Newly Developed Automatic Fluid Level Control System

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Overview

- Automatic fluid level measurements - WHY?
- Principle of operation - comparison
  - Conventional device
  - New automated device (MURAG-20)
- Examples of practical field experience with the new device
- Applications in gas well deliquification
- Conclusions
Automatic Fluid Level Measurements - WHY?

- Optimizing production
  - Adjust artificial lift equipment (ESP, PCP, SRP, Jet Pumps)
- Estimation of reservoir pressure
  - Determination and tracking of reserves
- Increase run time of downhole pumps
  - Increase economic lifetime in tail end production
Fluid level measurements – conventional devices

- Sonic method
- Gas gun generates a pressure pulse
- Pressure pulse travels down the annulus
- Reflections generated at couplings and fluid level
- Fluid level is determined based on avg. length of tubing joints
- Relatively little data collection
- Personnel-intensive
Fluid level measurement with a fully automatic, electronic device - MURAG-20

- Uses complex signal structure based on radar technology
- Signal is generated purely electronically
- Signal is propagated in annulus
- Fluid level is identified automatically by analysis of the reflected signal pattern (including frequency analysis)
- Fluid level is permanently displayed and available via 4 - 20 mA interface for SCADA systems
Automatic fluid level measurement – MURAG-20

Transducer

Analyzer

Signal processing

Measured fluid level

Automatic fluid level measurement – MURAG-20
Automatic fluid level measurement - MURAG-20

Signal Transducer

• Signal electronically generated
• zero emissions
• 5000 psi
• CE certified
• ATEX certified: II 2G Ex d IIB T4
Fluid level measurement – Response on change of ESP speed (well EN-005A)
Example demonstrating the sensitivity of the system

- Fluctuations in flowline pressure and its effect on the well’s fluid level (Sucker Rod Pump)
  - Dynamic fluid level (red) [m]
  - Casing pressure = Flowline pressure (black) [bar]

→ Shows sensitivity of the measuring device
Fluid level measurement after well shut-in

- Fluid level before and after shut-in (Sucker rod pump)
- Low noise level despite high GOR allows for pressure transient analysis
Permanent Bottom Hole Pressure from Fluid Level

- Comparison of downhole pressure curves (Sucker Rod Pump)

Well flowing: Match pressure from downhole gauge with simple black oil correlation

After shut-in: Difference depends on calculation effort, possible to match downhole gauge with transient multi-phase flow calculation
MURAG-20 - Further Development

- MURAG-20 device has integrated acoustic monitor for noise pattern recognition which can be used for condition monitoring of downhole equipment
- allows to detect abnormal conditions (valve function, tubing leak, rod buckling, etc.)
- under scientific investigation – PhD thesis project
Automatic Fluid Level Measurements - Applications in Gas Well Deliquification

- **Downhole Pumps – ESP, PCP, Sucker Rod Pumps**
  - Possible to set and maintain any desired fluid level
  - Prevents pumps running dry – increases pump run times
  - In combination with Variable Speed Drives (VSD) – allows for automatic control of production rate and fluid level
  - Safely make full use of available pump capacity
  - The device is mounted at the wellhead
    - therefore easy trouble-shooting
    - system is not sensitive to high well temperatures like downhole pressure sensors
Automatic Fluid Level Measurements - Applications in Gas Well Deliquification

• Jet Pumps
  • Pump works on the Venturi principle
  • Cavitation can occur in the diffuser if the dynamic fluid level gets too low
  • MURAG-20 can be used to automatically control the system or to set and maintain a desired fluid level
Planned Application in Gas Well Dewatering

- Well Weizberg 3
- High WGR (100 m³/d water @ 15,000 m³/d gas)
- Reservoir pressure = 160 bar, perforations at 1721-1733 m
- Well was produced with SRP – max. run time 4 months
- Problems: gas-locked pump due to insufficient control of fluid level, SRP was operated at its limit
- Planned dewatering method: ESP with Variable Speed Drive in combination with Automatic Fluid Level Measuring Device for automatic control of fluid level
Completion schematics - Well Weizberg 3

Chemical injection line

Fluid level measuring device

Water production

Variable Speed Drive (VSD)

Chemical injection valve

ESP with Vortex Gas Separator and Downhole Sensors (Press., Temp.)

VSD frequency (Hz)

Fluid level

Gas production

Gas production

2 3/8" Tubing

ESP cable

Chemical injection line
Conclusions

Automated fluid level measurement makes the following possible

• Permanent control of fluid level and bottom hole pressure
• Continuous, automatic adjustment of artificial lift systems (oil production and gas well deliquification)
• Protection of downhole equipment and improved run times

An increased economic lifetime in tail end production should result.