

NEFTEMER

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

by

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Complex Resource

Objectives of presentation

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- **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

- **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

- **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

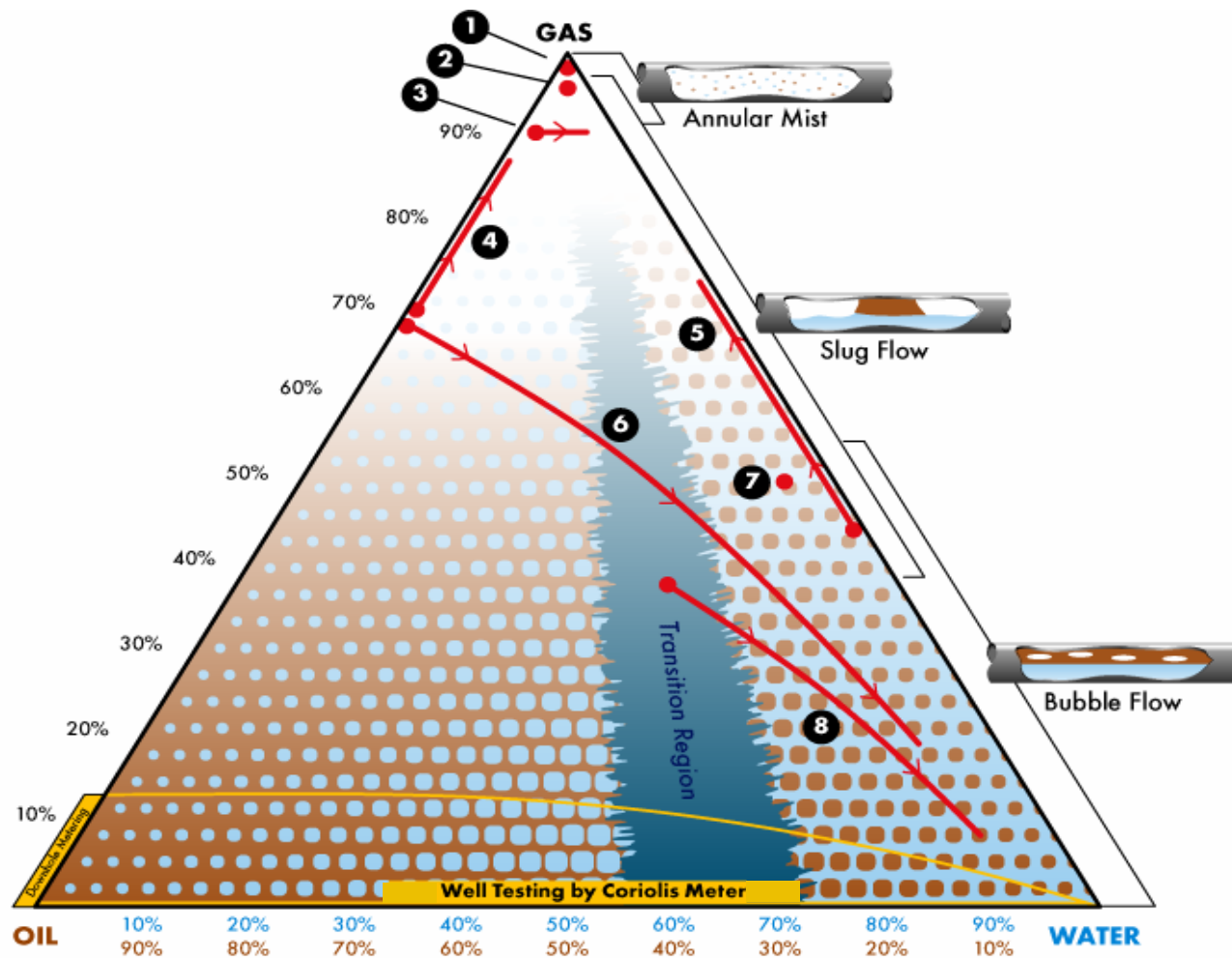
- Injected dyes for water and oil
- Useful for wet gas

