Monitoring Oil & Sand In Produced Water Through Dynamic Imaging Technology

Alan O’Donoghue
JM Canty International

Oil & Sand in Produced Water - Background

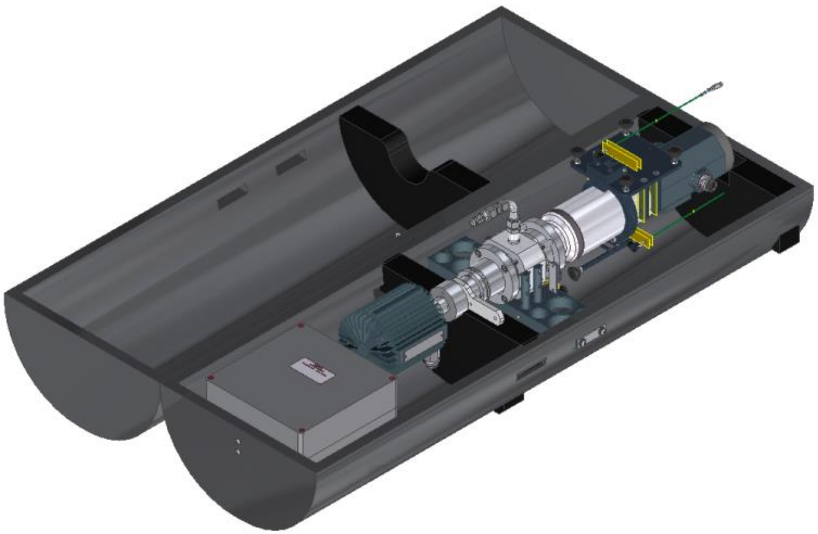
- Produced Water Analysis
  - Oil in Water
    - Environmental
      - 30ppm Dispersed Oil in Water
    - Process Control & Optimisation
      - Separation Equipment / Chemical Performance Analysis
  - TSS in Water
    - Process Control & Optimisation
      - Separation Equipment Performance Analysis
      - WFI – TSS Size & Concentration Analysis to Avoid Well Plugging
      - Well Formation Studies – Core Sample Testing

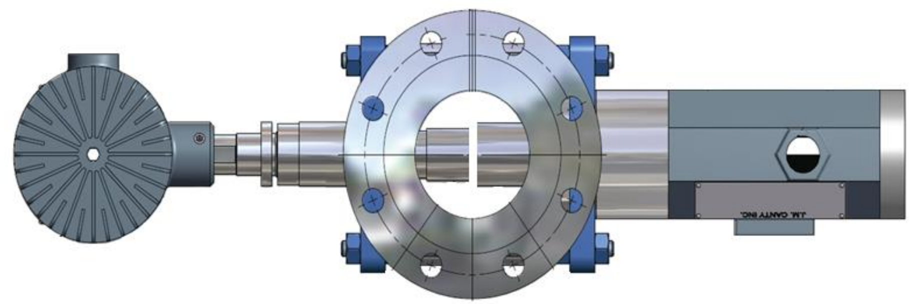
Vision Based Particle Analysis Basic Principle

JM Canty's vision based technique works on the basic principle of presenting the fluid between a high intensity light source, and microscopic camera

The captured images are then sent to CantyVision Client Software for analysis, where the suspended particulate (sand, water, oil, gas bubbles etc.) is measured under a number of different parameters to provide size, shape and concentration data

Image Retrieval - Hardware





Portable InFlow

½" Sample Line

Swagelock Tube Connection

Inline InFlow

½" to 22" Lines

ANSI / DIN Connection

Image Retrieval – Hardware – Sample Installations

- Portable InFlow connects to typical ½" sample points in process pipelines
- Outlet flow to open drain or lower pressure return point (ensure flow through analyser)
- System typically used for shorter term tests and can be easily moved to various sample points easily
- Wireless software operation options

Image Retrieval – Hardware – Sample Installations

Inline InFlow mounts as permanent spool piece in main process pipeline (½" to 22" lines)

