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# Portable InFlow™ Lab Test

## Aluminum Industry Particle Sizing Analysis

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# 1. Introduction

## 1.1 Objective

The purpose of the testing with the Canty InFlow™ particle sizing system was to demonstrate the system's capabilities in analyzing a number of different samples within the aluminum process. This report will detail the functionality of the InFlow™ in determining the particle size and shape characteristics. A gravity feed mechanism was used to present the samples between the microscopic camera and light source within the system.

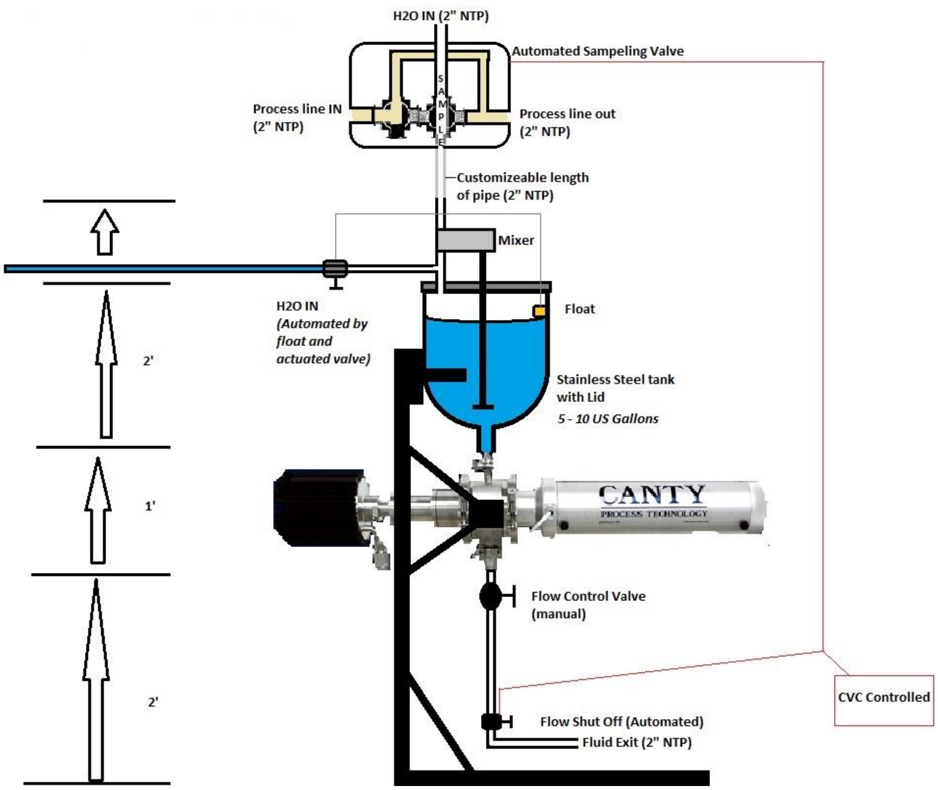



Figure 1 Lab Sampling System

## 2. How It Works

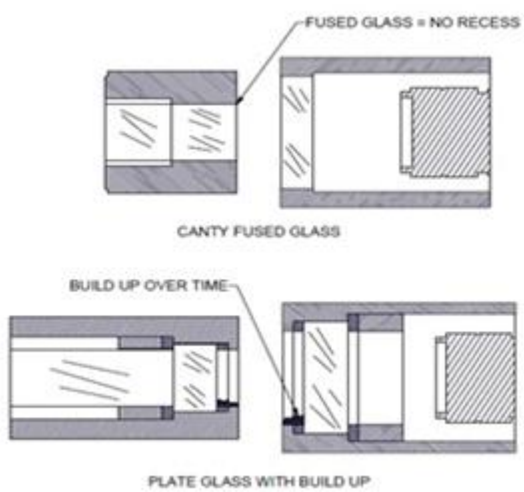
### 2.1 Hardware

There are 3 critical components to a Dynamic Imaging Based Analyser;

- Microscopic gigabit camera
- High intensity light source
- Flow path between two fused glass windows

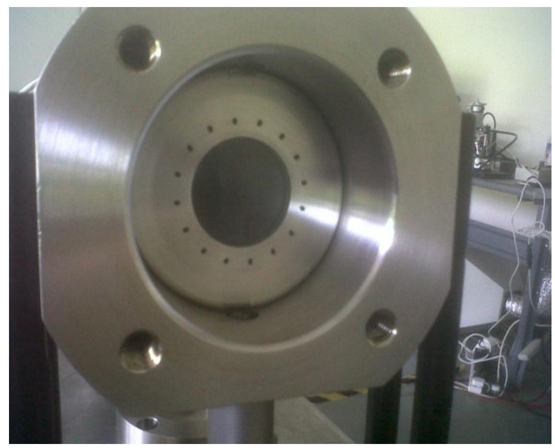
The gigabit camera is the simulation of the human eyes in the vision based system. The camera is an IP device with a simple RJ45 connection to allow for easy connection to the analyser network. The camera has the capability to take 30 frames per second, and with the current lens can magnify to a resolution of 0.2µm per pixel, to allow particles as small as 0.7µm to be analysed (maximum magnification dependent on light transmission through fluid, which is usually determined during lab testing phase).

