Environmental Sensing Using Fibre Optics

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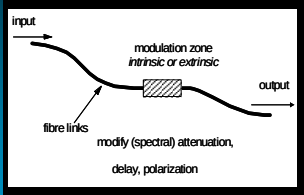
With OptoSci, Glasgow and Solus Sensors, St Asaph

Environmental Sensing Using Optical Fibre Technology

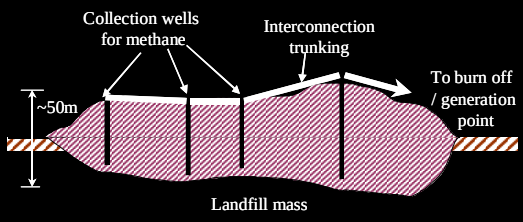
- General Introduction: why use this approach?
- Some current applications: new insights
- Potential implications
- Emerging opportunities.....
- Where will it lead???

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)*

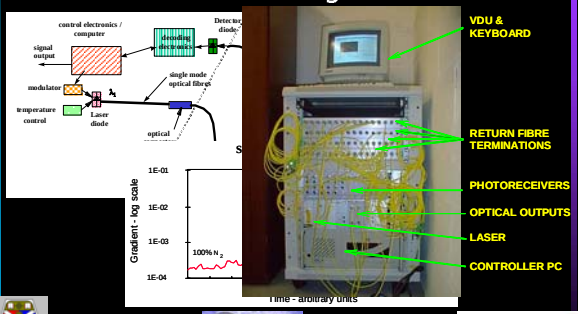
The first example: landfill gas -



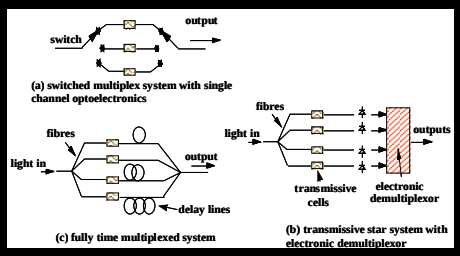
Landfill: What's important??

- 'Green' electricity generation
- Gas mixture, especially % Methane:
  - Typically 50% CH_4 remainder CO_2 plus traces
- 'Vacuum' for anaerobic decomposition
  - No O_2 or fire / explosion possibility
- Perimeter gas seepage

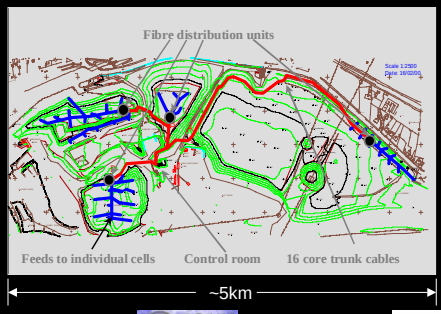
Landfill: detecting methane



Methane sensor network: to 128 points from one laser

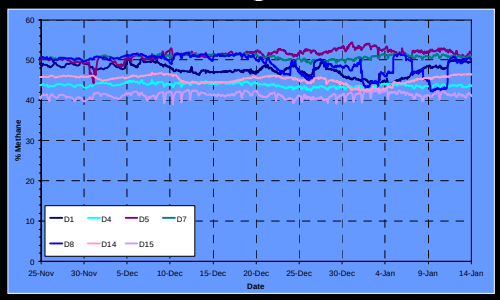


Network installation

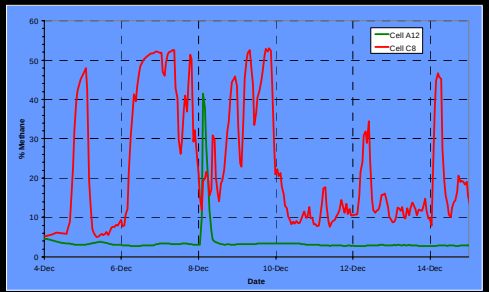


A typical site.....

