PROCESS ANALYZERS FOR MONITORING EFFLUENTS IN OIL & GAS APPLICATIONS
Oil & Gas Industry Effluents

Darn... I don't like the green ones...
Oil & Gas Industry Effluents is not milk!

..... although both are emulsions
Insights into Oil in Water Systems

**Ideal Situation**
- Oil Phase
- Water Phase

**Real Situation**
- Oil Phase
- Water Phase

- Water dissolved in oil, up to its solubility limit
- Oil dissolved in water, up to its solubility limit
Insights into Oil in Water Systems

Solubility of hydrocarbons in water
*Data from Price & All - 1982*

Actual amount of oil in water is 2000 ppm
Oil in Water Emulsions

Oil droplets in water
Water-in-oil-in-water-emulsion
Suspended solids in oily water emulsion
Oil in Water Emulsions

Oily Water Emulsions Lifetime
# Oil-in-Water Content Measuring Techniques

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Oil-in-Water Content Measuring Techniques

ALL TECHNIQUES REQUIRE VARIOUS DEGREES OF:

- **Sample conditioning** (original sample must be prepared for measurement)
- **Measurement** (Application of some physics and/or chemistry)
- **Interpretation** (Explaining the results e.g. as “Oil content [ppm]“)
- **Reaction** (e.g. switch some valve)
Oil-in-Water Content Measuring Techniques – Offline Methods

OFF-LINE-METHODS

- Typical „Laboratory methods“;
- Processing time: hours or days;
- Off-site-measurement; involves sample gathering, conditioning and transport;
- Complicated instruments, highly skilled personnel and complex procedures involved
- Methods as standard
Oil-in-Water Content Measuring Techniques – Offline Methods

SAMPLE EXTRACTION FOLLOWED BY IR-ANALYSIS (IMO REFERENCE METHOD), GRAVIMETRIC MEASUREMENT OR GC ANALYSIS

- In case of IR absorption wavelengths range are 3 μm-3.3 μm
- IR is sensitive to Carbon-Hydrogen interactions within the molecules
- Since water is highly absorbing at 3 μm water has to be removed off the sample prior analysis
- Hydrocarbons extracted from sample using solvents; results depends on solvent type as well as operator!
- HSE related issue, disposal problems, some solvents internationally banned
Oil-in-Water Content Measuring Techniques – Online Methods

- Our eye is an excellent multiplexing detector
- Most spectroscopic detectors are not multiplexing and need help!

Source

Object

Detector

- Reflected light
- Scattered (Raman) light
- Transmitted light
- Fluorescent light
Oil-in-Water Content Measuring Techniques – Online Methods

FLUORESCENCE TECHNIQUE

- Some components often found in mineral oils (e.g. polycyclic aromatic HC, PAH) fluorescence when stimulated with ultraviolet (UV) light
- Disadvantage: different "Oils" have different contents of PAHs; some "Oils" actually do not contain any fluorescent material at all
- Other disadvantage: non-hydrocarbon materials may display fluorescence
Oil-in-Water Content Measuring Techniques – Online Methods

TURBIDITY TECHNIQUE

- Droplets/particles in water reduce intensity of light
- Turbidity can be interpreted as oil content as long as there is only oil in clean water and oil droplet size distribution is constant
- Any suspended solids or dirt in the measuring system will add to the oil reading
- No differentiation of oil and solids possible
OTHER ONLINE METHODS

- Ultrasonic scattering: Scattering of ultrasonic waves at particles/droplets in water
- Photoacoustic effect: laser generation of micro-cavities in water, acoustic sensor
- HC solubility in solid polymers: a “solid solvent“ directly in contact with the sample acts as a mass sensitive sensor (polymer layer swelling by HC is actually measured)
- Their usability lack enough body of experience in industrial applications
Oil-in-Water Content Measuring Techniques – Online Methods

MULTIPLE WAVELENGTHS SCATTERING

Deckma Oil-In-Water Monitor Working Principle and Sensor
MULTIPLE WAVELENGTHS SCATTERING

- Measuring Principle: scattering of light
- Accurate detection of free oil and solids
- Fast response (seconds)
- Detected particle/droplet size: ~ 0.1 µm – 100 µm
- Non-invasive method
- No solvents used
- Dissolved hydrocarbon components do not interfere with measurement
- Dissolved hydrocarbon components undetectable
- Difficulties with excess surfactant concentrations (if present)
- (Definition Free Oil ?)
Deckma Oil-in-Water Content Monitors

OMD-12 : Range 0-30 ppm
OMD-15 : Range 0-10 ppm
OMD-17 : Range 0-99 ppm
OMD-7 : Range 0-200 ppm
OMD-7 MK Oil-in-Water Systems

Measures
♦ Oil
♦ Solids
♦ Turbidity
Deckma Oil-in-Water Content Monitors

INDUSTRIAL APPLICATIONS

- Cooling Water
- Process Water
- Oily-Water separators outlet monitoring
- Surface Water run off
- Condensate or Boiler feedwater
- Produced Water in offshore applications
- Monitoring quality of reservoir water injected in waterflood activities
Oil-in-Water Monitors Applications