Can also be mounted on fast loop bypass line for larger process lines

Image Retrieval – Hardware – CCD Camera

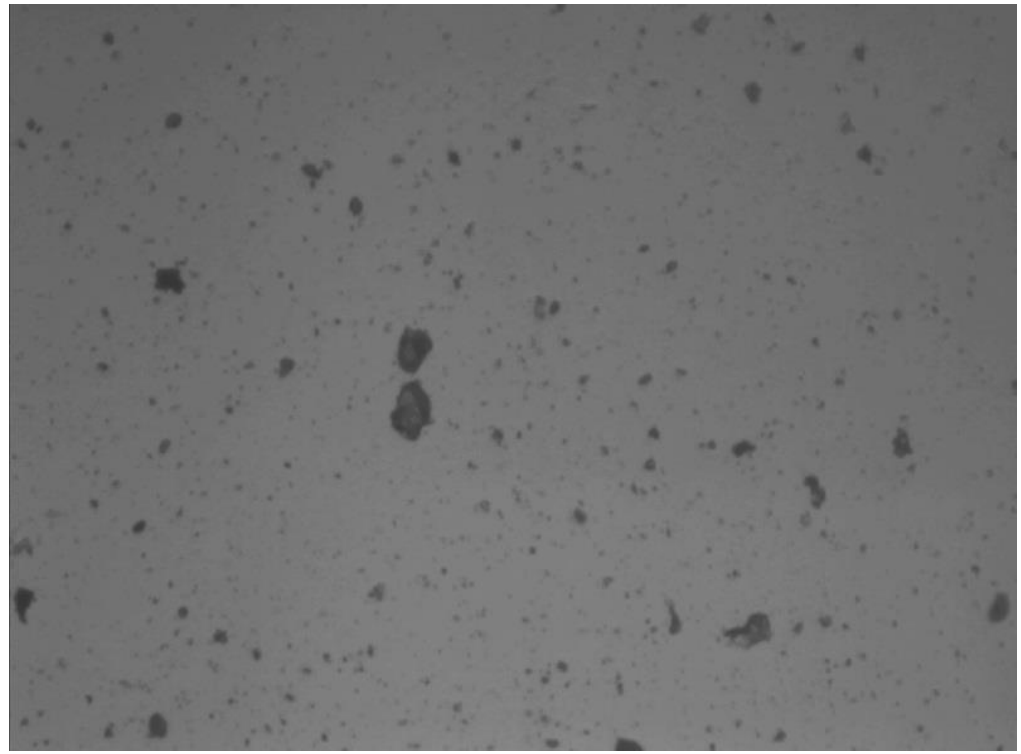
Gigabit Ethernet technology for optimum image retrieval

1600 x 1200 Pixel Array configurable to 0.35µm per Pixel Resolution

1/100,000s Shutter Speed

Particle / Droplet Size to 0.7µm

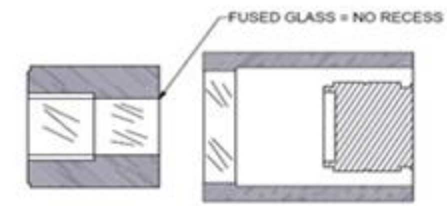
Simple RJ45 Network Connection to Control PC



Sand in Water

Image Retrieval – Hardware – Fused Glass Flow Path

- Fused one piece construction with no recesses or steps where product can adhere to and build up
- Pressures to 600 BAR
- Integral Jet Spray Ring
- Adjustable Gap Size dependent on sample present



CANTY FUSED GLASS

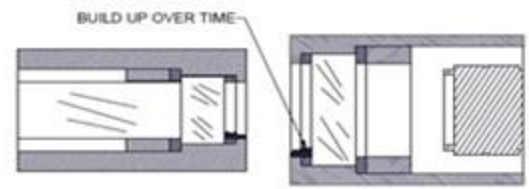


PLATE GLASS WITH BUILD UP

Image Retrieval – Hardware – Lighting System

High flow rates inline require an increased shutter speed and so an increased amount of light to capture particulate in "freeze frame" in order to perform software analysis

Flow speeds up to 2.75m/s

Pipe Line Size	Max Flow Rate
1"	83 l/m
2"	335 l/m
3"	750 l/m
4"	1340 l/m
6"	3000 l/m
8"	5300 l/m

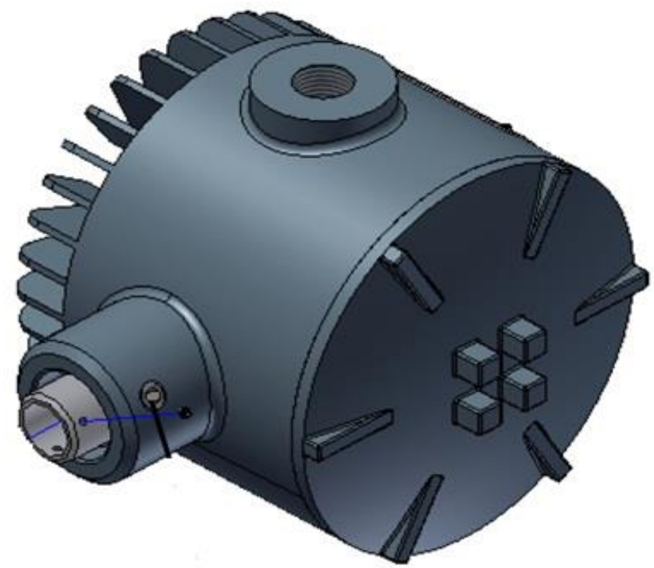


Image Analysis – Cantyvision Software

The retrieved images are analysed by the control PC running the Cantyvision Client Software

