NEXT GENERATION SUBSEA TECHNOLOGY - KEY CHALLENGES AND TECHNOLOGY TREND
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Agenda

- Petrobras’ subsea oil production - past, present and future
- Mature fields subsea technology challenges
- Pre-salt and green fields subsea technology challenges
- Summary
PETROBRAS’ OFFSHORE JOURNEY
PAST PRESENT AND FUTURE

- 70’s
  - Reservoir: < 2300 m
  - ENCHova 124m EN-1-RJS
  - BONITO 189m RJS-38
  - PIRAUNA 293m RJS-232
  - MARIMBA 383m RJS-284
- 80’s
  - Reservoir: < 3200 m
  - MARIMBA 492m RJS-376D
  - MELHOR 578m MRL-9
  - MARIMBA SUL 1709m MLS-3
- 90’s
  - Reservoir: < 3500 m
  - RONCODOR 1853m RJS-436
  - RONCODOR 1877m RO-8
  - RONCODOR 1886m RO-21
- 00’s
  - Reservoir: < 4300 m
  - CASCADE CHINOOK 2695m RJS-646
  - MOITA BONITA 2990m 3-BRSA-1296-SES
PETROBRAS´ OFFSHORE JOURNEY
PAST PRESENT AND FUTURE

- Subsea numbers

87 Manifolds

4.545 km of E-H Umbilicals

~4,000 tools (TRT, THRT, etc.)

1,002 WCT’s

6.836 km of flexible pipe

756 PDG’s
WE PRODUCE AROUND 2 MILLION BARRELS OF OIL PER DAY IN BRAZIL
PETROBRAS’ OFFSHORE JOURNEY
PAST PRESENT AND FUTURE

OIL AND NGL PRODUCTION IN BRAZIL
COMPARISON WITH 2014-2018 BMP

Millions bpd


2.0 2.1 2.4 2.5 2.8 4.2

PNG 2015-2019 PNG 2014-2018
UPCOMING SUBSEA PROJECTS (MOSTELY PRE-SALT BUT NOT JUST PRE-SALT)
• Huge subsea infrastructure installed
• Large variety of age, water-depth, flow rates, technologies, etc.

• More subsea equipment will be necessary to support the oil production expansion.
The next generation of subsea technology must support this diversity of subsea oil production projects at all their life cycle.
**Technological Focus**

- Refining, Transportation, Trade and Petrochemicals
- Exploration of new frontiers
- Reduced total cost of construction, maintenance and abandonment of wells
- Exploration of gas hydrates
- Production in the Pre-Salt
- Increased profitability of mature fields
- Subsea production systems
- Offshore logistics
- Refining pre-salt oils
- Maximizing the production of middle derivatives and gasoline
- Optimization, adaptation and integration of logistics and transport innovative products
- Valuation of assets and currents in petrochemical
- Integration of geological processes
- Sea production systems
- Mobility and Smart Grid
- New materials
- Renewable energy
- Exploration of gas hydrates
- Bioproducts Production
- Reducing raw material costs
- Construction and assembly
- Optimization of production processes and efficient use of energy
- Integrity, safety and reliability
- Environmental characterization and evaluation of environmental impacts
- Recovery of contaminated and degraded areas and support emergency
- CO2 and other air emissions and climate change
- Water, effluents and waste
- New monetization potential of natural gas in onshore conventional and unconventional reservoirs in the inland sedimentary basins in Brazil
- Integration and flexibility in supply and demand of energy and GN
- Natural gas logistics
- Adding value to the GN through the C1 chemistry
- Natural Gas Processing
- Energy and Reliability Integration
MATURE FIELDS

Campos Basin Overview

- 55 platforms over 100,000 km²
- Operating since 1977
- 15 fixed structures - WD 80 to 170 m
- 40 floating units - WD 80 to 1,800 m

Main challenges

- Life extension
- Field revitalization
- Subsea decommissioning
- Integrity
MATURE FIELD - LIFE EXTENSION

Motivations:
- Extend the life of a field is a business case
- Thinking ahead for pre-salt fields

