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

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- 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**



NEPTUNE ENERGY Oil (1.15 mill. Sm<sup>3</sup> o.e) Gas (10.43 mill. Sm<sup>3</sup> o.e) NGL (4.465 mill. Sm<sup>3</sup> o.e) Condensate (0 mill. Sm<sup>3</sup> o.e)



# **Gjøa Field and Production System**

### Gjøa Field



#### Facts

- Location Blocks
- Area
- Water depth 360 m

### History

1989 2007

2010

- 50 km NE Troll
- 68 km SW Florø
- 35/9 and 36/7
- 135.651 km<sup>2</sup>

Discovered

PDO approved

Production start-up

# **Gjøa Field and Production System**

### Gjøa Production System: The Development and Future Plan



#### Development

- Development
  - Platform type

Producers

Export

capacity

Future tie-in

Power supply

- Joint development with Vega (SS tie-back)
- Semi-sub
- 3 x 4-slot SS template
- 1 x 1-slot SS template
- 7 oil
  - 4 gas
  - Mongstad
  - 18 MSm<sup>3</sup>/d gas
  - 87000 bbl/d oil
- Export terminal St. Fergus (gas)
  - Mongstad (oil)
  - Duva
  - Nova



Bode

# Liquid Surging in Gjøa Oil Flowline

### Fluctuating P-risertop BUT Stable Well Rates



## **Gjøa FAS Observations**

### Water-discharge Following Each P-risertop Increase





# **Gjøa FAS Observation**

Water-cut of 0.55 - 0.58

ENERGY



- 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





# Verification

### Field Data



### **OLGA Calibrated Model**



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



## Verification

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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