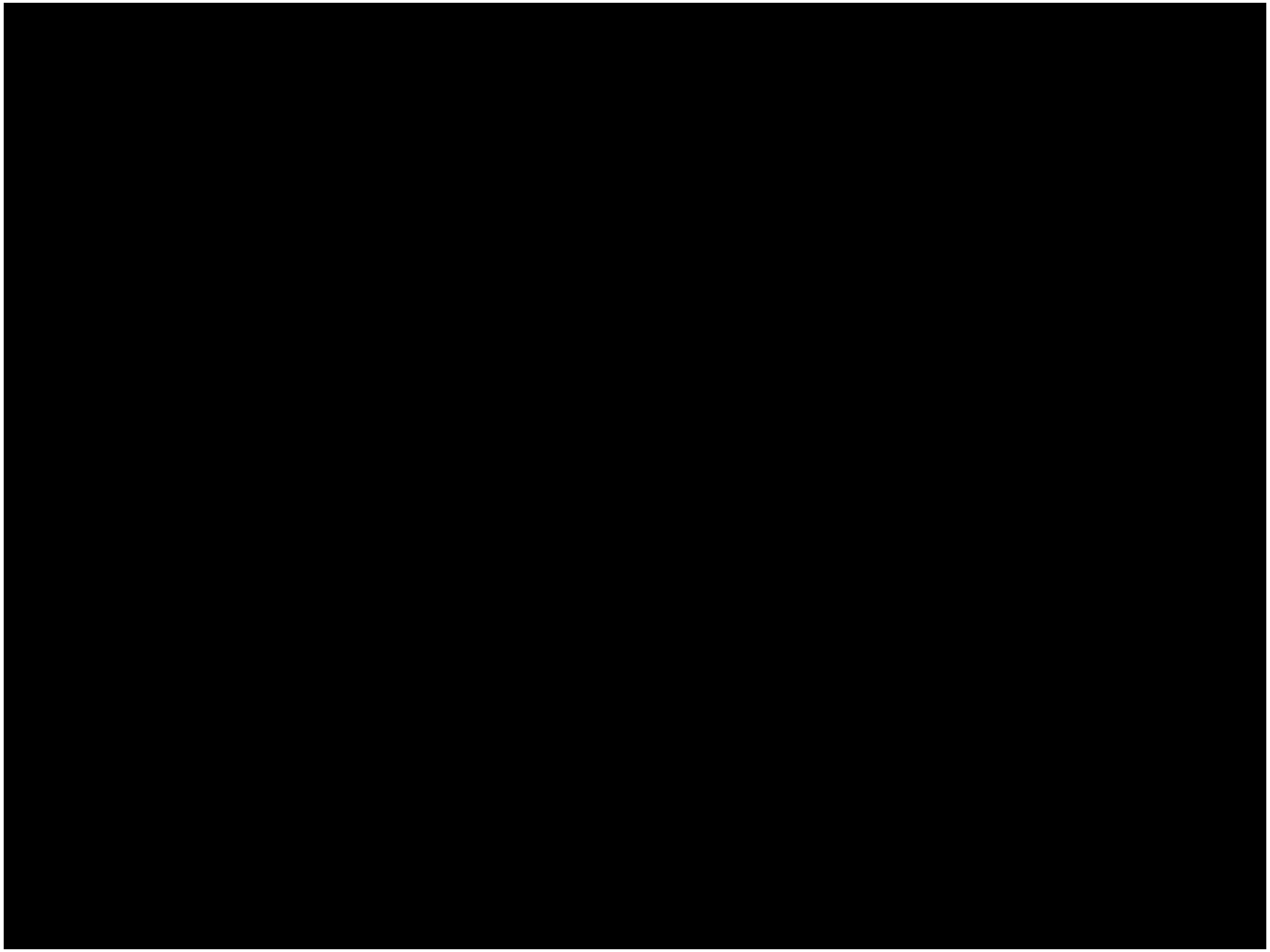
Each particle is analysed under a number of different parameters (major axis, minor axis, area, perimeter, circularity, aspect ratio….)

Oil droplets have a circularity value and an aspect ratio close 1

Solid particulate is randomly shaped

Air bubbles tend to be larger and have a clear centre

Software filters (size / shape) can be applied so only particles with the characteristics of oil, solids, or air bubbles are individually analysed



