Liquid Surging in Riser – A Challenge to Our Understanding and Technology
Gjøa Field, Norway

Presenters
Arild Sunde
Boon Li Tay *

Co-authors
Zheng Gang Xu *
Chris Lawrence *
Overview

- Gjøa field and production system
- Gjøa online flow assurance system (FAS)
- Liquid surging in Gjøa oil production line
- Observations, finding and verification
- Value of the finding
Gjøa Field and Production System
Gjøa PL153

Ownership

- Petoro AS (30%)
- Neptune Energy Norge AS (30%)
- Wintershall Norge AS (20%)
- OKEA ASA (12%)
- DEA Norge AS (8%)

Remaining Reserves

- Oil (1.15 mill. Sm³ o.e)
- Gas (10.43 mill. Sm³ o.e)
- NGL (4.465 mill. Sm³ o.e)
- Condensate (0 mill. Sm³ o.e)
Gjøa Field and Production System

Gjøa Field

Facts

- Location: 50 km NE Troll, 68 km SW Florø
- Blocks: 35/9 and 36/7
- Area: 135.651 km²
- Water depth: 360 m

History

- 1989: Discovered
- 2007: PDO approved
- 2010: Production start-up
Gjøa Field and Production System

Gjøa Production System: The Development and Future Plan

Development
- Joint development with Vega (SS tie-back)
- Semi-sub
- 3 x 4-slot SS template
- 1 x 1-slot SS template

Platform type
- 7 oil
- 4 gas

Producers
- 18 MSm³/d gas
- 87000 bbl/d oil

Power supply
- St. Fergus (gas)
- Mongstad (oil)

Export terminal
- Duva
- Nova

Future tie-in
- Mongstad
- Nova

Rich gas to St. Fergus (UK)
Oil to Mongstad (NO)
What is the MEG injection rate/time for safe shutdown?

Considering the field operating envelope, current conditions and WIM analysis: First, … Then, …
Liquid Surging in Gjøa Oil Flowline

Fluctuating P-risertop BUT Stable Well Rates
Gjøa FAS Observations

Water-discharge Following Each P-risertop Increase
A typical range of emulsion (phase) inversion point
- Liquid viscosity can be significantly higher
- Emulsion viscosity and (phase) inversion point of Gjøa fluid are not known
The Finding

Physical Understanding

- Unsteady flow accompanied by intermittent back flow
- Oil and water slip effect in riser
- Water droplets move slower than oil

OLGA Modelling and Calibration

- Flow regime definition
- Water distribution in oil, $C$
- Shall be applicable for different operating conditions

\[ u_{w,\text{droplet}} = C u_o + u_{\text{drift}} \]
Verification

Field Data

OLGA Calibrated Model

- Good agreement of surge pattern and cycle
- Fair agreement of P-risertop surge magnitude
Verification

Calibrated model is applicable for 2015 (stable) and 2017 (surging) operating conditions.
Value of The Finding

- Physical understanding and verification of the observed field phenomenon
- Improvement to simulator
- A calibrated and reliable simulation model for field operations, optimization and development planning
- Identified potential causes and mitigations for the surge behaviour
Acknowledgement

Neptune Energy Team

- Anne Sofie Olsen
- Mailin Seldal
- Neal Hewitt
- Niklas Olsen
- Torunn Haugvaldstad

Schlumberger Team

- Christian Trudvang
- Gustav Kjoerrefjord
- John Sundt
- Jon Reino Heum
- Kersti Ekeland Bjurstroem
- Morten Oeverland Espeland
- Nicolas Valaye
- Steffen Andersen-Holthe
- Tor Haugset