The high intensity lighting consists of a quartz halogen light source, focused through the use of a light guide into the area on which the gigabit camera is viewing. Typically it is an 80W light source, originally designed for the illumination of large pressure vessels that is used. All the power of this is focused into the small area which the gigabit camera is monitoring. This is critical in order to catch any moving particulate in freeze frame as it passes the camera in order for the software to be able to analyse it correctly. In order to guarantee the particulate can be caught in freeze frame, the shutter speed of the camera needs to be increased. As the shutter speed of the camera is increased, there is an increase in light needed which can be achieved through the use of the Canty high intensity light source. Currently the camera can capture



particulate moving up to 2.75m per second within a clear fluid (maximum flow speed dependent on light transmission through fluid, which is usually determined during lab testing phase).

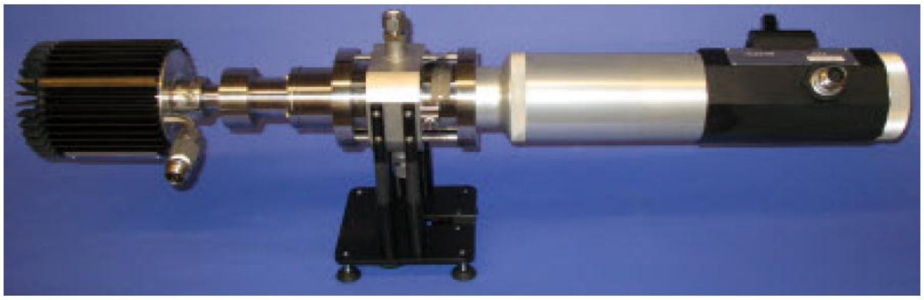
Fusion of glass and metal is a unique process whereby a one piece construction component is produced. BoroPlus™ glass in its molten form is poured into the centre of a metallic ring where it flows to the metal wall. At that point due to the chemical make up of BoroPlus™ glass, the glass fuses to the metal. As the unit is then cooled, the metal, having a higher coefficient of expansion than the glass, contracts onto the solidifying glass putting it under uniform radial compression. This fused glass and metal surface can then be finely polished to produce a smooth even surface with no crevices.

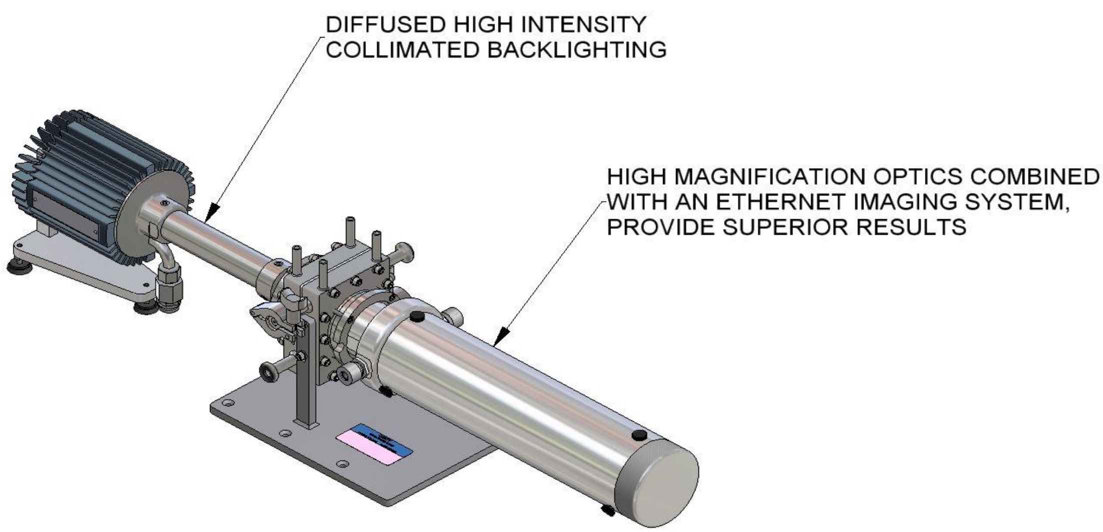


The importance of the fused glass relates to the ability of the unit to stay as clean as possible which is clearly critical for a vision based system. Due to the fact that there are no crevices or spaces between the fused glass and metal, there is nowhere for product to begin to build up. Non-fused glass and metal systems would not have a smooth transition from glass to metal, and it is in this step area that product (oil / solids) would inevitably build up. The fused glass also allows higher pressure operation of the systems (up to 600 Bar possible) due to the fact there is no danger of the glass and metal separating into 2 separate components. A jet spray ring is also included as standard in the system as a means of flushing the glass clean in the event that particulate does become lodged on the glass due to breaks in the flow etc.

