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Portable InFlow™

Core Sample Test Report

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1. Introduction

Within the oil and gas industry sand control is a major concern and challenge. The highly erosive nature of sand can cause extensive damage to surface equipment and well completions, resulting in poor operational performance or lead to production being shut down. Produced sand is also an environmental concern and needs to be disposed of in an environmental safe way. As produced sand can cause the industry billions of dollars, extensive ongoing research is carried out in order to effectively manage the production of sand whilst optimizing the hydrocarbon production. The JM Canty dynamic imaging analyser can be used in laboratory research or on-line. The dynamic imaging system delivers a particle size and concentration of the sand along with simultaneously analyzing water / oil droplets within the process. The below summary details a sand control laboratory test where the JM Canty Portable InFlow™ was effectively used to analyse and detect sand particles.

2. Summary of Application

The purpose of the testing with the portable InFlow™ was to determine the systems capabilities in analyzing sand particulate. This report will detail the functionality of the InFlow™ in determining the particle size and shape characteristics.
Two tests were performed: Test 1 Oil and Test 2 Brine.

Test 1 Oil

A cylindrical section of sandstone rock (Figure 1) was placed under stress using a core flood cell, whilst flowing oil 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.

Figure 1 Sandstone Rock

Observations and Analysis

As the pressure to the sandstone rock was increased, water droplets began to become more evident at 3,500psi, which could be due to residual water within the sandstone being forced out. The image detected the water droplets (software can distinguish between droplets and sand based on shape) and droplet size was measured (Figure 2, Table 1).

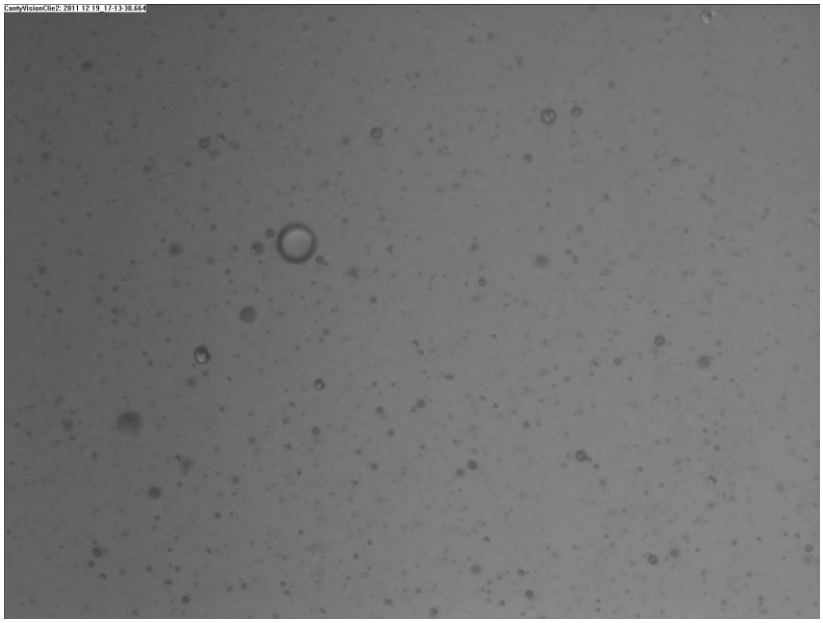

Figure 2 Live image of water droplets in oil (Approx. at 3,500 psi

Water Droplet Size

DV Values	Diameter (microns)
Dv 10	71.6471
Dv 20	91.2159
Dv 30	113.951
Dv 40	119.863
Dv 50	132.148
Dv 60	157.369
Dv 70	187.165
Dv 80	209.248
Dv 90	233.035
Dv 100	268.182

Table 1 Water Droplet Size

The first detection of sand was observed at a pressure of close to 5300psi. However, due to the oil (permeability), the sandstone rock did not fail in individual grains. Large clusters of grains were observed (Figure 3). The image analyser delivers an unparalleled view into the process allowing the user to better understand what is happening, compared to the existing method of visually viewing grains within a container with the unaided eye (Figure 5).

