Subsea High Boost Multiphase Pump System,
in operation at Petrobras' Barracuda Field

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Content

- Subsea Helico-Axial Multiphase Pumps Evolution
- High Boost MPP Development and Test Results
- Barracuda: World’s First High Boost Pump application
- Operational Experience
- Next High Boost Applications
- Conclusions
- Q&A
Subsea Helico-Axial MPP Evolution

Statoil - Gullfaks A 1993
- 1st Helico-Axial (topside)

Shell - Draugen Field 1994
- First Subsea Installation

Mobil – Topacio Field 1999
- First Multiphase Installation with Electric Drive

Petrobras’ - Barracuda 2012
- First High Boost Installation

Source: OneSubsea internal research and analysis
Water Depth Milestones by OneSubsea

Source: OneSubsea internal research and analysis
Shaft Power Evolution by OneSubsea

Source: OneSubsea internal research and analysis
Design Pressure Evolution by OneSubsea

Source: OneSubsea internal research and analysis
Multiphase Pumps DP Evolution by OneSubsea

Barracuda, World's First High Boost

Source: OneSubsea internal research and analysis
High Boost Multiphase Pump

Based on conventional OneSubsea pump design
Balance Piston

Function is to provide a counter-force to the axial thrust provided by the pump impellers to reduce thrust bearing loads.
OneSubsea High Boost Multiphase Pump Development

Qualification Program under a JIP

- Based on the standard, well-proven design
- JIP kicked off in 2007
- First test in 2008
- Re-test in 2009
- Last endurance test completed in 2011
Pump Performance

Performance Test:

- Water and Gas Mixture used
- Proved the hydraulic design
- Test points measured confirmed predictions

GVF 30%

GVF 60%

High Boost - PUMP PERFORMANCE MAP
Qualification Program Conclusions

Design Point Achieved
- 150 bar DP at 30% GVF

New Target Achieved
- 160 bar DP at 60% GVF

Final Endurance Test
- Typical field conditions tested
  (starts/stops and trips)
- No wear noted
Barracuda MPS

Design:

• Boosting one well
• Water Depth: 1040 m
• Tieback: 15.5 km
• Total flow: ~150 Am3/h
• DP: 60 – 80 bar
SIT - Slug Testing in Dock
Barracuda Subsea Multiphase Pump Installation

FLOWBASE

Pump Module

Control Module
Petrobras’ Barracuda: World’s First High Boost Pump System

In operation since: 14 July 2012
Tie-back: 10.5 km
WD: 1040 m
DP: 60 - 70 bar
GVF: 35% - 70%
Shaft Power: 1.5 MW

40% Production Increase

Source: 2013 OTC Brasil, "Subsea High Boost Multiphase Pump System Development and Applications"
Operational Parameters Measured

Average Monthly Values of Electrical Current, GVF, Power, Rotation and Differential Pressure in the SHMPPS

Courtesy of Petrobras
Operational Experience

- 100% Availability
- Stable Operation
- Shut Downs:
  - No shut down related to the pump system
  - 11, commissioning, pre-operation and training
  - 12, emergency shut downs from platform
  - Short downtime reported

SHMPP Events: Stopped and Started - Jul/2012 to Jun/2013

Courtesy of Petrobras
Barracuda Conclusions

- World’s first high boost pump system installed
- Achieved DP higher than 60 bar
- Substantial positive impact to the production
- Remarkable performance
- 100% Availability
Next High Boost Applications

**Total GiRi:**
- **Location:** Angola
- **WD:** 1400 m
- **Shaft Power:** 2.5 MW x 2
- **DP:** up to 130 Bar
- **GVF:** 20% - 60%
- **Flowrate:** 600 m³/h
- **Delivery:** mid 2014

**Total Moho 1bis:**
- **Location:** Congo
- **WD:** 800 m
- **Shaft Power:** 3.5 MW x 2
- **DP:** up to 130 Bar
- **GVF:** 10% - 70%
- **Flowrate:** 600 Am³/h
- **Delivery:** mid 2016
Conclusions:

- Standardized subsea multiphase pump design
- >1.8 million operational hours accumulated subsea
- High Boost concept successfully qualified
  - Tested up to 160 Bar Differential Pressure at 60% GVF
- Field proven technology
- Barracuda >1,5 years in continuous operation
- Ongoing projects with higher DPs
Thank you!