- Pattern recognition

- Low cost sensors and sophisticated computation

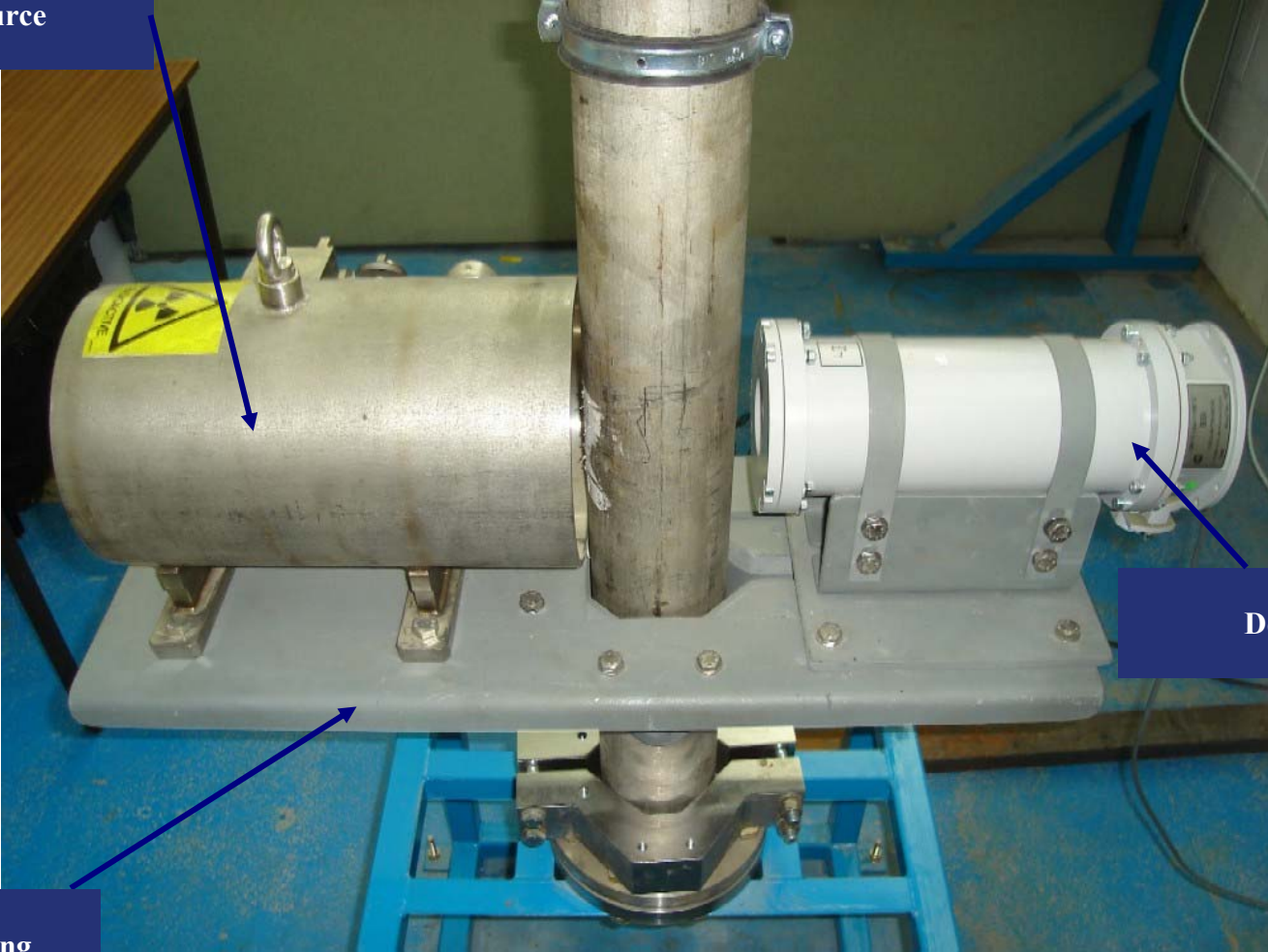
Multiphase triangle

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Neftemer construction

γ -Ray Source



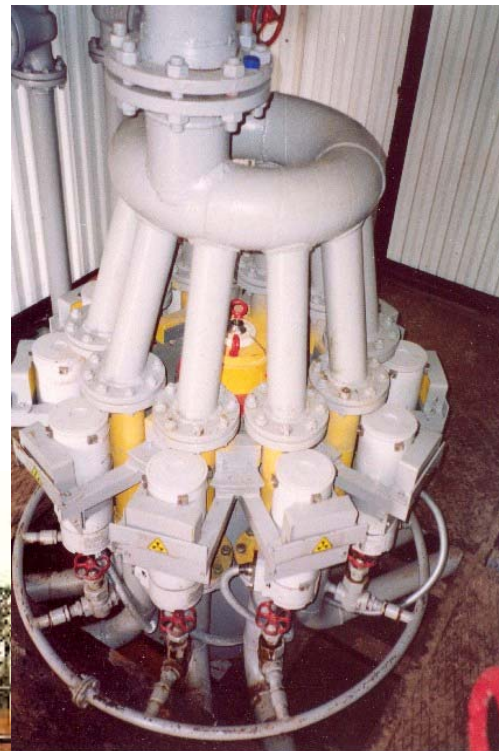
Detector

Clamp Mounting

Neftemer installations



Single meter on beam-pump well



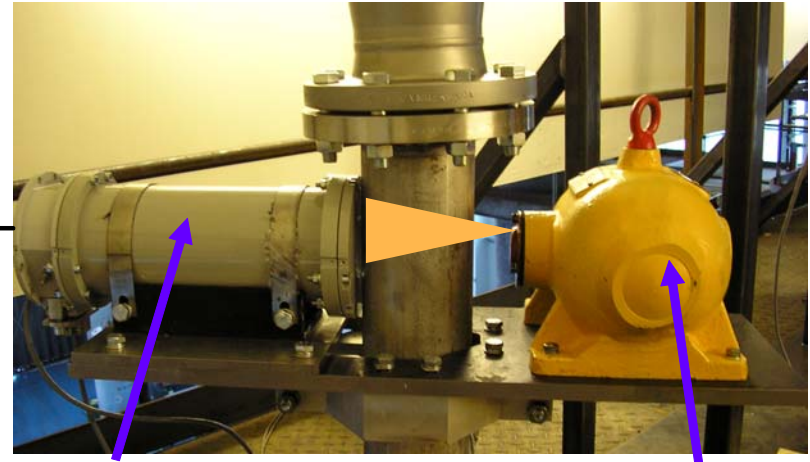
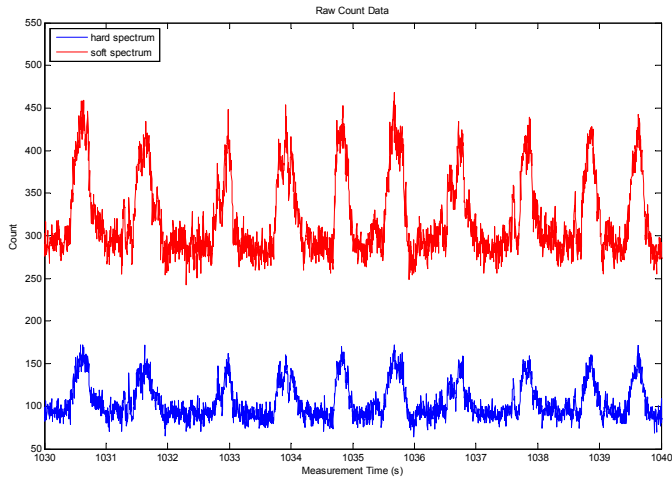
Multiple meters (up to ten) surrounding a single multi-window source



