Fiber Optic Sensing for Artificial Lift Pump Condition Monitoring and Optimisation

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The Fibre Bragg Grating (FBG)

- A point fiber optic sensor that reflects light
- Recorded with UV laser light
- Reflected wavelength varies with strain and temperature
A Fiber Bragg Grating Sensing System

Tuneable Laser Interrogator

Processing Unit

Sensor Arrays: multi-point, multi-parameter, quasi distributed

FBG Sensors

Temperature
Pressure
Accel.
Proximity
Load
Vibration
Torque
Rotation
Current

Strain

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Pump condition monitoring case study

Twin screw, high boost subsea oil pump

Bearung race strain...

Motor winding temperature

Lube oil pressure / temperature

Bearung housing acceleration
Pump condition monitoring case study

Static data: Vertical and Horizontal shaft loads match FE model

Dynamic data: signatures identify damaged roller

2 micron roller scratch detected from 10 Km
Why Monitor ESPs?

- Identify ESP faults as they develop
- Manage ESP deterioration with changes in operating parameters
- Keep ESP producing until a scheduled ESP exchange can be made

Why use an FBG monitoring System?

<table>
<thead>
<tr>
<th>FBG System Feature</th>
<th>Benefits for ESP Monitoring</th>
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<tbody>
<tr>
<td>Multiple measurands, single surface instrument</td>
<td>Fewer connections</td>
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<td>Simpler interface</td>
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<td>Lower cost</td>
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<td>All optical data</td>
<td>Measurements immune to EMI</td>
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<td></td>
<td>Measurements insensitive to cable impedance</td>
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<tr>
<td>Zero Power on fiber</td>
<td>ATEX certified for explosive environment use</td>
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<td>No downhole electronics</td>
<td>Long survival in harsh environments</td>
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<td>i.e. monitoring system outlasts the pump</td>
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ESP Monitoring Potential

**Internal to ESP**
- Motor winding temperature
- Motor oil temperature
- Motor oil pressure
- Motor current draw
- Radial bearing temperatures and loads
- Thrust bearing loads
- Pressure drops across pump stages
- Shaft angle and speed
- Shaft torque and orbit
- Vibration at key locations
- Acoustic noise

**External to ESP**
- Wellbore fluid level
- Intake and discharge pressures and temperatures
- Pump and motor casing deformation
ESP Monitoring Potential

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*With loose tube FBG temperature sensors*
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With FBGs measuring secondary current via temperature or magnetostrictive effect
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With FBGs embedded in bearing outer race
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With strain FBGs on load bearing plate
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With magnetostrictive FBG proximity sensor
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*With FBG acceleration transducer*
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With quasi-distributed acoustic sensing (QDAS)
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Conclusion

All the component parts exists to develop a fully integrated, multi-parameter ESP condition monitoring system using optical fiber Bragg grating technology

Thank You