Depending on where the measurement is to be taken there are a number of different systems which combine the 3 key features of camera, fused glass flow path, and high intensity light source;

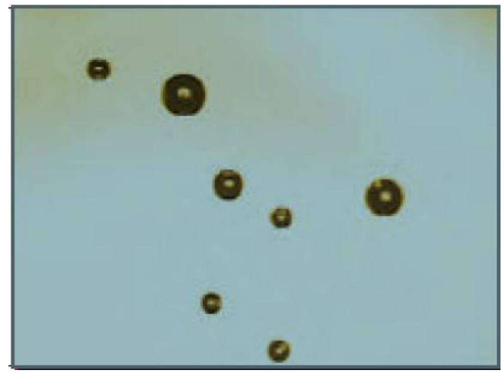
Portable Tru-Flow System (Lab / Portable Unit)



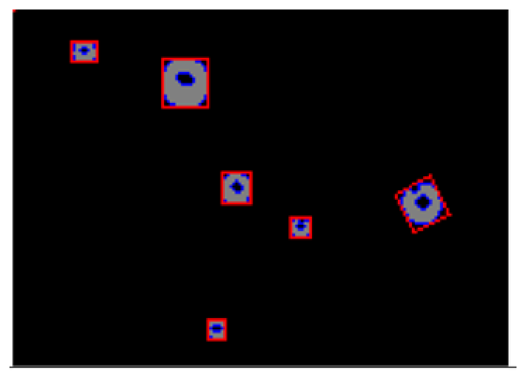


### 2.2 Software

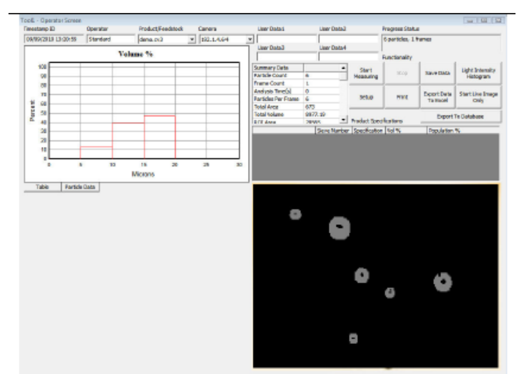
- **Image Collection:**
  Particles are sent through the flow cell body and back-lit with a high output CANTY Light. The particle images are collected in real time by the CCD camera. The image is then digitally transmitted to a PC with CantyVisionClient™ software for analysis.



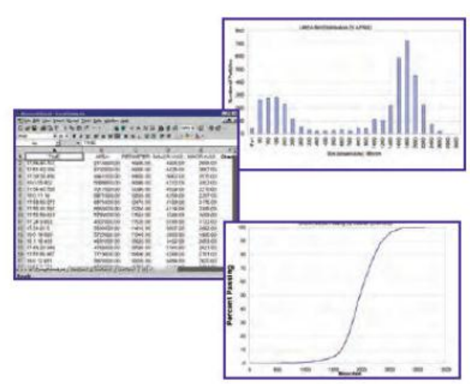
- **Binary Images:**
  The image is then broken down into individual pixels. The intensity difference between the particles and the background allows CantyVisionClient™ software to determine the perimeter of the particle, as well as the major axis, minor axis, area, and other characteristics about the particles dimensions.



- **Analysis:**
  Once the software determines the particles size and shape, the software can perform further analysis on the individual particles. The analysis includes particle filters to enable users to determine when particles are dissimilar or nonconforming to the entire distribution of particles.



- **Output**
  Once the software has analyzed the particles the information can be stored and/or output to a variety of locations. This includes PC databases, 4-20 mA current loop, OPC and more!