Prototype in field installation

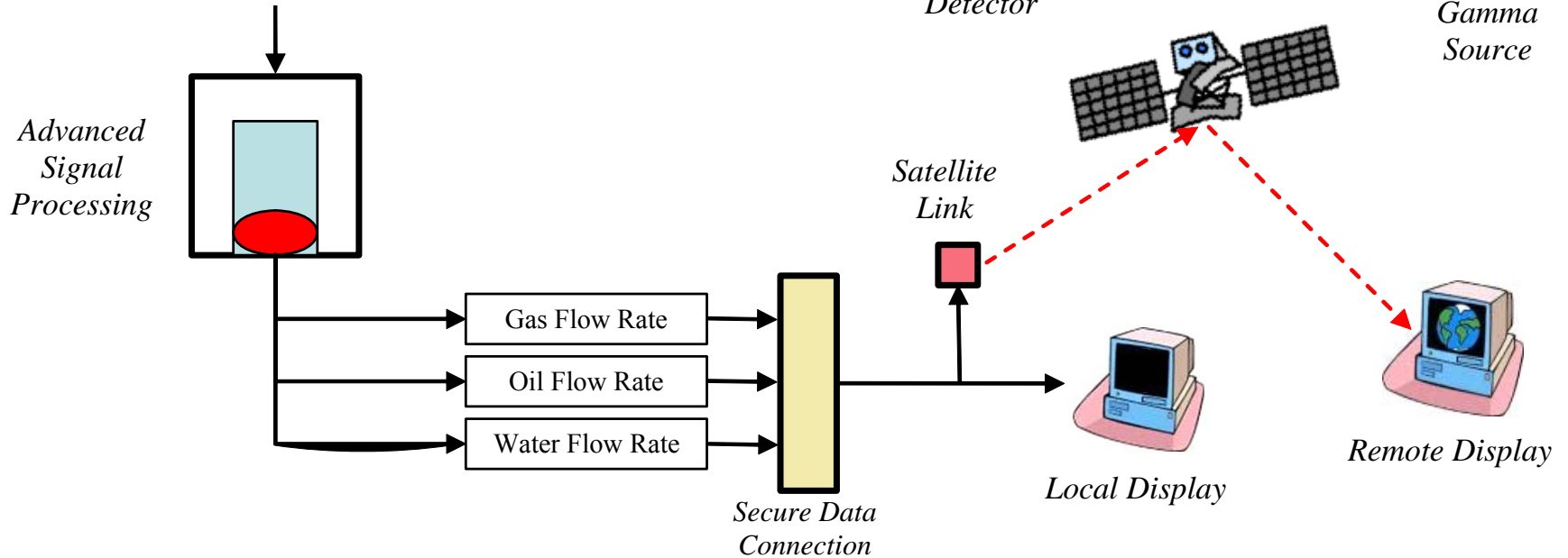
Neftemer operation

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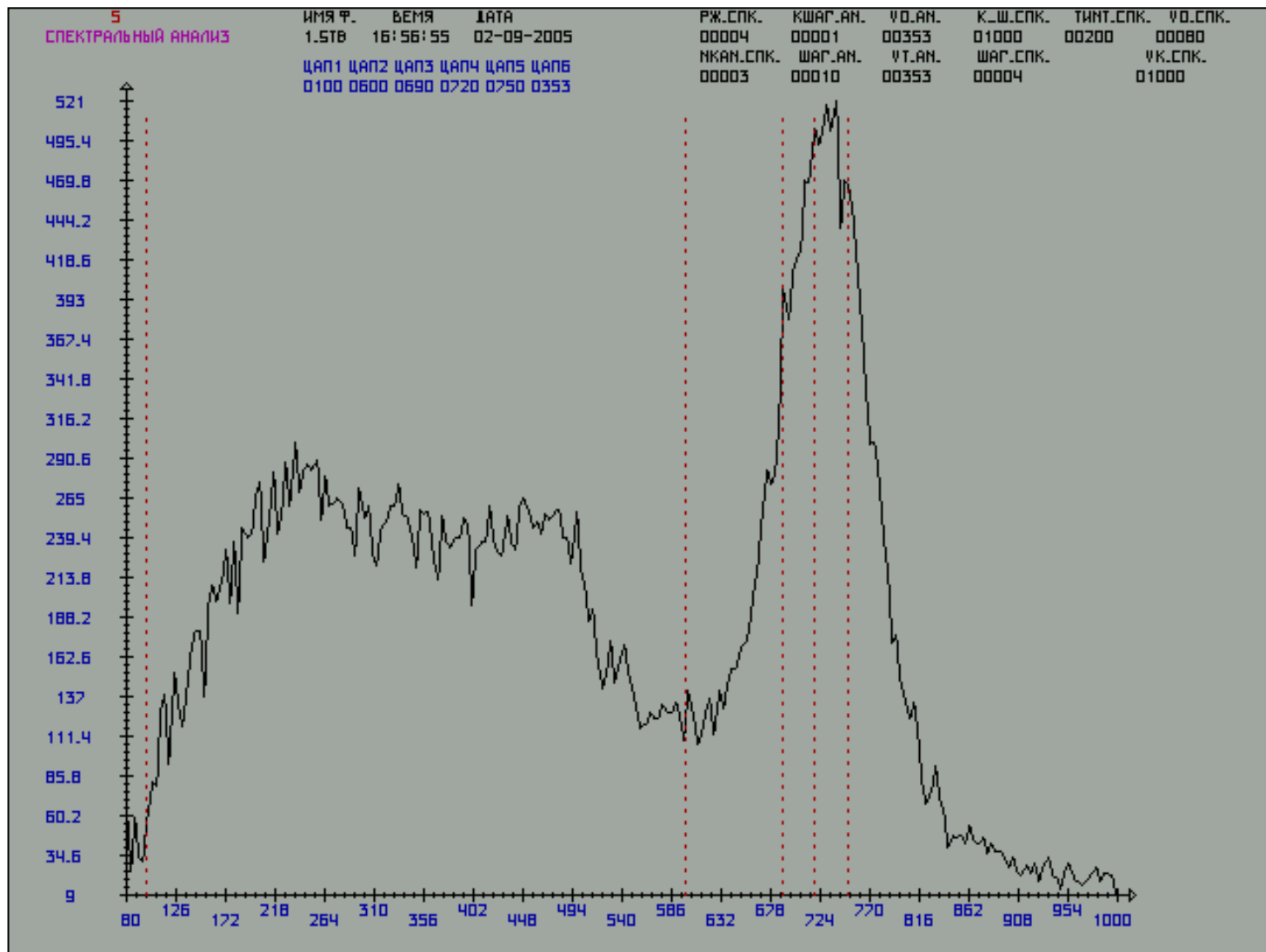
Detector

