

PETROBRAS CHOSE OPENpredictor™ FOR OPERATIONAL EXCELLENCE AT ITS P43 FPSO

Petrobras S.A., Brazil, one of the world's largest integrated energy producers, signed a contract with Rovsing Dynamics for an advanced monitoring solution for its P43 Floating Production Storage and Offloading (FPSO) unit. The objective is to optimize availability and efficiency, and to achieve operational excellence of the oil and gas producing FPSO.



José Antonio Figueiredo, Executive Manager in Petrobras.

FPSO, and a significant potential to increase revenue and reduce risk and cost. This is worth millions of dollars every year," says José Antonio Figueiredo, Executive Manager at Petrobras. "The business improvement is mostly linked to downtime reduction. To achieve higher machine availability and increased efficiency, we will in 2009 implement advanced, predictive monitoring of our most critical production assets. The project is an important element in our strategy to grow oil and gas production sustainably, and to be recognized for world class excellence in Exploration & Production operations."

The project aims to reach or surpass Petrobras' management benchmark objectives from a production point of view.

Mission critical assets

The analysis identified 3 mission critical production systems to be monitored by OPENpredictor™:

- 4 water injection pumps, each with an equivalent oil production capacity of 50,000 Barrels/day, are crucial for

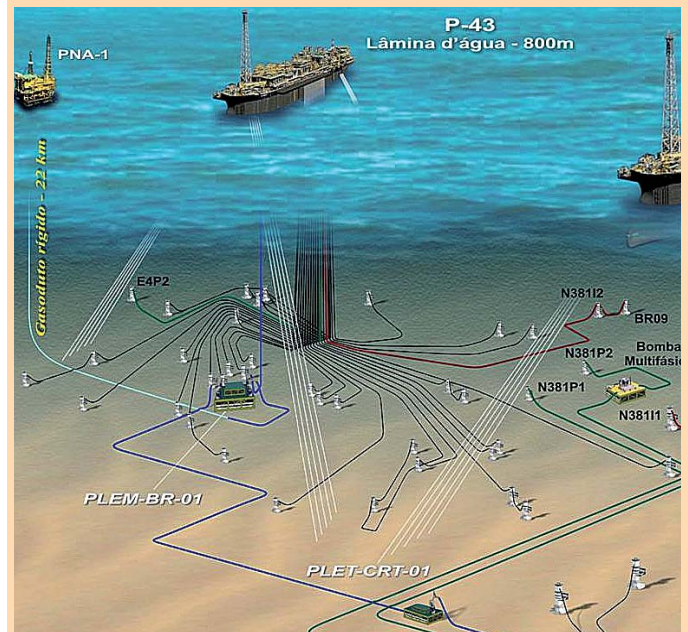
The cooperation project is defined to optimize production output at P43, one of the world's largest FPSOs, at Petrobras' mature Barracuda deepwater field in the Campos basin. This is Brazil's biggest oil reserve, accounting for nearly 84% of the country's oil production.

Huge economic potential

To identify unexploited business potential, Rovsing Dynamics and Petrobras initially conducted an analysis to assess

- Most important economical risks
- Main downtime contributors
- Opportunities to further expand condition based maintenance

"With support from Rovsing Dynamics we identified several improvement areas for our P43



About FPSOs

Floating Production, Storage and Offloading vessels are particularly effective for oil reserves in difficult to reach places e.g. in remote or deepwater locations where seabed pipelines are not cost effective. FPSOs eliminate the need to lay expensive long-distance pipelines from the oil well to an onshore terminal. They can also be used economically in smaller oil fields which can be exhausted in a few years and do not justify the expense of installing a fixed oil platform. Once the field is depleted, the FPSO can be moved to a new location.