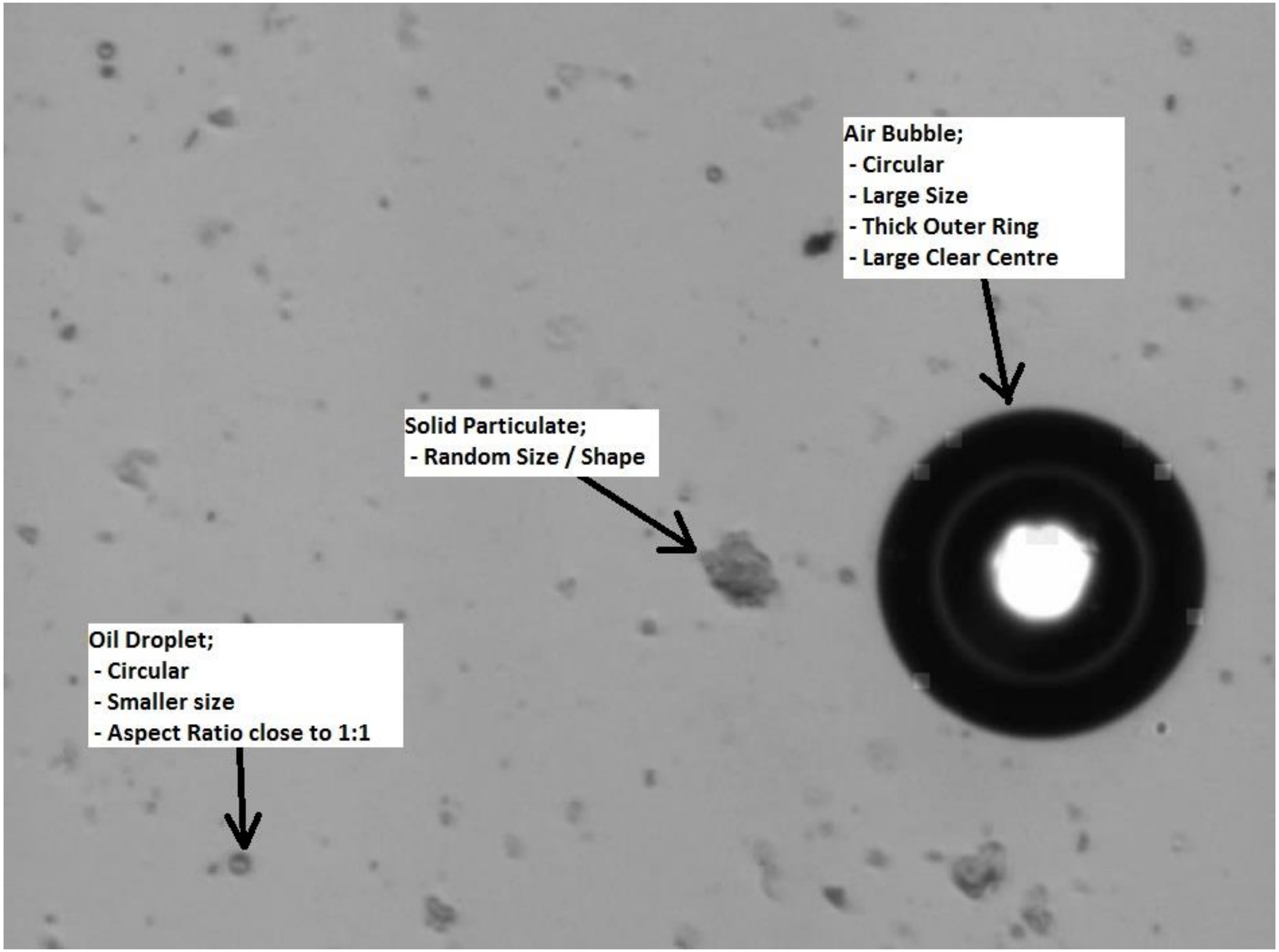
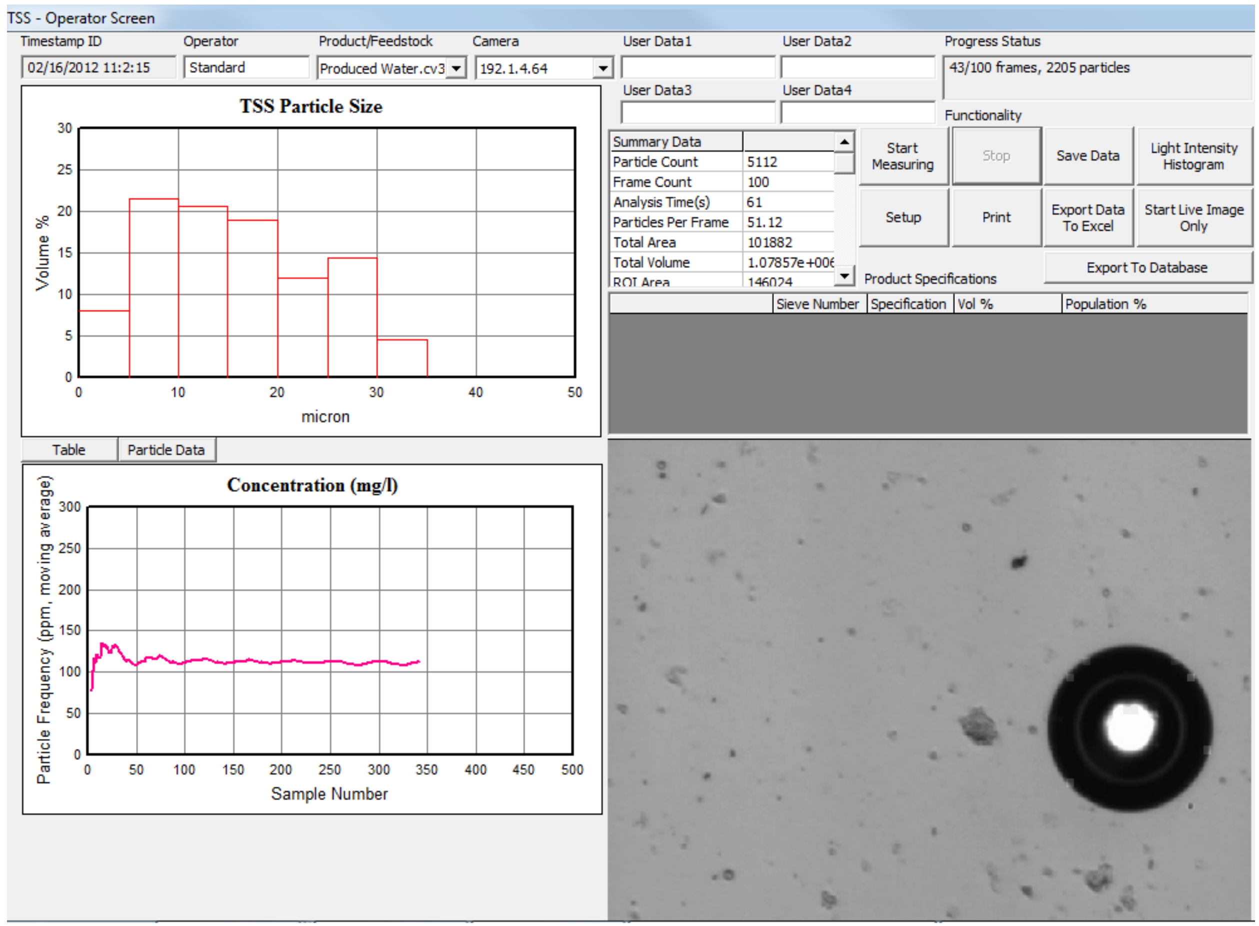