Gamma Source



Detected Spectrum

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How it works - Basics

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- **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

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- **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

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- **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**

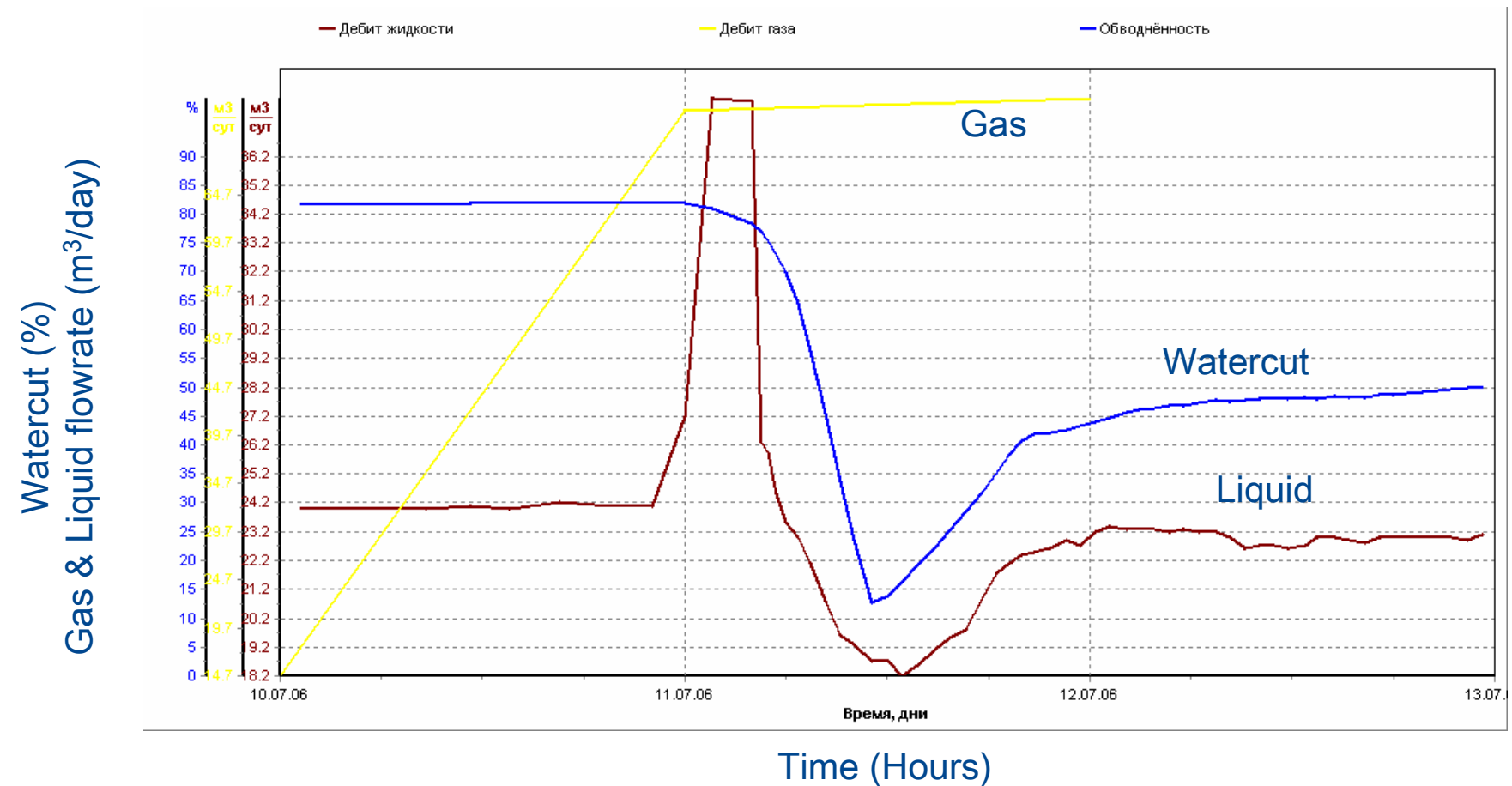
- Simplifications
 - To allow Neftemer to operate in real time
- Tuning
 - Required for a new application

Settling of well production over three days from opening up

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Скважина, оснащенная установкой ЭВНТ 25×1500