Sand Clusters

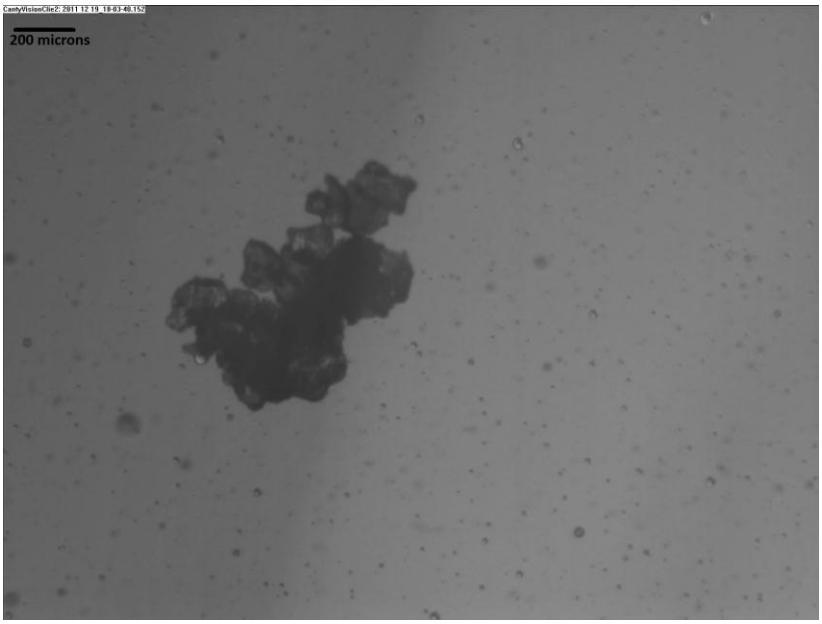

Figure 3 Before failure sand clusters observed and detected (Approx. at 5390 psi)

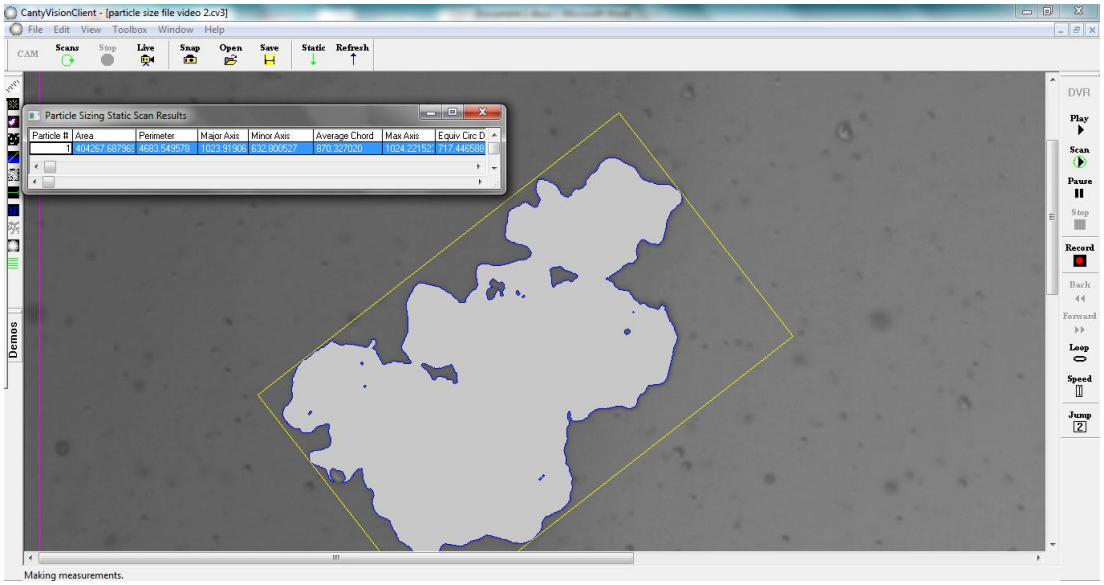

Figure 4 Displays the software interface and the detection of sand cluster from figure 3 (approx. 1mm in length)

Figure 5 Visual Detection of Grains

Test 2 Brine

The test set-up was identical to Test 1 with brine replacing the mineral oil.