## 3. Results

### 3.1 Alumina

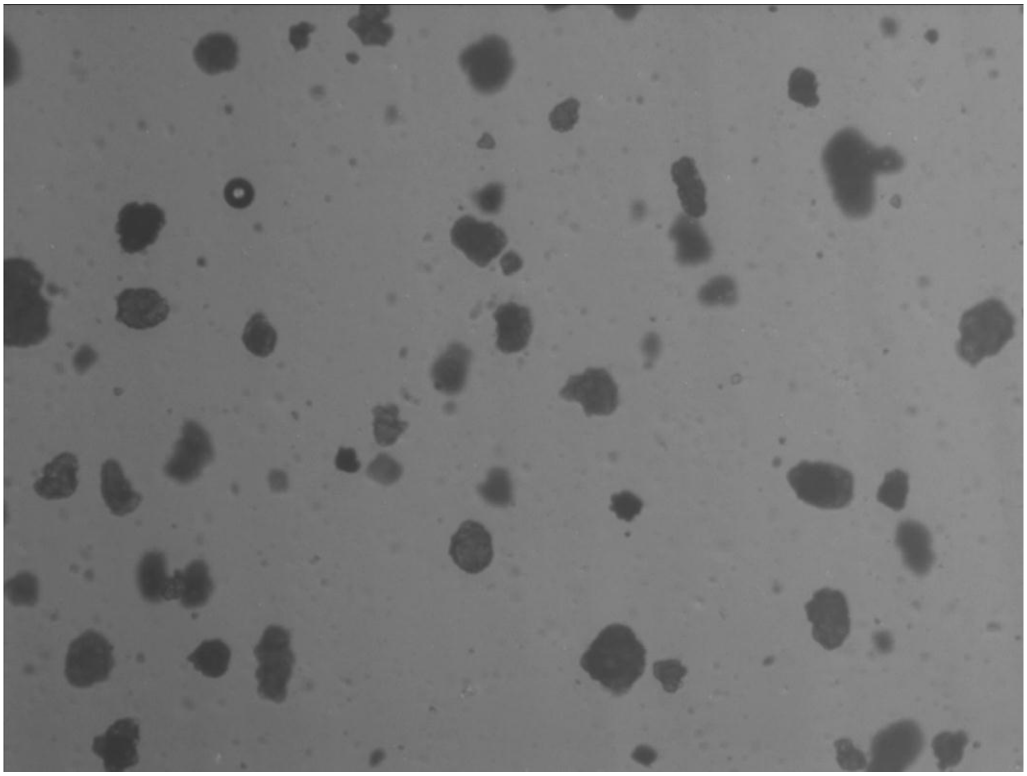


Figure 2 Live image of alumina particles (approx 2% wt.), Pixel Scale factor 1.1mpp

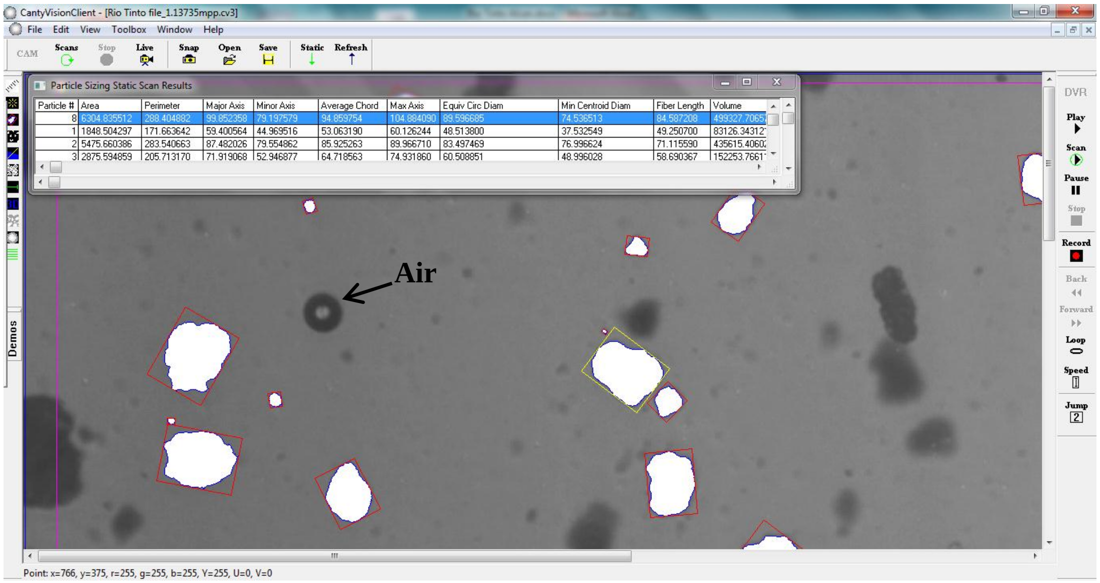



**Figure 3 Snapshot of software interface analyzing particles**

Figures 3 displays a snapshot scan of particles after digitization. Dimensions can be seen in the table (Area, Perimeter, Major, and Minor Axis) included at the top of Figure 3. Size for highlighted particle (yellow box) is the highlighted row in the table. The CantyVisionClient Software can filter out air bubbles based on shape parameters such as circularity allowing for a true particle size distribution output.