P43 - one of the world's largest

Petrobras' P43 FPSO is one of the world's largest oil rigs with a total weight equivalent to 80,000 cars, 337 meters long and 65 meters high. It has capacity to process 150,000 barrels of oil/day and store more than 1 million barrels. Gas compression capacity is 6 million m³/day. P43 was converted from a Very Large Crude Carrier into an FPSO and put into operation in 2004. It can accommodate a staff of 100 people offshore. P43 is linked to 18 production wells and 14 injection wells at 800 km depth 160 km off Brazil's coast. Oil is offloaded to a shuttle tanker, while the gas is transported to the shore via pipeline.



Water injection for oil production

In on- and offshore oil production water is injected back into the reservoir to increase pressure and thereby stimulate production. Water is injected for two reasons:

1. For pressure support of the reservoir (also known as voidage replacement).
2. To sweep or displace the oil from the

reservoir, and push it towards an oil production well.

Normally, only 30% of the oil in a reservoir can be extracted, but water injection increases that percentage (the recovery factor) and maintains the production rate of a reservoir over a longer period of time.

the oil production

- 3 centrifugal compressors for compression of natural gas
- 4 gas turbine generators with a capacity of 20 MW each, which provide power for the installations on the FPSO.

Failure Mode Effect Analysis

The project includes a Failure Mode Effect Analysis (FMEA) on downtime and economic risk. This is facilitated by the Dutch company MaxGrip, which is specialized in all facets

of maintenance & reliability engineering work processes. The outcome of the study will be:

- Business objectives with risk thresholds
- A set of failure modes for the considered system including mean times in between failures and mean times to repair
- Classification of critical and non-critical failure modes with corresponding effects per business objective

Integrated (user-oriented) solution

Different monitoring types will be applied to assess the electrical, mechanical and performance condition of the machines to assess future business risk.

Advanced **Online Condition Monitoring** will assess machinery condition and automatically warn about changes in the dynamic behaviour of critical machines related to short term operation risk and long term maintenance.

Performance deterioration is continuously monitored to assess future capacity reduction. Early warnings and forecasts facilitate better planning of overhauls and cyclic maintenance.

The FMEA analysis gives input to OPENpredictor's **Reliability Monitoring** module, which provides statistics on machine downtime, reliability, availability and utilization. Decision makers use such Key Performance

Indicators to identify non-performing assets and prioritize maintenance based on historic and future downtime assessment.

OPENpredictor™ **integrates** signals and data from several subsystems such as vibration protection devices, partial discharge monitors, local control system and data historian.

Partial Discharge Monitors

of the electric motors and generators are supplied by the Swiss company PDTech to identify insulation deterioration between high voltage windings (see page 8).

OPENpredictor™ also analyzes **off-line vibration measurements** from non-critical machinery, obtained with a new type of handheld data collector, developed by the French company Impédance, and providing on-the-spot fault analysis (see page 8)

Remote monitoring will enable turbine specialists at Petrobras's headquarter in Rio de Janeiro to effectively support field operation.

"OPENpredictor™ provides one common interface with information distribution and prioritization to operation, maintenance and management," says Director Henk Smith from Rovsing Dynamics. "As part of the delivery, we will also develop a training and knowledge exchange program for the Petrobras University.

Automated fault diagnosis & prediction

"OPENpredictor™ performs fully automated interpretation of machinery fault symptoms (AutoDiagnosis™) with early warnings and prediction of lead time to inspection. This is a cost-efficient way to provide Petrobras' operation and maintenance staff with insight into actual and future machinery health," says Henk Smith. "The vital information from the integrated, predictive monitoring solution will facilitate a significant improvement of the availability and efficiency, and result in operational excellence at P43".

