid type, solids shape, size and concentration, polymer type and concentration, rock permeability and applied differential pressure on filtration properties of the fluids.

Regarding bridging materials, granular, laminated and fiber-like solids act quite differently during filtration through a high permeability unconsolidated porous medium, confirming the importance of shape effects on filtration mechanisms. Also, an

increase in solids concentration does not necessarily lead to lesser invasion into the medium. Particle size distribution and particle shape seem to be the major factors governing fluid invasion.

Commercial non-invasive fluid formulations based on physical-chemical mechanisms or surface interactions between additives and the permeable rock may be recommended for some specific applications, depending on rock type, down hole conditions and drilling scenario.

Q: Brazil Oil and Gas – *How is the problem of Hydrates countered?*

A: Rosana Lomba – The potential for hydrate formation in drilling fluids increases as a result of increasing deepwater drilling. The low seabed temperatures and high pressures provide the proper conditions for hydrates formation and growth especially in aqueous drilling fluids. Once the formation starts, growth may be quite rapid and a solid mass may be formed in the well bore, kill and choke lines and/or inside the blowout preventers. The solid mass may block fluid circulation or be strong enough to even prevent drill string movement.

To avoid the problem, drilling fluids are formulated to either inhibit or delay hydrate formation. Another approach involves the prevention of the growth of hydrates.

Thermo dynamic Inhibitors

Glycols and salts are commonly used additives to prevent hydrate formation in drilling mud. The combinations and product concentrations are established depending upon temperature and pressure conditions and the required degree of inhibition. P/T diagrams are experimentally obtained to define the more suitable mud composition for a given set of drilling conditions. Typical concentrations are 20% NaCl and 10% ethylene glycol (EG).



Kinetic inhibitors

Kinetic inhibitors are used to delay hydrate formation under certain conditions by delaying the appearance of the critical nuclei. Kinetic additives are copolymers or surfactants used in low concentrations so that they do not affect fluid properties much. The performance depends on the required sub-cooling.

Anti agglomerants

These kinds of additives are used to avoid hydrates growth once they begin to form. They are also called crystal modifiers. They may slow the rate of hydrate formation and/or prevent the agglomeration process.

Q: Brazil Oil and Gas – *How does temperature affect rheology?*

A: Rosana Lomba – The low temperatures encountered at the seabed (below 5 °C) directly affect fluid rheology and lead to severe gel development of the drilling fluid. Moreover, the hydrostatic pressures at the bottom of the riser are usually very high, depending on fluid density and water depth. The rheological properties of aqueous drilling fluids increase with the decrease in temperature and are only slightly affected by pressure. On the other hand, synthetic non-aqueous drilling fluids rheological behavior is affected by both temperature and pressure.

Significant differences may be found in computed equivalent circulating density (ECD) compared to an ECD calculated without considering rheology dependence with temperature and pressure. The variations may cause well control problems, especially in the particular scenario characterized by the occurrence of a narrow operational margin between pore pressure and fracture.

The reduced downhole rheology and equivalent circulating density (ECD) often results in poor wellbore cleaning, barite sag, or other problems related to low rheology at bottom hole static and circulating temperatures. Adjusting the rheology upwards can result in excessive ECD values and gel strengths.

Loss of circulation problems caused by the adverse increase of viscosity and ECD may result in well control problems, high operational costs and severe environmental damages. Therefore, new drilling fluid systems should show improved flat rheological profile over a wide range of temperature and pressure. This behavior would allow for the maintenance of higher viscosities for improved cuttings carrying capacity and barite sag prevention without negatively affecting ECD. 🌱



CTDUT



The 'Pipeline Technology Center – CTDUT' is a laboratory equipped with field facilities for testing/certifying products, full scale simulations and the research and development of new technologies in pipeline activities. CTDUT is also designed to offer specialized pipeline training. CTDUT contains a pull test unit for Pig testing, an Integrity Laboratory for burst tests, a Gas Flow Loop, and a separate liquid loop for tests under real operating conditions.