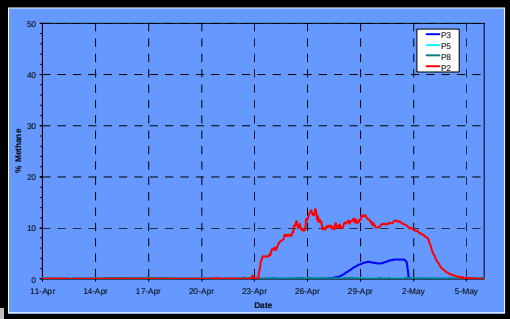
Some results: gas generation - *wells behaving well*



Some results: gas generation - *wells behaving badly*



Perimeter monitoring: *LEL 5%* volume



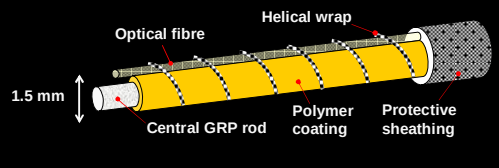
Landfill gas: some observations

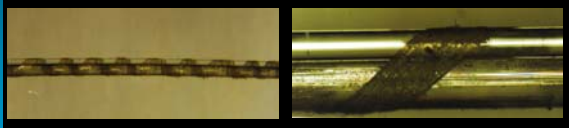
- Demonstrated that sites can exhibit unexpected short term (days) potentially hazardous transient behaviour
- Demonstrated reliable operation; stable measurement; on site over almost four years
- *Only working approach to continuous monitoring*
- Additional possibilities in waste water treatment, manure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

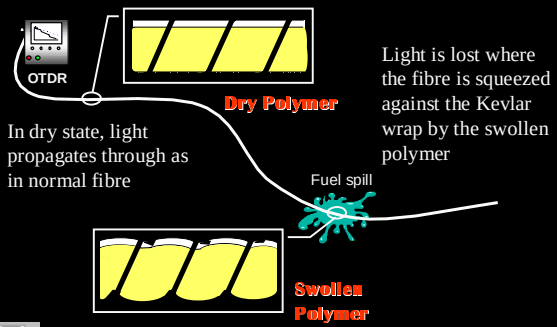
Construction of sensor element



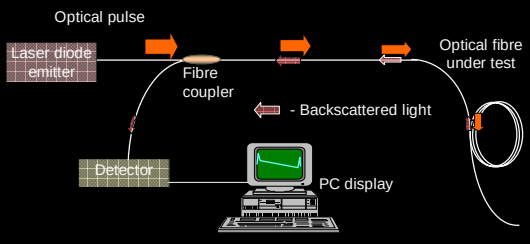


Microscope photographs of sensor

Loss due to fibre microbending

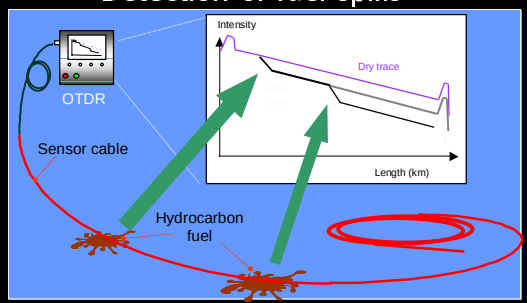


Optical Time Domain Reflectometry



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

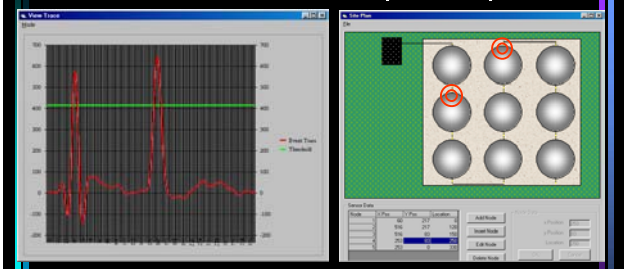
Detection of fuel spills



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

Tank Farm monitoring

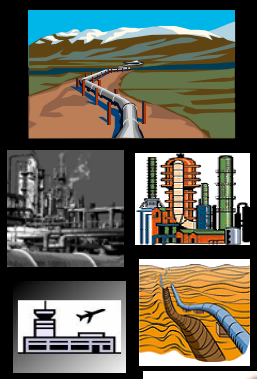
Automatic location of petrol spills



Two spills show as peaks above a set threshold mapped onto a plan of the monitored site

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

With thanks to……

- DTI/EPSRC UK, Shanks, Patterson, SEPA, WDA, Envirosense, Pinacl / Tyco, SDA, GMI and no doubt others
- George Fleming, John McCormack, Goeff Andrews, Alistair Maclean, Craig Michie, Dave Moodie…….