Environmental Sensing Using Fibre Optics

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Environmental Sensing Using Optical Fibre Technology

- General Introduction: why use this approach?
- Some current applications: new insights
- Potential implications
- Emerging opportunities
- Where will it lead???

The optical fibre sensor:

- Why use for environmental monitoring?....
  - Illuminates at long distances: spectroscopy
  - Passive multiplexing
  - Intrinsic safety
  - Distributed measurements
  - Continuous monitoring (rather than occasional sampling)

The first example: landfill gas -

Landfill: What’s important??

- ‘Green’ electricity generation
- Gas mixture, especially % Methane:
  - Typically 50% CH₄ remainder CO₂ plus traces
- ‘Vacuum’ for anaerobic decomposition
  - No O₂ or fire / explosion possibility
- Perimeter gas seepage

Landfill: detecting methane
Methane sensor network: to 128 points from one laser

Network installation

A typical site.....

Some results: gas generation - *wells* behaving well

Some results: gas generation - *wells* behaving badly

Perimeter monitoring: *LEL 5% volume*
Landfill gas: some observations

- Demonstrated that sites can exhibit unexpected short term (days) potentially hazardous transient behaviour
- Demonstrated reliable operation; stable measurement; on site over almost four years
- Only working approach to continuous monitoring
- Additional possibilities in waste water treatment, manure digesters etc.

Locating liquid spillage:

- A viable technology to detect and locate liquid spillages along pipelines and in storage vessels
- Uses an optical fibre distributed sensing architecture

Construction of sensor element

- Polymer coating
- Central GRP rod
- Protective sheathing
- Helical wrap
- Optical fibre

Loss due to fibre microbending

In dry state, light propagates through as in normal fibre

Light is lost where the fibre is squeezed against the Kevlar wrap by the swollen polymer

Optical Time Domain Reflectometry

Light scattered back to the detector is plotted as a function of distance down the fibre

Detection of fuel spills

Spillages appear as a change in the signal trace 50cm long events have been detected
Other prospects......

- **Oil industry:**
  - Pipelines in sensitive marine or other environments
  - Oil storage: airports, docks, process plant...

- **Other industrial:**
  - Water transport: pipelines
  - Irrigation
  - Power cable coolants

Environmental sensing using fibre optics

- Fibre optic technology has unique, quite specific application benefits e.g. wide area coverage, distributed monitoring, self calibration / resetting, chemical selectivity, stability, dynamic range......
- Landfill gas case study has established field trial confidence
- Trials of distributed leakage system imminent

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