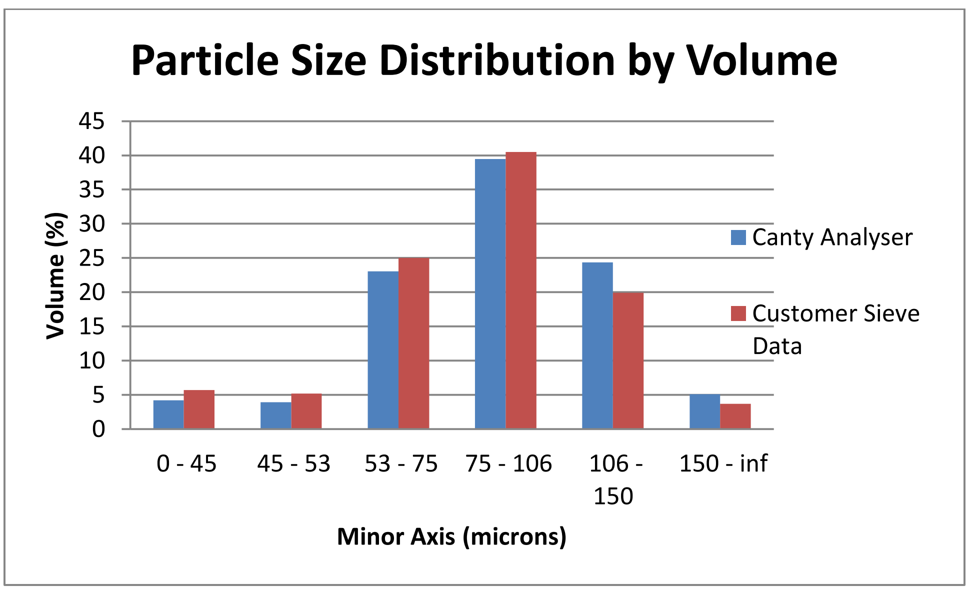



**Figure 4 Comparison between Canty image analysis system and manual sieves**

Figure 4 represents the detection and analysis of 7,000 particles using the JM Canty portable InFlow™ analysis system. The graph was plotted based on minor axis (particle width) which correlates best with manual sieve data. Data can also be plotted based on major axis, average chord length etc.

| Alumina Sample | |
|---|---|
| Dv10: | 55.654 |
| Dv20: | 65.9677 |
| Dv30: | 73.9645 |
| Dv40: | 81.343 |
| Dv50: | 88.437 |
| Dv60: | 95.2353 |
| Dv70: | 105.373 |
| Dv80: | 116.928 |
| Dv90: | 134.063 |
| Dv100: | 191.344 |

| Aluminia | Size (microns) |
|---|---|
| Mean Major Axis (Particle length): | 57.9121 |
| Min Major Axis: | 2.2747 |
| Max Major Axis: | 255.146 |
| Mean Minor Axis (particle width): | 46.4255 |
| Min Minor Axis: | 2.2747 |
| Max Minor Axis: | 191.344 |

