NEFTEMER
A clamp-on multiphase meter for cost-effective well monitoring

by

V. Kratirov, D. Gazin, A. Jamieson
Neftemer Ltd
A. Kolonskih
Complex Resource
Objectives of presentation

- LPI and Neftemer Ltd are working to improve
  - Well head flow measurement
  - Information gathering in the Libyan oil industry
- Neftemer clamp-on multiphase meter
  - Key element in this activity
- Illustrations of well monitoring
  - Basic measurements
  - Production with different types of pumps
Well Monitoring

- **Current practice**
  - Not to monitor wells continuously
  - Well testing for several hours per month
    - Fixed or mobile test separators
    - Mobile multiphase meter assemblies
    - Problem wells may receive more attention

- **Key assumptions**
  - Wells produce in a stable manner
  - Switching to test does not affect production
  - But these assumptions are seldom valid

- **Continuous monitoring**
  - Long recognised as key to optimising production
  - Requires inexpensive measurements per well
Measuring “unseparated flow”

Four categories of measurement techniques

- Compact separation systems
  - Rough separation into liquid and gas
  - Detailed measurements on separated phases

- Phase fraction and velocity measurement
  - Identify fractions of oil, water and gas
  - Determine the usually different phase velocities

- Tracers
  - Injected dyes for water and oil
  - Useful for wet gas

- Pattern recognition
  - Low cost sensors and sophisticated computation
Neftemer construction

γ-Ray Source

Detector

Clamp Mounting
Neftemer installations

Single meter on beam-pump well

Prototype in field installation

Multiple meters (up to ten) surrounding a single multi-window source
Neftemer operation

Advanced Signal Processing

Gas Flow Rate
Oil Flow Rate
Water Flow Rate

Secure Data Connection

Local Display
Remote Display

Gamma Source
Satellite Link
Detector

Raw Count Data

Count
hard spectrum
soft spectrum
Detected Spectrum
How it works - Basics

- Calculation cycle runs every 2 seconds
  - Effectively flow is divided into 2-second sections
    - liquid mass flowrate
    - gas volume flowrate
    - (mass) watercut of liquid
  - Integrate to get totals for liquid, oil, water, gas

- Neftemer depends on density fluctuations
  - In practice for much of the time there aren’t any
    - Hold last good calculated values, update when data allows

- Gas bubbles give liquid and gas velocities
  - Bubble sizes can be inferred from amplitude and width of density fluctuations
How it works - Velocities

- Bubbles below critical size are entrained in liquid
  - Give liquid velocity
- Average velocity of all bubbles
  - Gives gas velocity
- From R&D programme, spectral patterns found
  - For both liquid and gas
  - Frequency of appearance strongly related to velocity
- High scan rate of 250 Hz
  - Allows velocities to be calculated over wide range
How it works – Phase fractions

• Single phase γ-absorptions
  ➔ Input to system during calibration

• Phase fractions determined using
  ➔ First, overall γ-density
  ➔ Second, standard dual-energy equations
    • Absorptions at two pre-defined energy levels in detected spectrum
  ➔ Third, overall shape of detected spectrum
    • Shape related to oil, water and gas fractions
    • For liquid, shape related to carbon/hydrogen ratio

• Phase fractions and liquid and gas velocities
  ➔ Combined with area gives phase flowrates
How it works – In practice

• Basis of method
  ➔ Sophisticated mathematical analysis
  ➔ Sophisticated statistical signal processing
  ➔ Yields accurate measurements

• In practice
  ➔ Simplifications
    • To allow Neftemer to operate in real time
  ➔ Tuning
    • Required for a new application
Settling of well production over three days from opening up

Скважина, оснащенная установкой ЭВНТ 25×1500

Показания прибора Нефтемер (оперативные значения массового расхода жидкости, объемного расхода газа и обводненности) при выходе скважины на режим после освоения.
Different wells routed in turn to same measurement section

Показания прибора Нефтемер (массовый расход жидкости) при направлении в один и тот же измерительный участок по очереди потоков продукции только одной из скважин с разной производительностью.

Liquid flowrate (m³/day)

Time (Hours)
Production increase on increasing speed of pump

Скважина, оснащенная установкой ЭВНТ 25×1500 (ВВД)
Изменение показаний прибора Нефтемер (оперативные значения массового расхода жидкости) после увеличения оборотов ЭВНТ с 1000 до 1200 об/мин.

Liquid flowrate (m³/day)

Time (Hours)
Increased production from injection of light oil into well

Скважина, оснащенная установкой НН2Б-70-30

Реакция прибора Нефтемер (оперативные значения массового расхода жидкости) на промывку (прокачку) скважины легкой нефтью агрегатом АДП.
Beam Pumped Well

- Liquid flowrate (T/day)
- Watercut (%)
- Gas flowrate (m³/day)

Скважина 8331 (НН2Б 44-30)
Downhole centrifugal pump

- Liquid flowrate (T/day)
- Watercut (%)
- Gas flowrate (m³/day)

Graph showing data from 3 June to 6 June for a well named Скважина 3026 (ЭЦН 80-1400).
Downhole screw pump

- Liquid flowrate (T/day)
- Watercut (%)
- Gas flowrate (m³/day)

**Scavetta 3308 (ЕВН 25-1500)**
Discussion

- **Neftemer can readily monitor oils wells**
  - Normal production and optimisation
  - Fault detection
  - This is not practical with conventional methods
- **Pay back: oil price $50/bbl, 3% improvement**
  - Well 200 bbl/day oil, less than 1 year
  - Well 1000 bbl/day oil, less than 10 weeks
- **In Libya there are many types of oil**
  - Extensive evaluation is required
  - Evident that there are large potential benefits
The way forward

- Perception that multiphase metering is a mature technology
  - 0.3% market penetration suggests not
    - about 3000 meters for 1 million wells worldwide
  - We consider impact is just beginning to be felt

- Diverse range of meters and equipment required
  - Neftemer a cost-effective and versatile addition to that range

- Practical standards beginning to appear
  - Verification techniques for field use
  - Allocation in multi-producer systems with different accuracies

- Need to extend international co-operation