Air Bubble;
- Circular
- Large Size
- Thick Outer Ring
- Large Clear Centre
Solid Particulate;
- Random Size / Shape
Oil Droplet;
- Circular
- Smaller size
- Aspect Ratio close to 1:1

Image Analysis – Cantyvision Software – Operator Screen

Puts information and configuration in an easy to read format fore ease of operator control

Graphical outputs of particle size distribution and concentration

Configurable calculation for client specific products



Case Study 1: Oil & TSS in Water
Dynamic Imaging Applied to IGF & Filtration Performance Analysis

The Canty Portable InFlow unit was connected to 3 different sampling points to determine if the inlet / outlet oil & solids were within specification;

- IGF Inlet
- IGF Outlet / Filter Inlet
- Filter Outlet (Discharge Water)

Case Study 1: Oil & TSS in Water
Dynamic Imaging Applied to IGF & Filtration Performance Analysis

IGF Inlet

IGF Outlet / Filter Inlet

Filter Outlet

Case Study 1: Oil & TSS in Water
Dynamic Imaging Applied to IGF & Filtration Performance Analysis

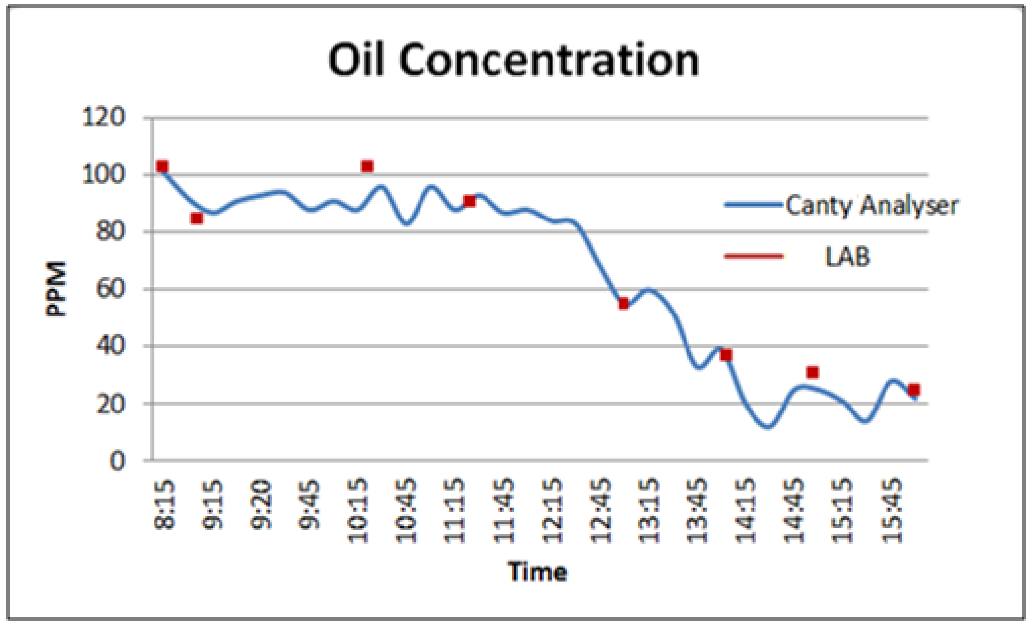
Oil	Untreated	IGF Outlet	Filtered Discharge
PPM	250-350	60-80	20-30
Dv 10*	13.7	6.5	6.0
Dv 50*	38.2	14.2	11.4
Dv 90*	94.2	28.7	19.1