### 3.2 Hydrates (Fines & Coarse Particles)

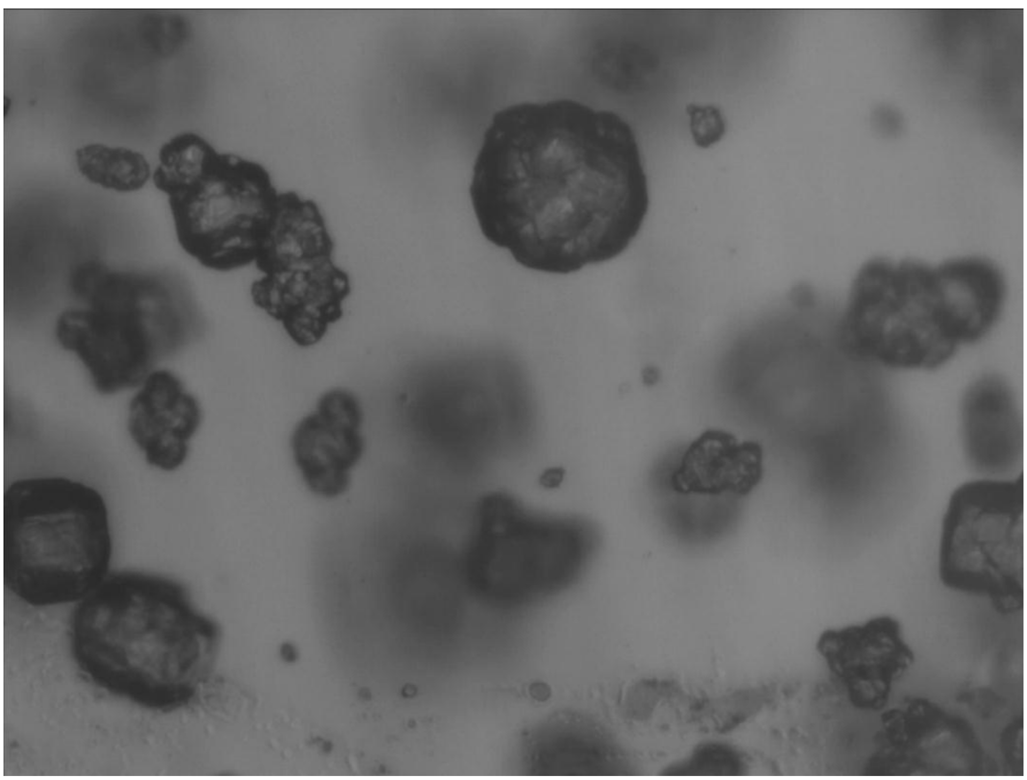


Figure 5 Live image of hydrates (approx 2% wt.) , Pixel Scale Factor 0.48mpp

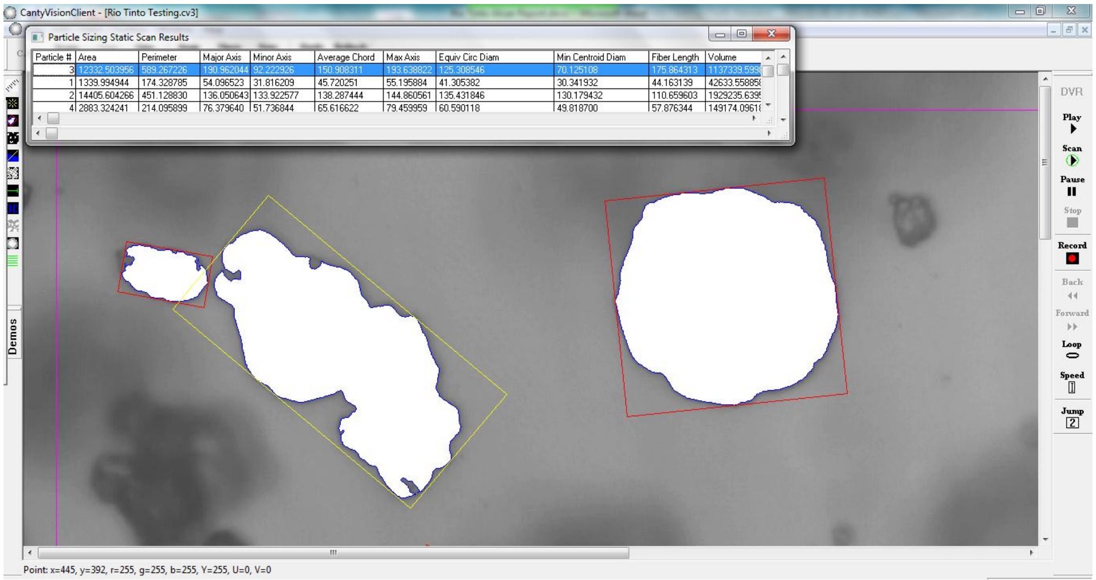



Figure 6 Snapshot image of software interface analyzing particles

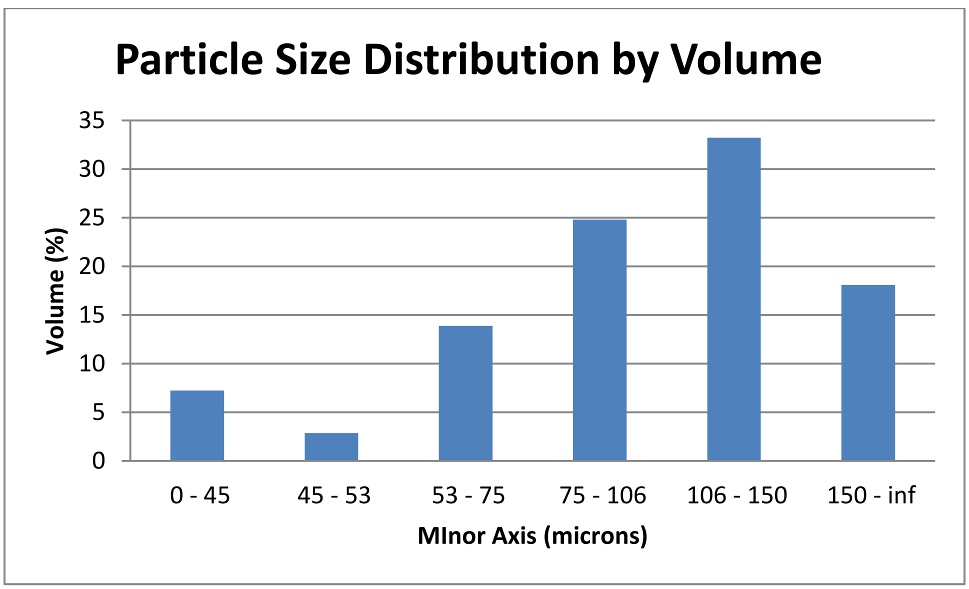



Figure 7 Particle size distribution of hydrates

| Hydrates | |
|---|---|
| Dv10: | 52.6717 |
| Dv20: | 70.4697 |
| Dv30: | 82.633 |
| Dv40: | 96.0142 |

| | |
|---|---|
| Dv50: | 107.344 |
| Dv60: | 116.407 |
| Dv70: | 130.747 |
| Dv80: | 147.661 |
| Dv90: | 163.312 |
| Dv100: | 207.949 |

| **Hydrates** | **Size (microns)** |
|---|---|
| Mean Major Axis (Particle length): | 24.251 |
| Min Major Axis: | 0.978772 |
| Max Major Axis: | 268.003 |
| Mean Minor Axis (particle width): | 18.3465 |
| Min Minor Axis: | 0.489386 |
| Max Minor Axis: | 207.949 |