Observations and Analysis

As the pressure was increased, the sandstone cylindrical section failed into individual grains (Figure 5 & 6) due to the water dispersing the sand. Table 1 on page 7 details the PSD for the sand at 10 minute interval for the complete test. As expected, as the pressure increased throughout the test, fines were observed at the beginning and coarse particles at the end just before catastrophic failure at 5,300 psi. Figure 7 on page 7 displays the continuous sand concentration measurement for the complete test up to catastrophic failure of the sandstone rock.

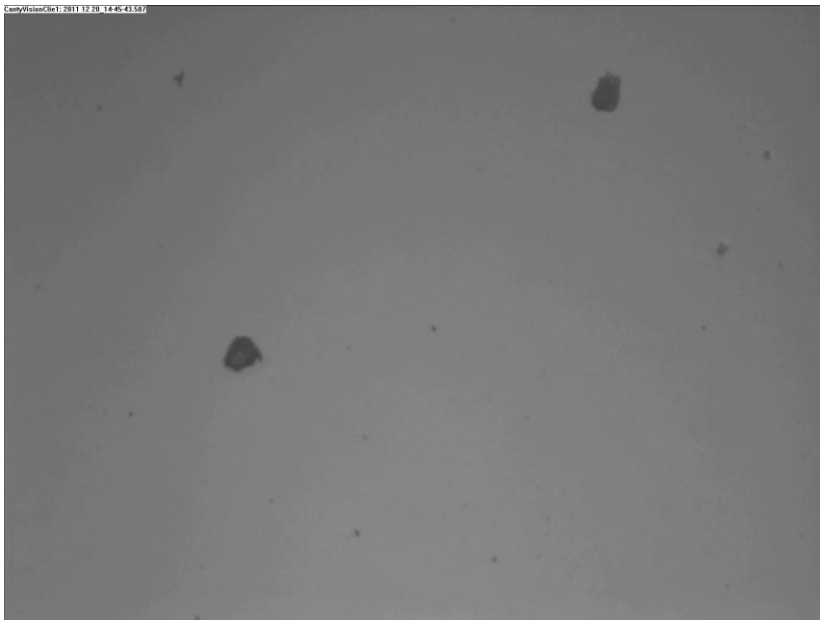

Figure 5 Before failure sand particles observed and detected (Approx. 5,150 psi)