Increased machine availability

i.e. process uptime by 1-2% is typically achieved through

- Reduction of unscheduled downtime due to fewer trips and faster start-up after trip
- Reduction of scheduled downtime due to fewer inspections and optimized maintenance planning (clustering of activities)
- Focus on avoiding re-occurring problems, which contribute most to the downtime

Efficiency/capacity improved

by 0.5-1.0%, will typically be achieved by

- Planning overhauls and cyclic maintenance (compressor wash, filter cleaning/exchange etc.) for the best economic moment, balancing production loss due to deterioration/fouling with the loss due to standstill and market demand.
- Optimizing machinery work

point and losses due to bleeding, leakage and recycling

- Choosing the most efficient production units in case of redundancy

Overall benefits from higher availability and efficiency:

- Increased production output at the same cost level
- Reduced energy consumption and emissions/produced unit
- Less flaring – and image loss

November 24 the project was officially kicked-off by Mrs. Marina Fachetti, General Manager of Petrobras' Exploration and Production Division Rio de Janeiro at an official ceremony. Both Mrs. Fachetti and Mrs Thea Larsen, CEO Rovsing Dynamics concluded that the high annual business potential will form the basis for a long term cooperation to sustain the value and 'close the value loop'.



Petróleo Brasileiro S.A. (Petrobras), is a semi-public Brazilian integrated energy producer with oil and oil by-product exploration, production, refining, marketing, and transportation in Brazil and abroad.

The company has more than 100 production platforms, 16 refineries, 30,000 kilometers of ducts and more than 6,000 gas stations. Total output from upstream operations is > 2 million barrels of oil equivalent/day.

Petrobras is headquartered in Rio de Janeiro, employs 112,625 employees and had a turnover of USD 100,000 million in 2007. The oil major is a world leader in development of advanced technology from deep-water and ultra-deep water oil production.

Read more: www2.petrobras.com.br

NEW OFF-LINE MONITORING APPROACH PROVIDES DIAGNOSIS IN THE FIELD

The OPENpredictor™ solution for Petrobras includes a new approach for off-line monitoring of non-critical machinery based on integration of OPENpredictor™ and StudioVib, a software developed by the French company Impédance dedicated to off-line data acquisition and analysis.



StudioVib and OPENpredictor™ will run in parallel on a small, rugged tablet-PC for industrial field use.

“The huge benefit of the new off-line approach is that when StudioVib has acquired field data from a machine part, OPENpredictor™ immediately interprets the machine condition and on the spot provides the operator with an AutoDiagnosis™ of the most common machinery problems,” says Hamid Saiah, Managing Director at Impédance. “In

Hamid Saiah, Managing Director at Impédance

the traditional approach the staff first collects data from all machines, uploads data to a PC for analysis – and then, if more data is needed for supplementary analysis, they go back to a machine to collect additional data. This is not necessary anymore.”

When all field work is done the results can be downloaded via the office network to the main on-line OPENpredictor™ system. Back in the office, specialists have access to the raw machinery vibration signals for post-processing in combination with on-line collected process data from the control system

to verify the field conclusions. This simplifies detailed diagnosis and brings off-line condition monitoring to the quality level needed.

“The new, integrated StudioVib and OPENpredictor™ approach offers a very high efficiency for off-line data collection, condition assessment and machine fault verification in combination with flexibility of data post-processing for advanced diagnosis in case of complex machinery problems. All in all it will save a lot of time and resources,” Hamid Saiah concludes.

Read more: www.impedance.fr

PARTIAL DISCHARGE MONITORING

Partial Discharge (PD) Monitoring is a valuable method to identify insulation deterioration of generators and high voltage electrical motors. It is important to know well in advance that sparking is degrading insulation as repair of high voltage components requires long outage time.

PD converters from the Swiss company PD Tech convert high frequency sparks occurring between high voltage parts into signals measurable by OPENpredictor™, which will monitor, trend and forecast the PD levels so appropriate diagnosis and inspections can be scheduled.

The PD levels depend on load and winding temperature conditions and therefore need to be interpreted with care. OPENpredictor's unique pre-classification methodology is used to create comparable process circumstances for

trending, warning and forecasts of the PD levels. Instantaneous AutoDiagnosis™ automatically warns about increased PD levels for similar operating conditions, indicating the need for a detailed diagnosis to identify the root cause. This

is done with an off-line Partial Discharge Analyzer also from PD Tech. Based on the results an inspection can be scheduled to the effected machine parts.

Read more: www.pdtech.ch