Figure: DECKMA HAMBURG OMD-7 Test Results
Open coolant system of a coastal power station with periodical tidal influence on the solids content. The general increase in the solids reading is due to seasonal changes.
Oil-in-Water Monitors Applications

Solids: High content, tidal variations

Oil reading: not influenced by solids content & solids content variations
Oil-in-Water Monitors Applications

Oily water separator – water leg quality monitoring
Oil-in-Water Monitors Applications

Lafarge Romania runoff water fluent quality monitoring – 2004

Electrocentrae Bucuresti effluent monitoring – 2008
Oil-in-Water Monitors Applications

Petrobrazil WWT effluent monitoring – 2013 - Typical example
Oil-in-Water Process Spectrometry

SPECTROSCOPY  nmr / esr / microwave  IR / vis / UV  X-ray

WAVELENGTH  10m  100cm  1cm  100µm  1µm  10nm

far-IR  mid-IR  near-IR  visible/UV

Raman

Wavenumber (cm⁻¹): 100  500  2,000  5,000  10,000  20,000  30,000

Wave number (µm): 100  20  5  2  1  0.5  0.33

Alconex™
UV-VIS Spectrometer Oil-in-Water Content Monitors

Oil & Solids in water content and particle size distribution
Raman Process Spectrometry

- Complimentary to Infrared
- High Specificity
- Fast & Non-Invasive
- Non-destructive
- Simultaneous multi-component analysis
- Can resolve organics in aqueous solutions
RPM View™ Process Raman Photometer

A revolutionary photometer removing much of the cost and complexity from using the powerful Raman spectroscopy technique, enabling a wide range of previously un-addressable applications.
A Raman photometer operates in a similar fashion to the common IR and NIR photometer.

Only wavelengths required for the analyses are collected by the analyzer.
**Example of combination peaks in a oil in water application**

- benzene
- cumene
- cyclopentane
- isooctane
- isoctane
- m-xylene
- o-xylene
- toluene

**RPM View™ Process Raman Photometer**

Aromatic (Green) & NonAromatic (Red) Scans
RPM View™ Process Raman Photometer

The “Measurement filter” captures the integrated energy of the band.
Alconex Corporate Outline

- Romanian Private Company
- Founded August 1990
- Turnover $3MM÷$6MM
- Staff: 30 people (28 university graduates)
Main Lines of Activity

- Oilfield Equipment Packager
- Metering Solutions Provider
- Contract Service, Maintenance, Proving & Meter Checking
- Oil Patch Technology Provider
Core Expertise

System integrator; equipment packager

Gas and crude processing: separation, dehydration, filtration

Liquids & gas metering solutions provider; extensive knowledge on custody transfer

Industrial Metrology (liquids & gas). Meter checking, proving and calibration

Metering systems condition monitoring and maintenance

Consulting: metering and processing
Oilfield Equipment Packager

ROMGAZ – Gas Processing & Dehy Unit - 2009
Oilfield Equipment Packager

PETROFAC UK – CPI Separator Unit - 2011
Oilfield Equipment Packager

PETROFAC UK – Backwash Water Filtration Unit - 2011
Oilfield Equipment Packager

LTS & Condensate Stabilisation Project OMV Petrom - 2012
Filtration Equipment Packager

Ceramic Reservoir Water Filtration Unit – OMV Petrom 2012
Metering Solutions

Oil Terminal Romania - Crude Oil Carrier
Custody Transfer Unloading Terminal. 2000

OMV Petrom – Fuel Depots
Custody Transfer Metering Skids - 2005
Metering Solutions

SNGN Romgaz Custody transfer gas stations

GC & Dewpoint Sampling Points

Water Dewpoint Monitor

Process GC

OMV Petrom Waterflooding monitoring – 400 units
Metering Solution-Gas Quality Monitoring Process GC

- Sitrans CV Siemens
- Danalyzer 700 Emerson
- FXi 930 Hamilton-S.
Metering Solutions-Water-cut Metering

MICROWAVE WATER CUT MONITORS

Water Cut Probe
Local Display
Net Oil Meter Computer Power Source

“Full bore” Style Vertical Install

“Full bore” Style Horizontal Install

Temperature Probe
Separator Crude Oil Leg
Probe
Integrated Process Monitoring
Automatic Interface Control

OMV Petrom ARPECHIM Refinery Automatic Tank Drainage Control System
Legal Metrology Services

Mobile Calibration Unit – 2008 Inhouse design & built
Industrial Metrology Services

- Romanian W&M Licensed Metrology Laboratory (ISO 17025)
- Laboratory traceable to Romanian and German W&M
- 2 Mobile calibration units
- Legal Metrology proving & checking
- Industrial metrology portfolio: flowrate, pressure, temperature, density, water cut
- Consulting: metering and proving
Main customers

OMV PETROM
SNGN ROMGAZ
THE ROMPETROL GROUP
LUKOIL ROMANIA
AMROMCO
TOREADOR RESOURCES
PETROFAC ROMANIA
PETROSANTANDER ROMANIA
Why Alconex?

- An experienced, professional and enthusiast team
- Largest metering installed base in Romania’s E&P sector
- Wide range of services, from design & engineering to turnkey installation and equipment rent
- Integrated solutions
THANK YOU !