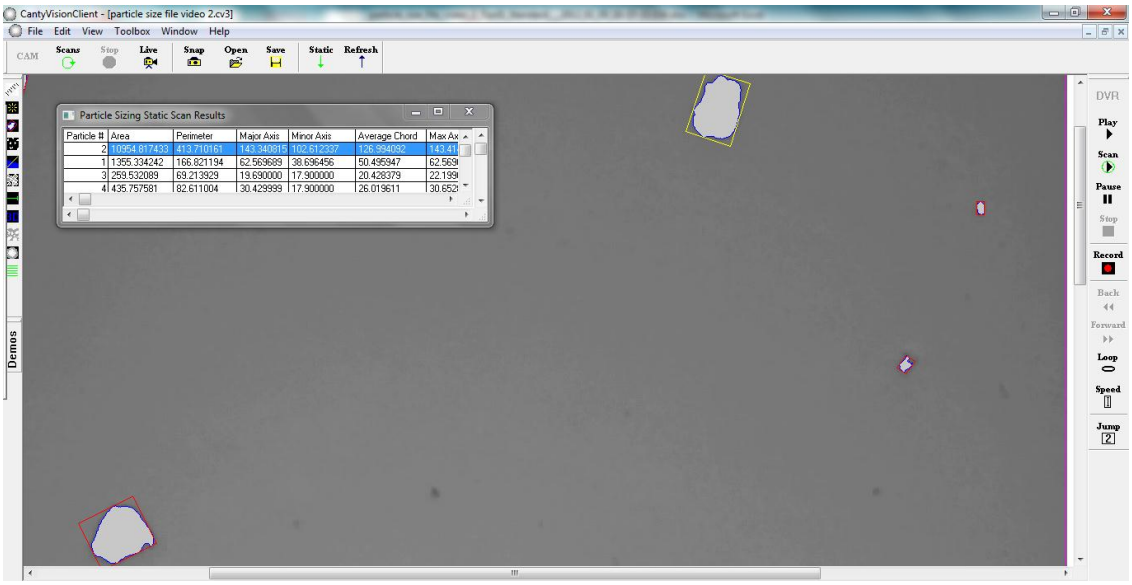

Figure 6 Displays the software interface and the detection and analysis of sand particles

0-10 Minutes		11-20 Minutes		21-30 Minutes		31-40 Minutes		41-50 Minutes	
DV Values	Minor Axis (microns)	DV Values	Minor Axis (microns)	DV Values	Minor Axis (microns)	DV Values	Minor Axis (microns)	DV Values	Minor Axis (microns)
Dv 10	14.4476	Dv 10	16.2698	Dv 10	17.9002	Dv 10	13.0126	Dv 10	19.3387
Dv 20	22.992	Dv 20	26.8505	Dv 20	27.105	Dv 20	17.4217	Dv 20	33.0769
Dv 30	29.8377	Dv 30	35.7407	Dv 30	36.0393	Dv 30	20.776	Dv 30	42.2934
Dv 40	34.6833	Dv 40	45.6363	Dv 40	50.1207	Dv 40	25.0604	Dv 40	51.1626
Dv 50	43.6623	Dv 50	63.2325	Dv 50	54.6894	Dv 50	31.2569	Dv 50	69.0444
Dv 60	60.4913	Dv 60	68.0207	Dv 60	60.2976	Dv 60	34.1292	Dv 60	83.4214
Dv 70	71.1488	Dv 70	85.9203	Dv 70	69.8103	Dv 70	38.8483	Dv 70	83.4214
Dv 80	80.3852	Dv 80	85.9203	Dv 80	72.6854	Dv 80	44.6082	Dv 80	83.4214
Dv 90	86.1794	Dv 90	94.872	Dv 90	72.6854	Dv 90	50.9803	Dv 90	120.315
Dv 100	86.1794	Dv 100	94.872	Dv 100	92.8906	Dv 100	63.1896	Dv 100	120.315

51-60 Minutes		61-70 Minutes		71-80 Minutes		81-90 Minutes		Catastrophic Failure	
DV Values	Minor Axis (microns)	DV Values	Minor Axis (microns)	DV Values	Minor Axis (microns)	DV Values	Minor Axis (microns)	DV Values	Minor Axis (microns)
Dv 10	14.3212	Dv 10	28.6419	Dv 10	26.3377	Dv 10	32.2158	Dv 10	42.8068
Dv 20	25.4378	Dv 20	59.3422	Dv 20	59.992	Dv 20	60.5284	Dv 20	71.3619
Dv 30	37.5901	Dv 30	86.2153	Dv 30	84.2383	Dv 30	101.538	Dv 30	108.203
Dv 40	49.7532	Dv 40	114.561	Dv 40	105.923	Dv 40	124.797	Dv 40	125.69
Dv 50	75.2213	Dv 50	115.021	Dv 50	142.57	Dv 50	138.166	Dv 50	135.123
Dv 60	97.5982	Dv 60	118.14	Dv 60	147.865	Dv 60	152.119	Dv 60	145.013
Dv 70	108.986	Dv 70	169.251	Dv 70	149.652	Dv 70	169.993	Dv 70	165.965
Dv 80	108.986	Dv 80	169.251	Dv 80	150.991	Dv 80	185.168	Dv 80	198.231
Dv 90	136.129	Dv 90	195.275	Dv 90	158.344	Dv 90	208.435	Dv 90	237.742
Dv 100	136.129	Dv 100	195.275	Dv 100	198.818	Dv 100	224.233	Dv 100	351.44

PSD & Concentration Measurements

The above Dv values are plotted based on minor axis (particle width). Distributions can be plotted based on major axis (particle length), average chord, equivalent circular diameter etc.