Challenges:
- Recover and validate operational data
- Modelling of degradation mode and calculate remaining life
- To execute in a safe and cost effective way
MATURE FIELD - REVITALIZATION - SUBSEA PROCESSING

- Subsea Raw Water Injection
- Subsea Boosting
- Subsea Oil-Water Separation
MATURE FIELD - SUBSEA DECOMMISSIONING

Campos Basin Scenario

• Fixed platforms with dry completion and some subsea satellite wells
• Floating production units with subsea wells

Equipment and lines

• Very old equipment, various models
• Lines crossing in several points
• Planning challenging
• More ROV than diving to reduce risk
MATURE FIELD - SUBSEA DECOMMISSIONING

Challenges

• Recovering vessel must be able to deal with residual oil and several sizes and types of flowlines and umbilicals

• Availability of cutting, plugging and pulling tools ➔ cutting speed and oil leak prevention

• Contingency tools and procedures must be planned in advance to avoid operation discontinuities

• Regulatory frame still in progress ➔ longer interaction with regulatory bodies

• Problems vary from one project to the other ➔ dedicated design for each one

• Previous survey is necessary to allow consistent operation planning

• Final destination of recovered equipment must be defined in advance
Apply new technics to:

- Detect, monitor and assess damage of subsea hardware more effectively
- Reduce diving for subsea inspection
- Reduce intervention costs
- Predict intervention to reduce downtime due to failure.
PRE-SALT - SUBSEA TECHNOLOGY CHALLENGES

- CAMPOS BASIN
- SANTOS BASIN

Key:
- Petrobras Exploration
- Petrobras Exploration / Partnership
- Petrobras Production
- Evaluation Plan
- Transfer of Rights
Pre-Salt drivers and challenges

A. Very heterogeneous carbonate reservoirs & seismic imaging complexity
B. Thick salt layer & very deep reservoirs
C. Presence of contaminants (CO2 and H2S) in the reservoirs
D. Ultra-deep waters
MAIN CHALLENGES TO NEW SUBSEA PROJECTS

- Enabling technologies
  - Harsh environment and fluid characteristics
- Optimizing technologies
- Think ahead integrity, intervention and decommissioning
DEVELOPMENT OF NEW AND RELEVANT TECHNOLOGIES FOR SUBSEA SYSTEMS AT PRE-SALT
First Buoy Supporting Risers (BSR) (> 2,100 m)
First Steel Catenary Risers (SCR) with Lined Pipes installed by reel lay method
Deepest Steel Lazy Wave Riser (SLWR), in 2,140 m WD, totally composed of lined pipes and metallurgically clad pipes.
Deepest flexible riser installed in Lula field (2,220 m)
First application of flexible risers with integrated tensile armor wire-monitoring system
Subsea trees with standard mechanical interfaces
OPTIMIZATION TECHNOLOGIES FOR SUBSEA GREEN FIELDS
Optimization Installation
Optimization Layout

Risers and mooring interference
Optimization Equipment
ASSET OPTIMIZATION REQUIRES THE INTEGRATION OF TECHNOLOGIES IN DIFFERENT DISCIPLINES

- **WELL**
  - Intelligent completion
  - Acid frac/stimulation

- **SUBSEA**
  - Flexibility to operate with coupled/decoupled, rigid/flexible risers
  - WAG manifold

- **PROCESSING PLANT**
  - High-capacity gas plant with CO₂ separation

- **FLOW ASSURANCE**
  - Hydrate prevention in WAG cycles
  - Scale management
The mixture of CO₂ and heavy hydrocarbons generates instabilities in the traditional phase equilibrium, creating an unusual envelope, which looks like Liquid-Liquid equilibrium.
SUMMARY

The next generation of subsea technology must support a diversity of fields at all their life cycle. The future of oil production at PETROBRAS will be Pre-salt plus Mature fields.

The challenges of Mature fields are related to life extension, revitalization, integrity management and decommissioning.

Many enabling technologies have been developed to Pre-salt fields as well as optimizing technologies. The main challenge to the future will be optimizing technologies.

We need to think ahead integrity, intervention and decommissioning to these fields.

Step change technologies to asset optimization would require the integration of different disciplines.