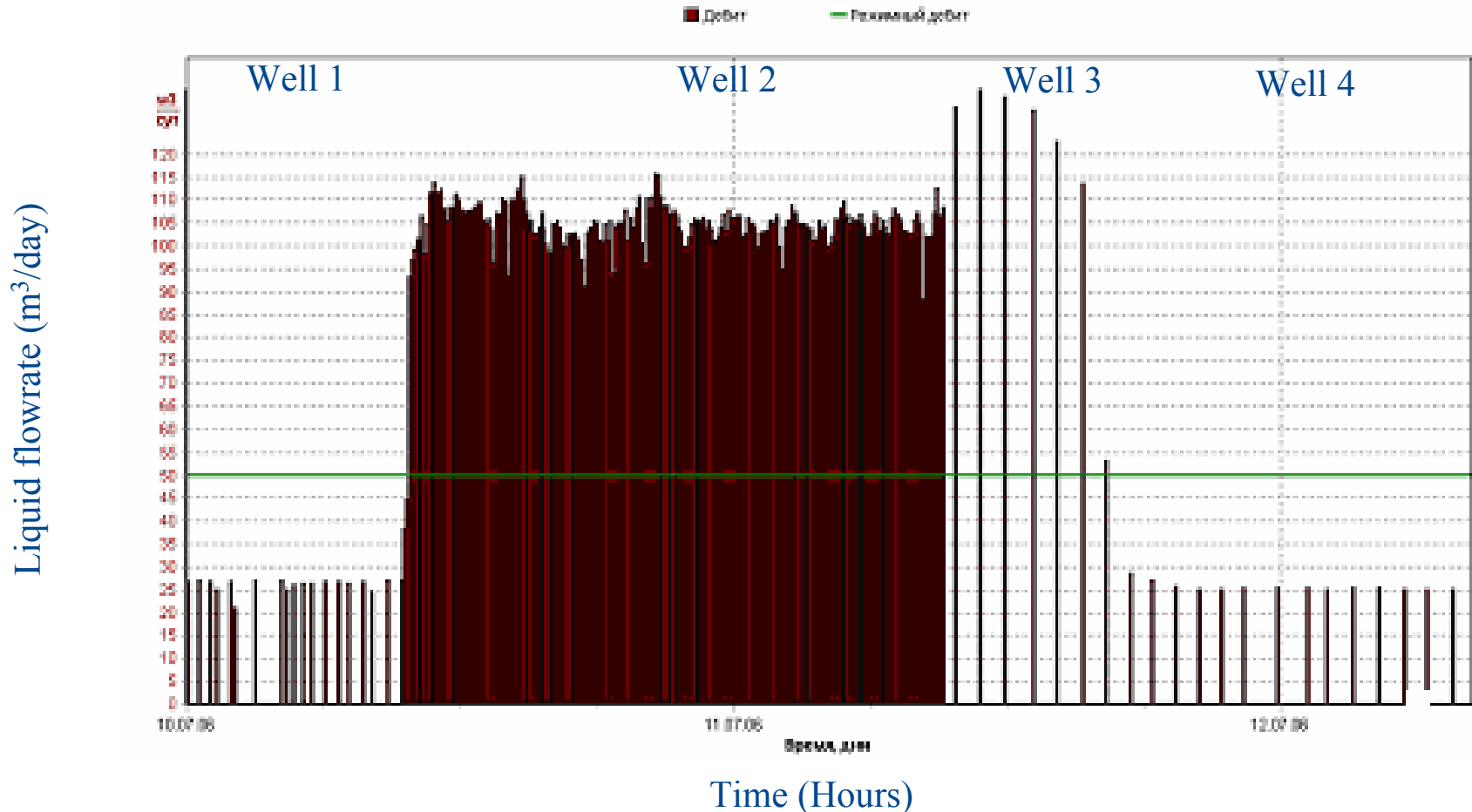
Показания прибора Нефтемер (оперативные значения массового расхода жидкости, объемного расхода газа и обводненности) при выходе скважины на режим после освоения.



Different wells routed in turn to same measurement section

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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.