TSS	Untreated	IGF Outlet	Filtered Discharge
PPM	150-170	70-100	10-20
Dv 10*	7.5	6.7	3.9
Dv 50*	21.4	19.7	10.2
Dv 90*	23.9	27.4	21.6

Case Study 2: Oil in Water
Dynamic Imaging vs Operator Lab Test

The test was carried out at the Mid East operator's Offshore Formation Water Disposal Plant. Produced water from different offshore sources (Source 1 and Source 2) were analysed and compared

Field Source	Time	Canty OiW Analyser	Operator's Lab
Source 1	8:15	101	101
Source 1	9:13	92	86
Source 1	10:30	96	102
Source 1	11:30	93	94
Source 2	13:00	55	56
Source 2	14:00	39	40
Source 2	15:00	25	27
Source 2	16:00	22	25



Case Study 3: TSS in Water
Dynamic Imaging Applied to Well Formation Studies

Overview

A cylindrical section of sandstone rock was placed under stress using a core flood cell, whilst flowing brine through the sandstone.

Pressure was increased until sandstone rock failed catastrophically. The unit was connected to the core flood cell output for monitoring sand particle size and concentration

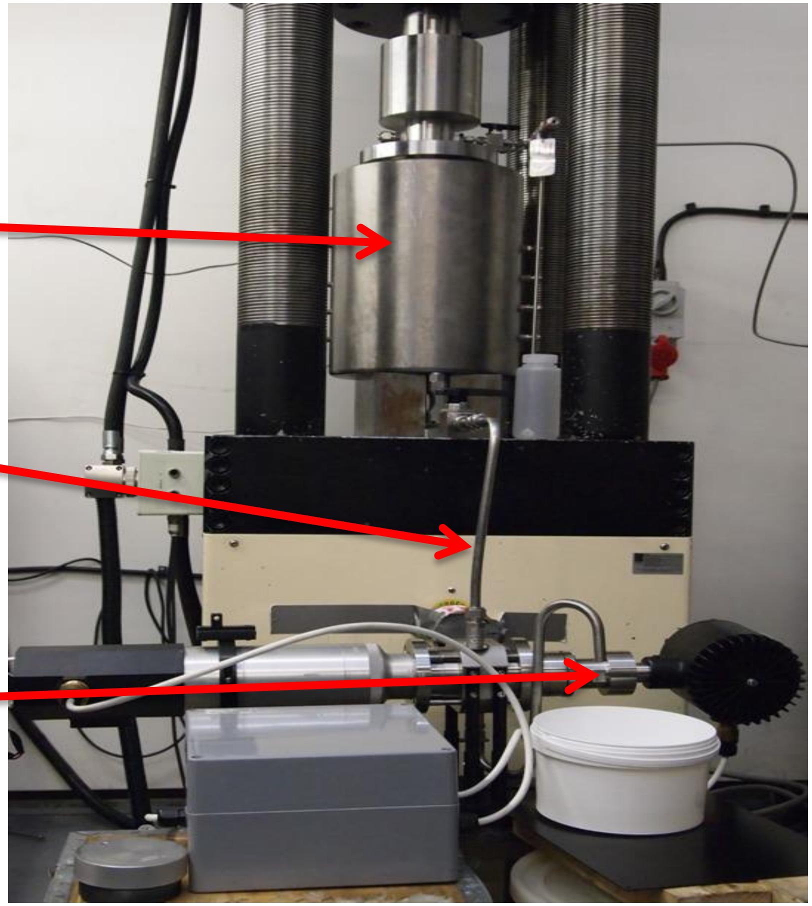
Case Study 3: TSS in Water

Test Setup

Core Flood Cell

Outlet of Flood Cell Connected to Inlet of Analyser

Analyser Outlet Fluid Collected for Visual Observation



Case Study 3: TSS in Water
Dv10-100 Particle Size vs Time

0-10 Minutes	
DV Values	Minor Axis (microns)
Dv 10	14.4476
Dv 20	22.992
Dv 30	29.8377
Dv 40	34.6833
Dv 50	43.6623
Dv 60	60.4913
Dv 70	71.1488
Dv 80	80.3852
Dv 90	86.1794
Dv 100	86.1794

11-20 Minutes	
DV Values	Minor Axis (microns)
Dv 10	16.2698
Dv 20	26.8505
Dv 30	35.7407
Dv 40	45.6363
Dv 50	63.2325
Dv 60	68.0207
Dv 70	85.9203
Dv 80	85.9203
Dv 90	94.872
Dv 100	94.872

21-30 Minutes	
DV Values	Minor Axis (microns)
Dv 10	17.9002
Dv 20	27.105
Dv 30	36.0393
Dv 40	50.1207
Dv 50	54.6894
Dv 60	60.2976
Dv 70	69.8103
Dv 80	72.6854
Dv 90	72.6854
Dv 100	92.8906