Raimar Van den Bylaardt – CTDUT

CTDUT is a Technology Center created by Transpetro, Petrobras and PUC-Rio (The Catholic University) with support from the Federal Government, resources from the Oil and Gas Sectorial Fund (CTPETRO), and linked to the Ministry of Science and Technology through FINEP. It is a non-profit association open to all companies working in pipeline operation, construction, engineering, R&D, training, environment, services, and also government sectors and regulating agencies.

In the search to develop leading edge technology for pipeline transport, CTDUT is emphasized as the fundamental link in the implantation of a Brazilian network of competence in pipelines, bringing together pipeline operators, companies, universities, research centers, civil society and government agencies.

The structure built to comprise the technological center is open to all those companies and institutions that wish to strengthen the development of this project, thus enabling the

multiplication of activities planned for the business and academic sectors.

Nowadays, CTDUT has 19 associates: Azevedo & Travassos, Chemtech, GDK, IMC Saste, Intec do Brasil Ltda., Intech Engenharia, Pipeway, TDW, TSA Tubos Soldados Atlântico, TWI, Universidade Federal Fluminense (UFF), Conduto, Brazilian Petroleum & Gas Institute (IBP), Petrobras, PUC-Rio, Transpetro, IEC and Aselco.

CTDUT headquarters is located in the city of Duque de Caxias, state of Rio de Janeiro, close to a Terminal from Transpetro that supplies the center facilities with oil, diesel and natural gas.

The use of the pull test unit began in 1999 to verify the capability of detection, the precision of sizing and the absence of false calls. Since then, several tests of pig performance have been done with the goal of testing new technologies, tools for applications, innovative prototypes and adaptations for special case inspections. This pull test unit consists of several pipeline segments installed in a metallic structure containing shelves and an electrically powered winch that moves a wire inside all of the section of the shelves.

Some Tests Realized in CTDUT

The internal coating of pipeline has become more important in internal corrosion prevention. More frequently pipelines are built and assembled with internal coating for reducing friction and assure a better quality of the product. Apart from application coating before pipeline assembly, sometimes the coating is applied in pipelines in operation. In these cases it is named internal coating in-situ. This kind of application is more complicated

due to the difficulty of surface preparation and the application of the coating itself, that is commonly applied by using pigs. In Brazil, the first in-situ coating application was done in 2002[1]. The average coating thickness is about 300 μm . As with any pioneering work, many tests were performed to assure the quality of this new technology. Part of those tests were performed in CTDUT pull test unit to check if the MFL tool would damage the coating after a certain amount of runs and verify the influence of the coating in detecting and sizing external defects.

To realize this test a 28m length specimen of pipeline segment was built and assembled into the shelves of the pull test unit. In this segment flanged spools were introduced which had the same coating as the pipeline. After the specimen was assembled, an internal inspection was realised by a MFL.

From results of the test, it was concluded that when the in-situ coating was applied, the MFL tool does not damage the coating and nor is its accuracy affected by the coating.

Some Projects in Development

Nowadays, CTDUT is working on the construction of 3 loops:

- 14" diameter and 100m in length for liquid transport;
- 12" diameter and 2,4km in length for liquid transport;
- 16" diameter and 2,4km in length for gas transport.

These projects will be used for research, test and training, with a participation of research centers and universities of Brazil, as well as with the operators, service companies and equipment manufacturers.

The following needs had been identified to develop these projects:

- Research and development of new equipment, tools, inspection systems and pipeline protection.
- Flow tests for simulation software approval.
- Tests and certification of equipment and control system, protection, corrosion control, inspection and maintenance of pipeline.
- Certification of process and procedures of operation, inspection and maintenance.
- Training and qualification of operators and technicians. 🦋



14" diameter loop - 120 meters in length.



12" diameter - 2.4km in length with integral supply tanks, pumps, automation and state-of-the-art controls.



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