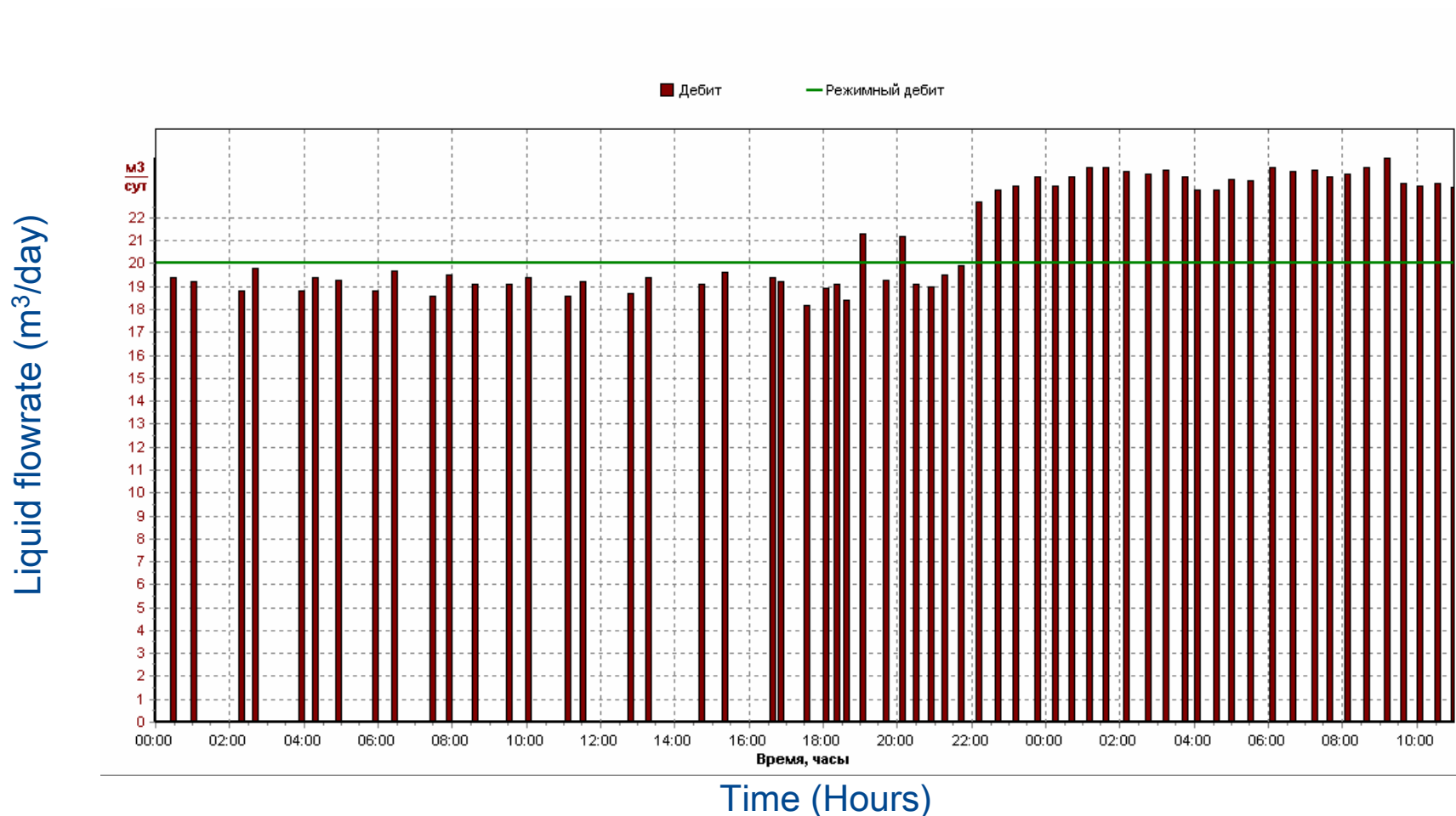


Production increase on increasing speed of pump

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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.

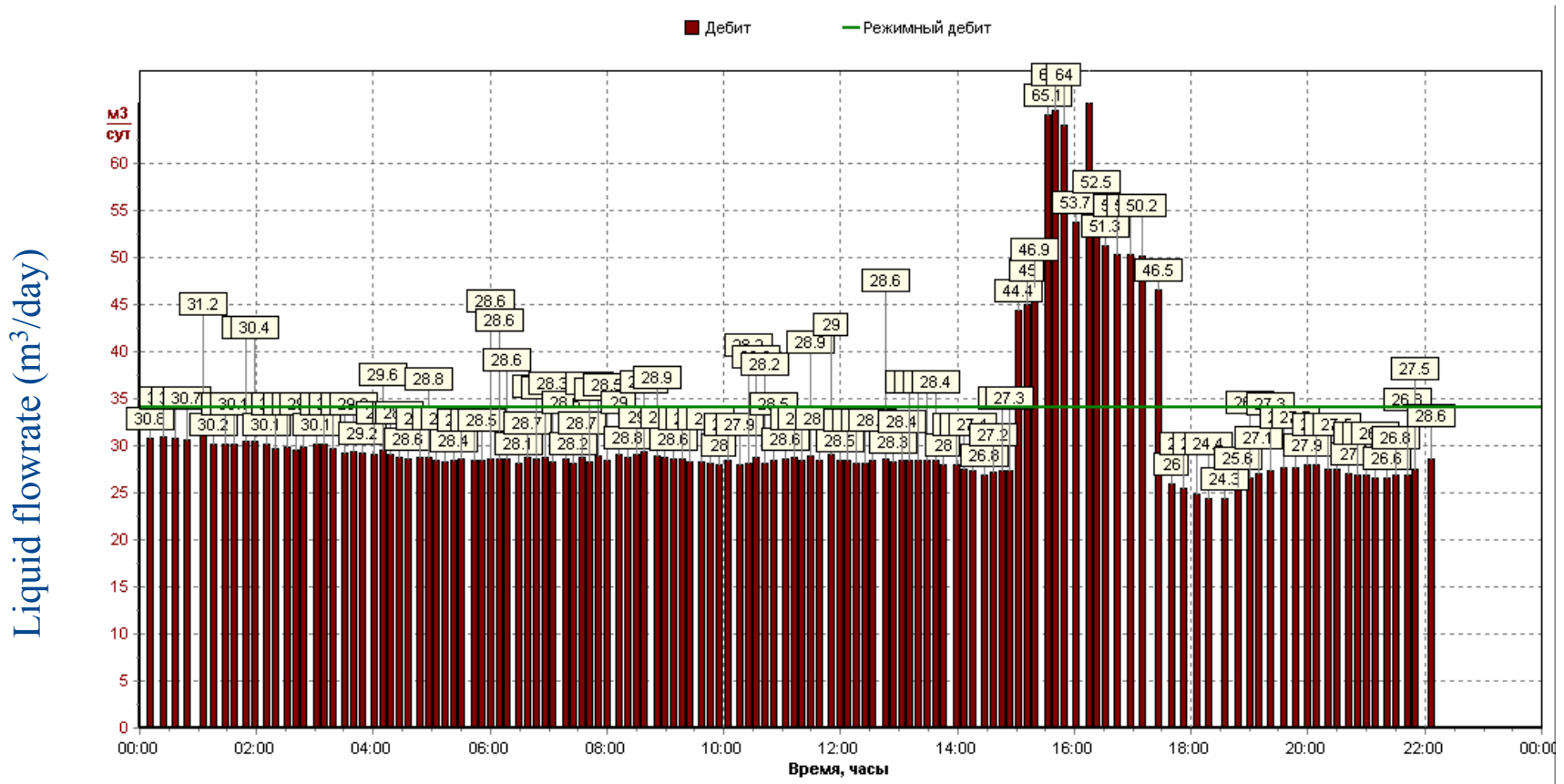


Increased production from injection of light oil into well

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Скважина, оснащенная установкой НН2Б-70-30

