Monitoring of oil wells

Monitoring of unauthorized pipeline tie-in (pipeline security)

Oil tank monitoring

Monitoring of pipeline structural integrity (leakage)

Monitoring of oil field and offshore structures and equipment
Oil well monitoring

- Structural health monitoring of production strings
- Flow measurement from each layer, oil well potential evaluation
- Fluid pressure and temperature measurement of the extracted product
- Tubing leakage and pumping vibration monitoring
- Intelligent production management
- Integrity verification of reservoir-well-collection system
Oil well monitoring options

- Point-by-point high-definition temperature measurement
- Recovery rate monitoring from each layer of an oil well
- Real time thermal profile measurement for a well's full length
- Well multi-point pressure monitoring
1. Surface measurement complex (recorder unit)

2. Armored fiber-optic cable (distributed temperature measurement)

3. Fiber-optic pressure sensor (pressure and temperature)

4. Fiber-optic recovery rate sensor (vibro-acoustic sensor)

5. Monitoring system installation equipment

6. Customization option of incorporating a fiber optic cable into a power cable
Oil well monitoring system deployment

Surface recorder unit

Data transfer to the control center

Control center

Well №1

Well №2

Well №3

Well №4

Fiber-optic sensors of temperature and pressure

screened pipe

production string
Oil well monitoring system installation

Cable attachment (distributed temperature measurement):

1. Application of special non-damaging clip attachments for fiber cables
2. Customization option of incorporating a fiber optic cable into a power cable

Recovery rate sensor attachment:

Attachment of fiber-optic sensor to production string

Point pressure and temperature sensors attachment:

Special sensor die-attachment to be installed on piping

Optical output:

Special pressure-seal lead-through fiber cables connectors to be used on packers and wellhead equipment
Monitoring of unauthorized pipeline tie-in (pipeline security)

Attachment of cable directly to a pipeline (inside or outside), or near a pipeline in soil (the most suitable distance from a pipeline - 0.5 meter)

Maximum length of a pipeline – up to 50 kilometers
Unauthorized pipeline tie-in monitoring system deployment

Surface recorder unit

optical signal from fiber-optic sensors (cable)

Distributed pipeline control sensor

local sensors

Control center

Receiver/transponder

data processing

data visualisation

prognosis

notification

ACTIONS

RX  TX

pipeline

Configure
Pipeline structural health monitoring system

**Leakage control:**

- Pipeline temperature field control
- Leakage location determination within the accuracy of 1 meter
  Maximum pipeline length – up to 40 kilometers

Fiber-optic cable-sensor

Pipeline temperature field change in case of oil leakage

Pipeline temperature field change in case of gas leakage
Pipeline structural health monitoring system installation

Multiple ways to mount a fiber cable onto a pipeline (pipeline's type and location-based)

1. New pipelines (attachment of a cable to the external surface of a pipeline and burying it in soil in close proximity to a pipeline)

2. Pipelines in operation (putting a fiber cable through a pipeline and burying it in the subsurface)
Fiber-optic pipeline monitoring system implementation benefits

<table>
<thead>
<tr>
<th>Before implementation</th>
<th>After implementation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. The current control method based on pressure difference monitoring in pipeline does not always predict pressure loss with pinpoint accuracy</td>
<td>1. Sensors trace pressure loss, even in case of a very small leakage of transported fluid by analyzing changes of the temperature field</td>
</tr>
<tr>
<td>2. Location of a pressure loss point takes a long time due to necessity of a pipeline's full length visual inspection</td>
<td>2. Accuracy of leakage location is within 1 meter</td>
</tr>
<tr>
<td>3. Allocation of a large amount of human resources and transport to monitor the whole pipeline system</td>
<td>3. No need for frequent visual inspections, thus human resources and transportation expenses could be gradually reduced</td>
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<tr>
<td>4. Visual inspection of a pipeline performed only during daylight hours.</td>
<td>4. 24-hours online automated monitoring of pressure and temperature</td>
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Environmental aspects of pipeline monitoring system implementation

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<td>1. A large time gap between detecting a leakage by visual inspection and repair operations, which leads to the expansion of contamination area</td>
<td>1. <strong>Timely detection of pressure loss minimizes environmental issues and fluid loss</strong>;</td>
</tr>
<tr>
<td>2. High penalties imposed by environmental agencies</td>
<td>2. <strong>Lower penalties due to the reduction of contamination area</strong></td>
</tr>
<tr>
<td>3. Expensive methods and activities for environmental rehabilitation</td>
<td>3. <strong>Minimizing of expenses due to gradual reduction of contamination areas</strong></td>
</tr>
<tr>
<td>4. Double risk of water conservation zones contamination due to the damage done to soil and water</td>
<td>4. <strong>Minimizing risks of water conservation zones contamination</strong></td>
</tr>
</tbody>
</table>
Oil storage tanks monitoring

- Structural health monitoring of oil tanks and cisterns (corrosion, damage)
- Temperature field control for fire security
- Adjustment to fire extinguisher systems

Alert about structure’s critical state

Fire alarm

Recorder unit

Data transfer to other control systems

Fiber-optic measurement system (temperature and strain sensors)

Fiber-optic cable
Monitoring of oil field and offshore structures

- Real time monitoring of primary structures' health
- Real time monitoring of service equipment's health
- Measurement of structure loading
- Timely critical state alerts about any changes in the structure's health
Monitoring system specification

- Length of a measurement line up to 50 kilometers (for pipelines) 
  up to 20 kilometers (for wells)
- Temperature measurement range -70 +350°C 
  (pipelines and wells)
- Measurement line resolution – 0.1°C (pipelines, wells)
- Temperature measurement at 1-meter pitch along 
  the cable (pipelines, wells)
- Elongation measurement range -1 - 1% 
  (for structure monitoring)
- Strain monitoring - 0.1% of measurement range 
  (for structure monitoring)
- Pressure monitoring range 0-30 MPa on surface, 
  0-100 MPa for wells
- Pressure sensors for one measurement channel – up to 15 (min 4 sensors for one 
  measurement channel) (wells)
- Pressure sensors resolution (0.01 MPa) (wells)
- Vibro-acoustic measurement range – 
  4 Hz–1,2 kHz (for pipeline security system)
Measurement system's installation features

1. Installation to and integration with existing structures and objects
2. Integration of the measurement system at the design stage for new structures
3. Integration with existing monitoring systems
Technical and economic benefits of monitoring system usage

- Decrease of environmental and economic damage due to the prevention of fluid leakage
- Control of well operating procedures due to temperature field, pressure and vibro-acoustic field measurement
- Prevention of industrial disasters
- Fire safety control
- Pipeline security zone control
- Decrease of costs for geophysical activities
Benefits of monitoring system

Measurement of temperature, pressure and vibro-acoustic fields with a single measurement channel

Wide measurement zone (up to 50 km) for pipelines

Fiber-optic sensors with long-time performance

Simplicity of measurement system maintenance due to utilizing commonly used fiber-optic cables

Fire and explosion safety