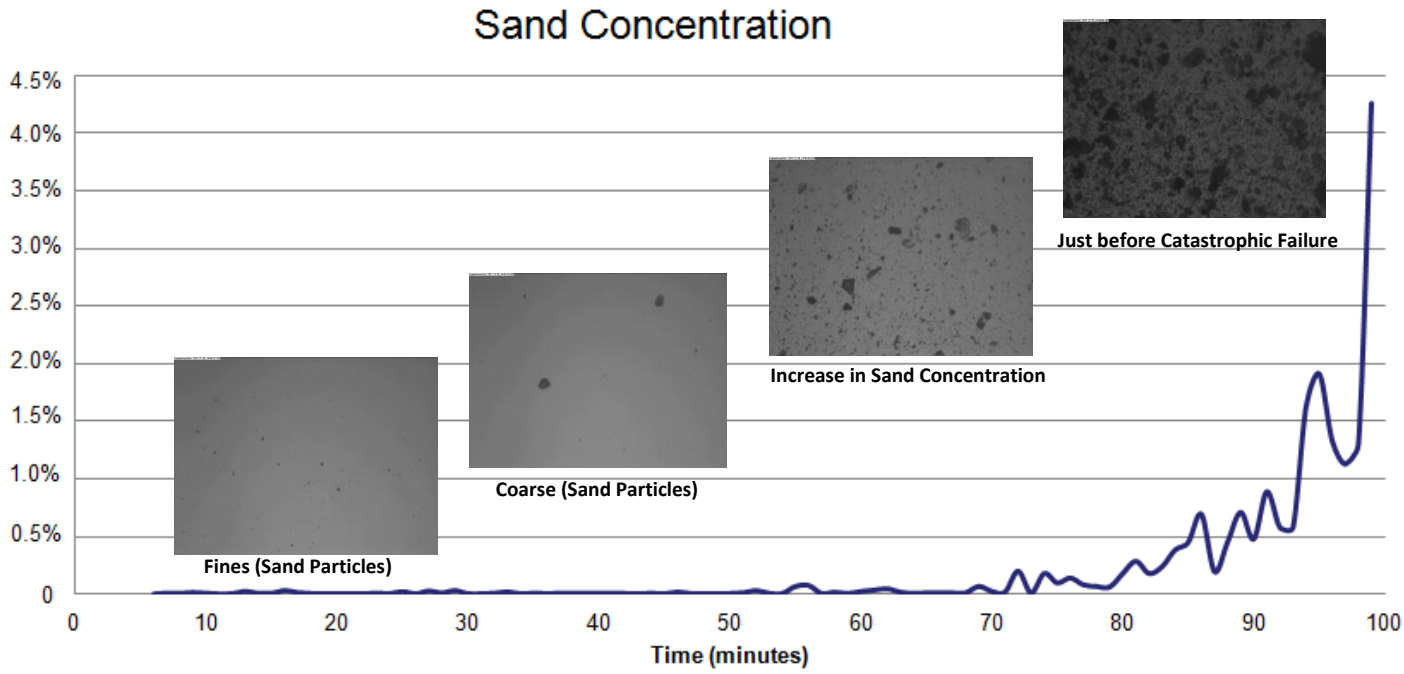

Figure 7 Sand concentration for complete test duration

The particle size, concentration measurements of water/oil droplets and sand delivered by the Canty InFlow™ makes the dynamic imagine technique a unique analysis system for effectively managing the production of sand. The vision based technique gives the operator an unparalleled view into the process, which allows the user to better understand what is happening and the effect of any changes made. The system used for this test was a portable analyzer. Both the portable inflow and inline inflow systems are optically identical allowing for consistency between results at line and in line