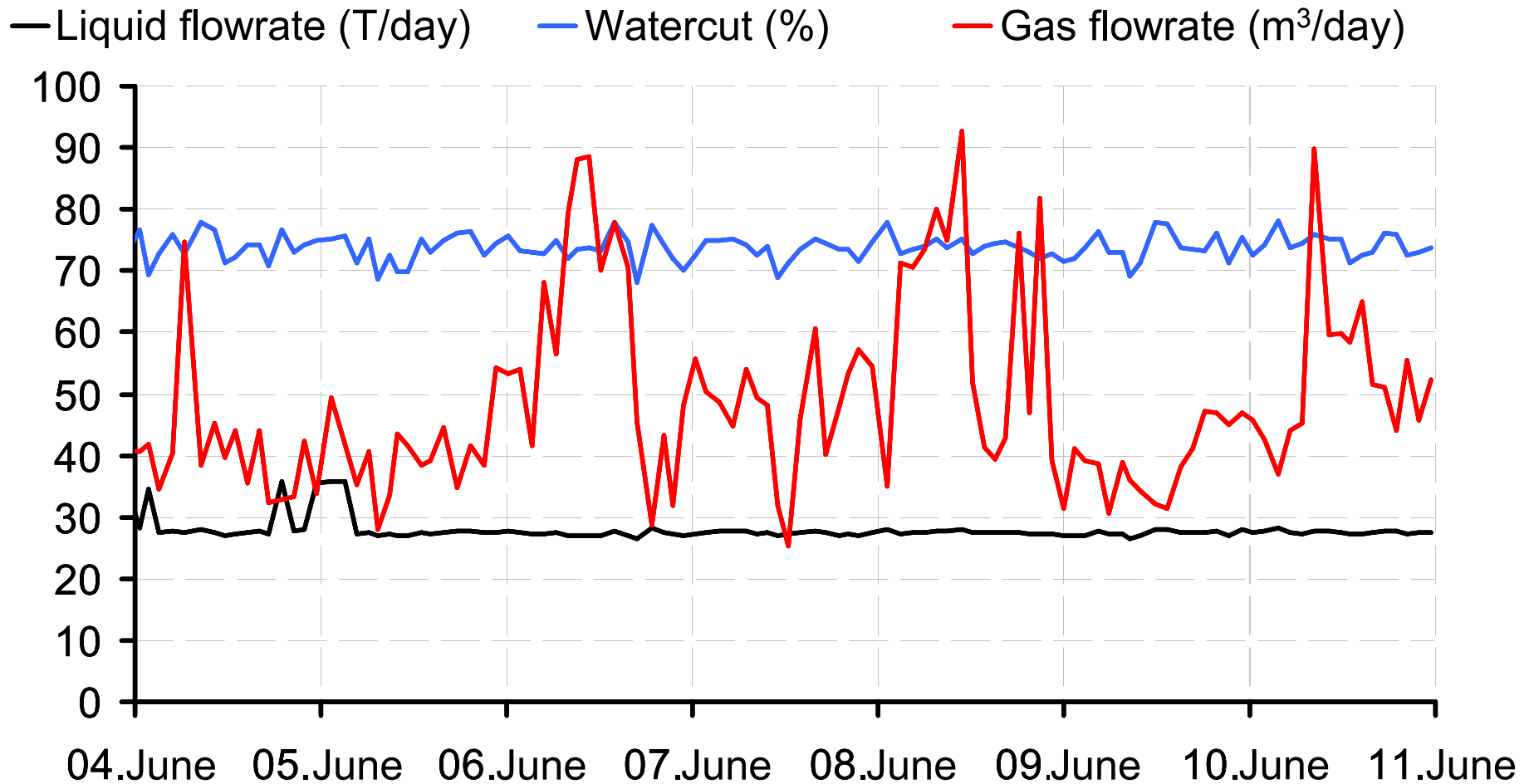
Реакция прибора Нефтемер (оперативные значения массового расхода жидкости) на промывку (прокачку) скважины легкой нефтью агрегатом АДП.



Time (Hours)

Beam Pumped Well

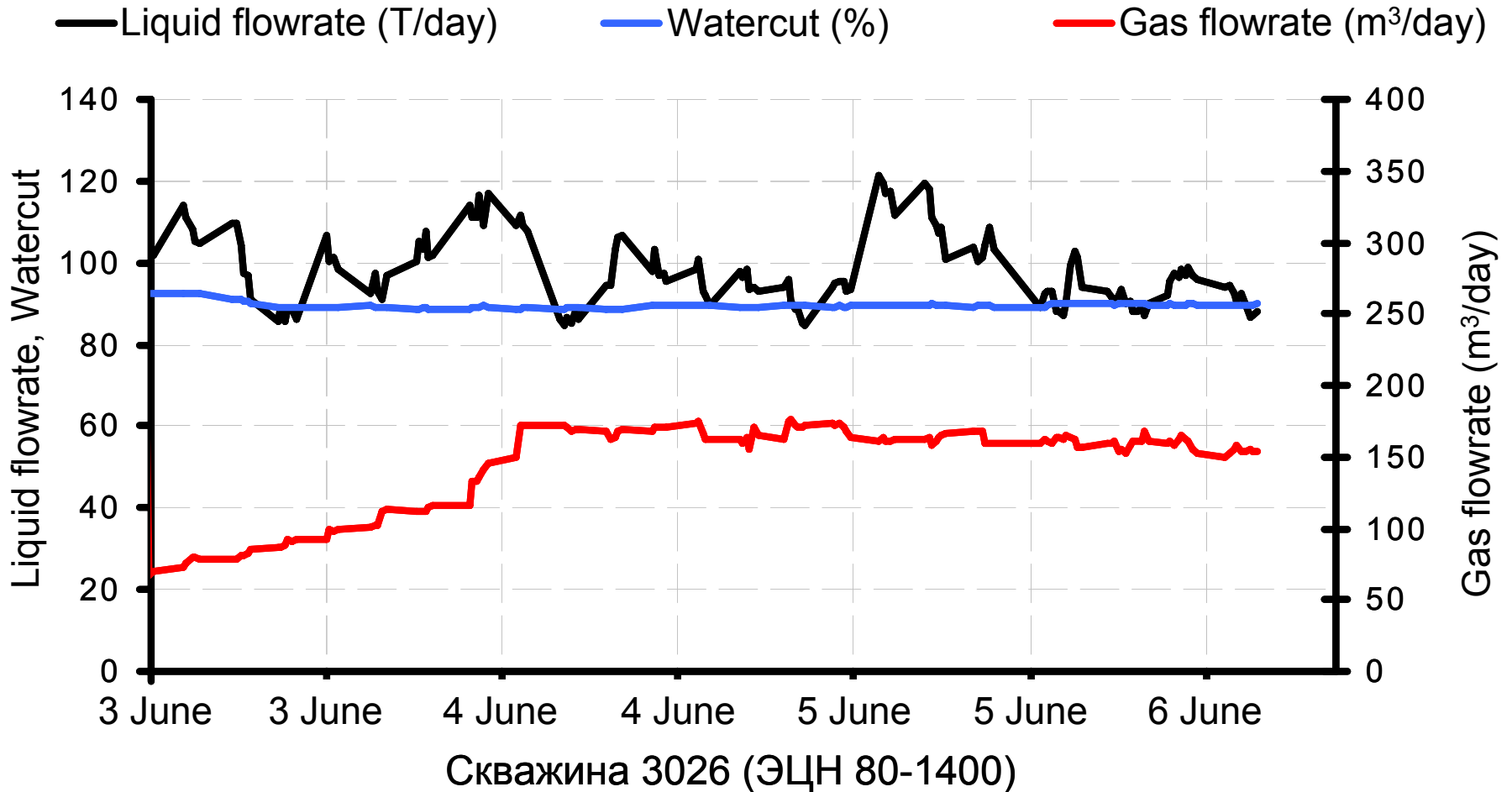
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Скважина 8331 (НН2Б 44-30)