31-40 Minutes	
DV Values	Minor Axis (microns)
Dv 10	13.0126
Dv 20	17.4217
Dv 30	20.776
Dv 40	25.0604
Dv 50	31.2569
Dv 60	34.1292
Dv 70	38.8483
Dv 80	44.6082
Dv 90	50.9803
Dv 100	63.1896

41-50 Minutes	
DV Values	Minor Axis (microns)
Dv 10	19.3387
Dv 20	33.0769
Dv 30	42.2934
Dv 40	51.1626
Dv 50	69.0444
Dv 60	83.4214
Dv 70	83.4214
Dv 80	83.4214
Dv 90	120.315
Dv 100	120.315

51-60 Minutes	
DV Values	Minor Axis (microns)
Dv 10	14.3212
Dv 20	25.4378
Dv 30	37.5901
Dv 40	49.7532
Dv 50	75.2213
Dv 60	97.5982
Dv 70	108.986
Dv 80	108.986
Dv 90	136.129
Dv 100	136.129

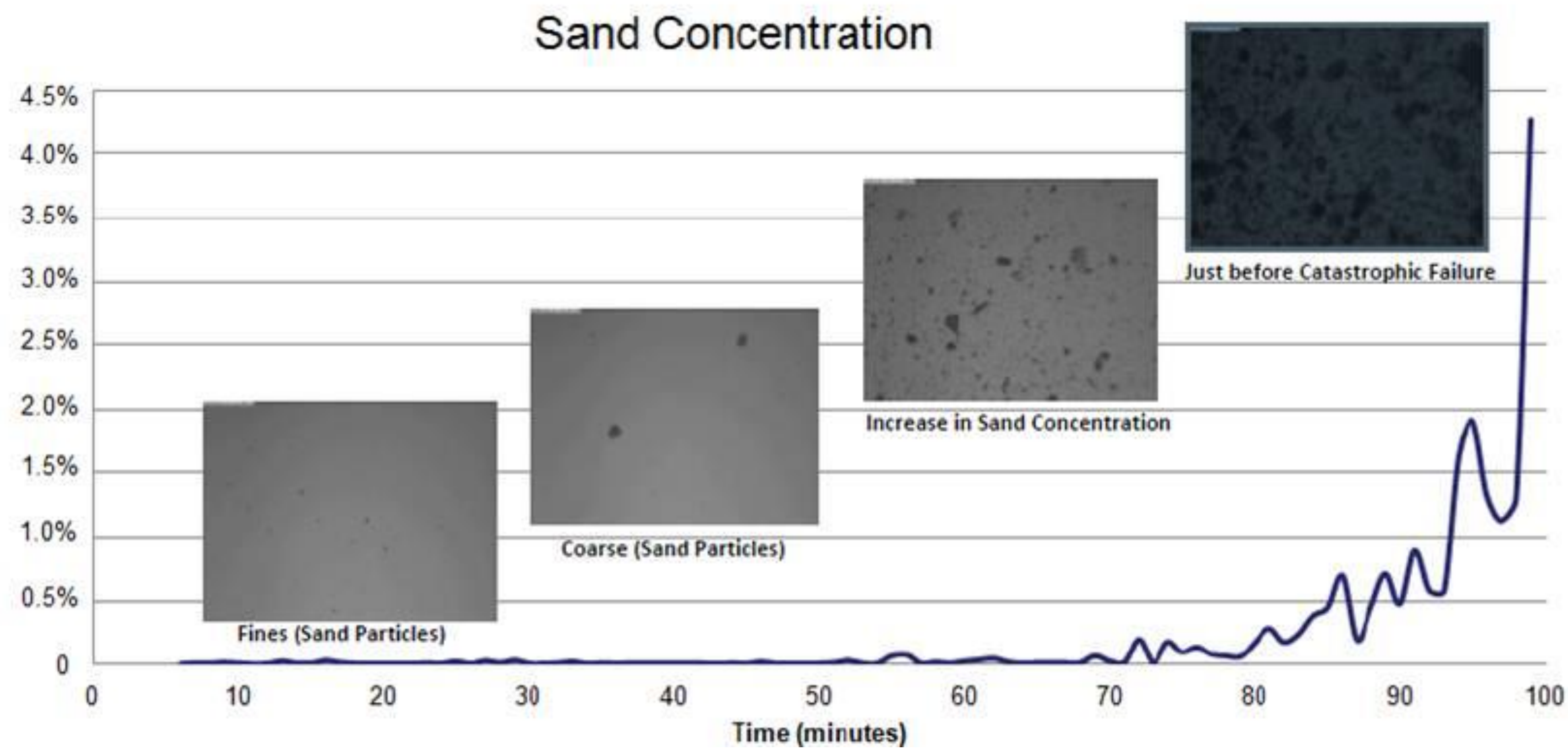
61-70 Minutes	
DV Values	Minor Axis (microns)
Dv 10	28.6419
Dv 20	59.3422
Dv 30	86.2153
Dv 40	114.561
Dv 50	115.021
Dv 60	118.14
Dv 70	169.251
Dv 80	169.251
Dv 90	195.275
Dv 100	195.275

71-80 Minutes	
DV Values	Minor Axis (microns)
Dv 10	26.3377
Dv 20	59.992
Dv 30	84.2383
Dv 40	105.923
Dv 50	142.57
Dv 60	147.865
Dv 70	149.652
Dv 80	150.991
Dv 90	158.344
Dv 100	198.818

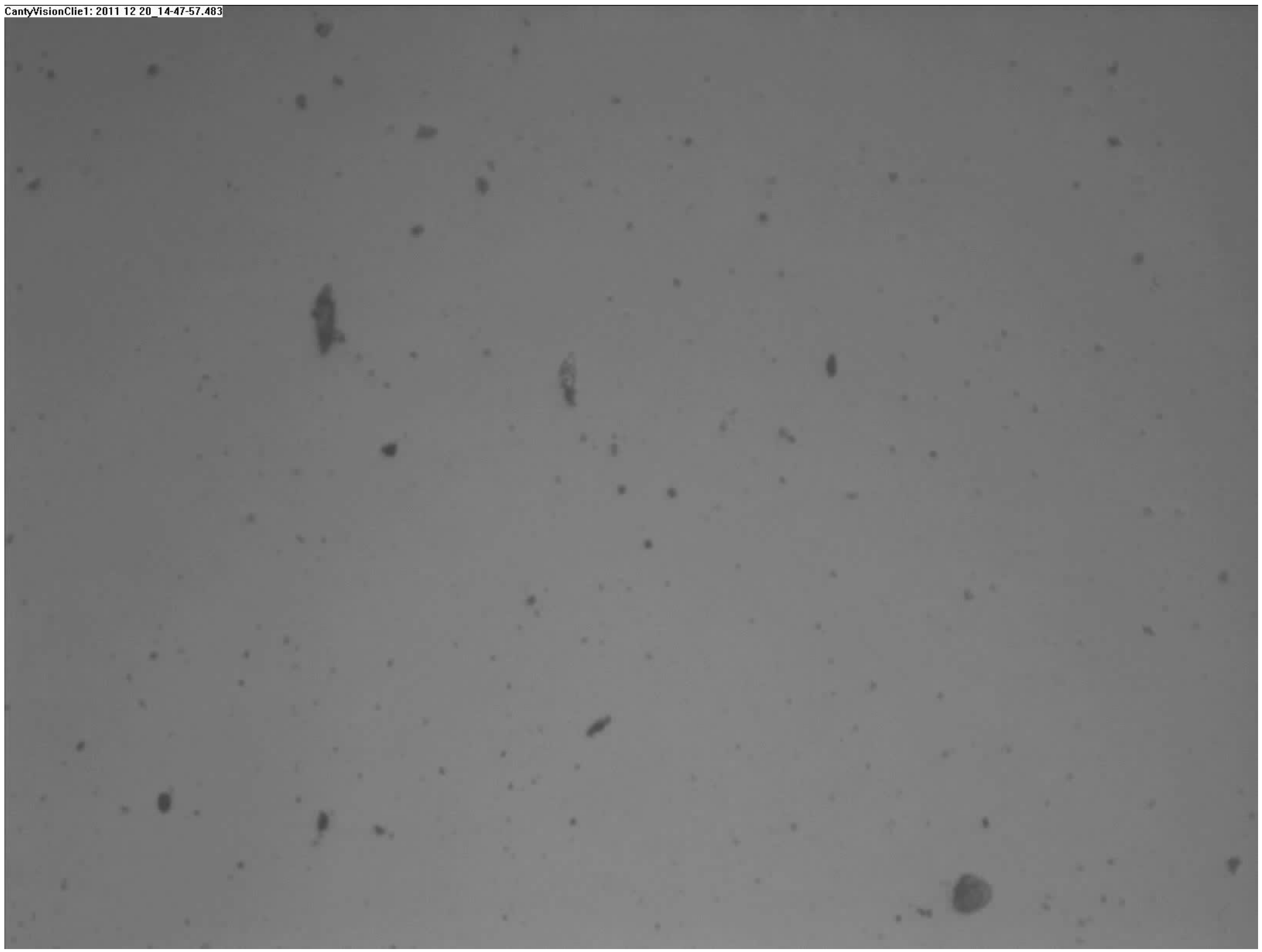
81-90 Minutes	
DV Values	Minor Axis (microns)
Dv 10	32.2158
Dv 20	60.5284
Dv 30	101.538
Dv 40	124.797
Dv 50	138.166
Dv 60	152.119
Dv 70	169.993
Dv 80	185.168
Dv 90	208.435
Dv 100	224.233

Catastrophic Failure	
DV Values	Minor Axis (microns)
Dv 10	42.8068
Dv 20	71.3619
Dv 30	108.203
Dv 40	125.69
Dv 50	135.123
Dv 60	145.013
Dv 70	165.965
Dv 80	198.231
Dv 90	237.742
Dv 100	351.44

Case Study 3: TSS in Water
Sand Concentration vs Time



Case Study 3: Dynamic Imaging Applied to Well Formation Studies



Questions & Answers

*Illustration above property of Ascom BV