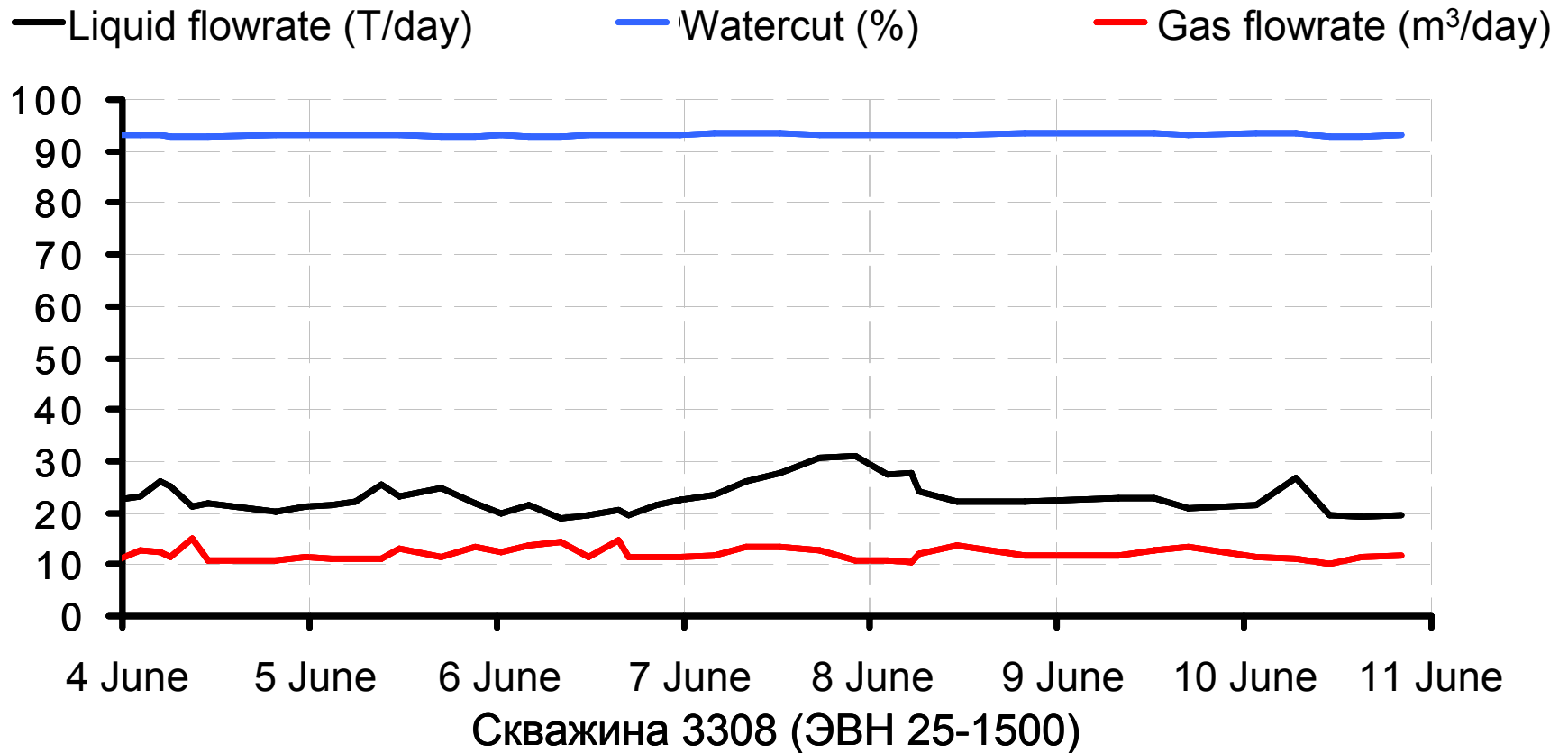
Downhole centrifugal pump

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Downhole screw pump

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- **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

- **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**