### 3.3 Bauxite

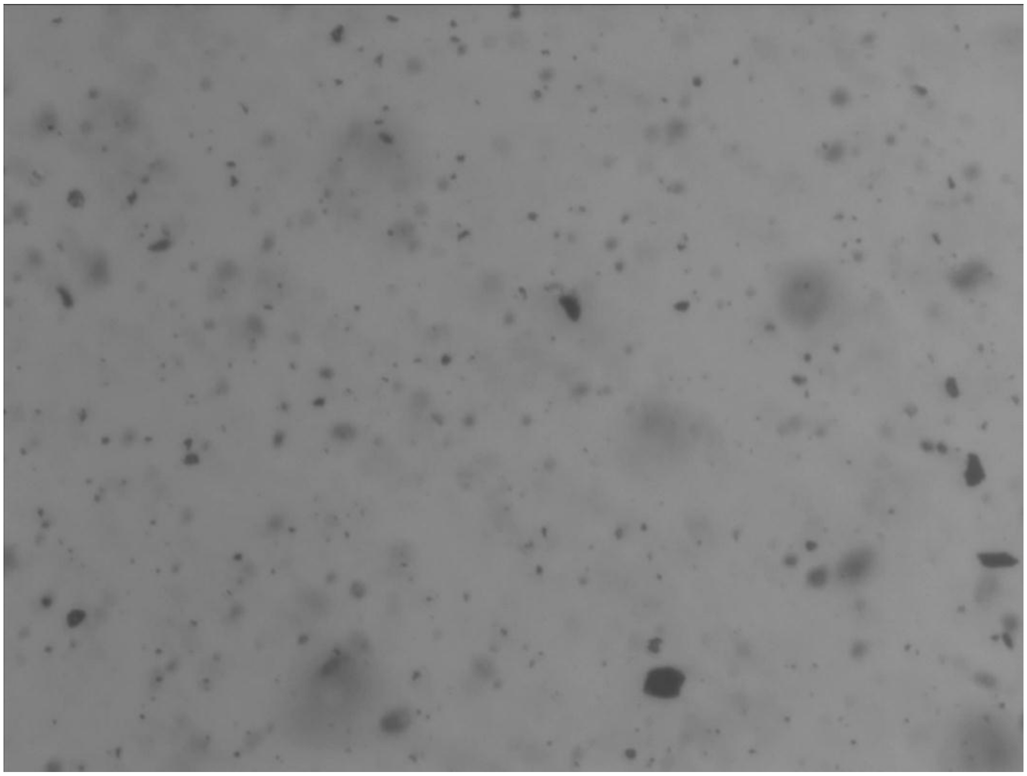


**Figure 8 Live image of bauxite particles (approx 2% wt.) Pixel Scale Factor 0.48mpp**

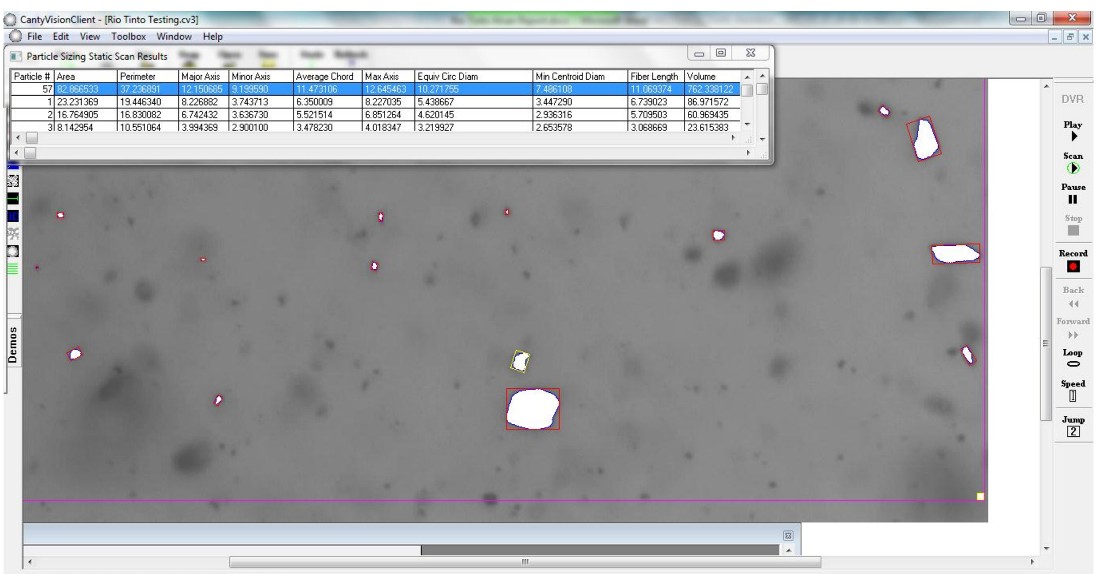



**Figure 9 Snapshot image of software interface analyzing particles**

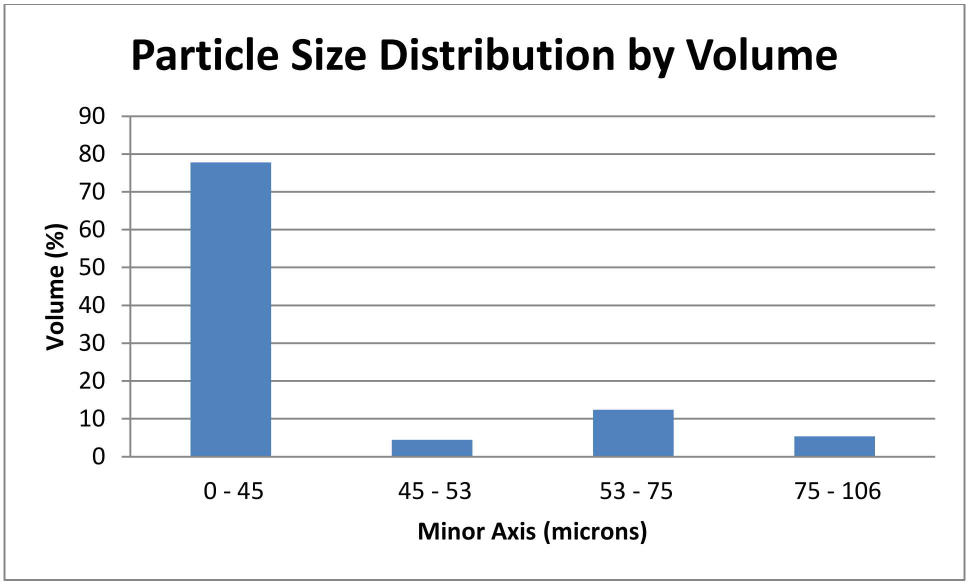



**Figure 10 Particle size distribution of Bauxite**

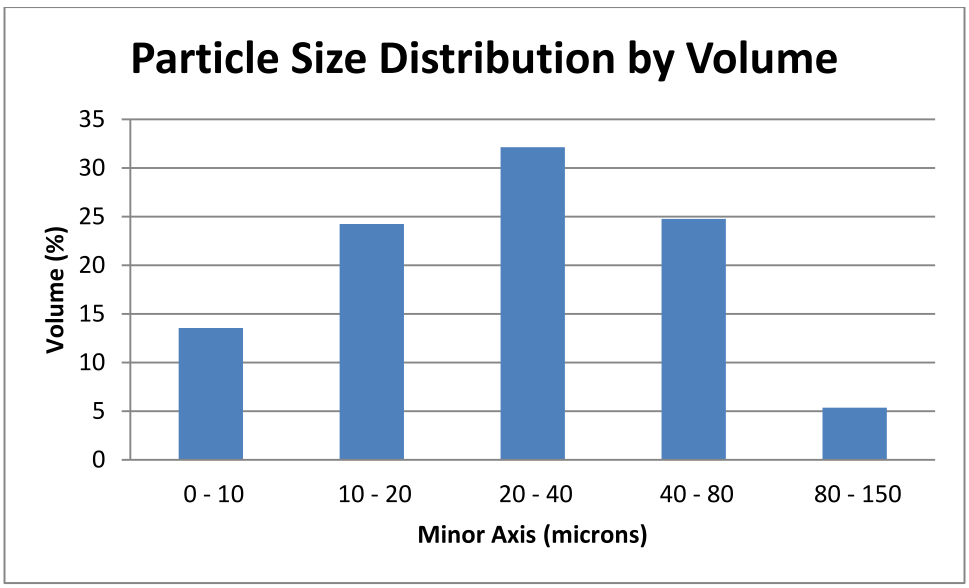



**Figure 11Bin sizes reduced**

| Bauxite | |
|---|---|
| Dv10: | 8.57968 |
| Dv20: | 12.7141 |
| Dv30: | 16.4426 |
| Dv40: | 21.1437 |
| Dv50: | 26.4276 |
| Dv60: | 31.7398 |
| Dv70: | 39.6616 |
| Dv80: | 47.4704 |
| Dv90: | 60.8118 |
| Dv100: | 81.5552 |

| Bauxite | Size (microns) |
|---|---|
| Mean Major Axis (Particle length): | 8.3191 |
| Min Major Axis: | 0.978772 |
| Max Major Axis: | 128.541 |
| Mean Minor Axis (particle width): | 5.84628 |
| Min Minor Axis: | 0.835434 |
| Max Minor Axis: | 81.5552 |

### 3.4 Redmud (Q4 2011)

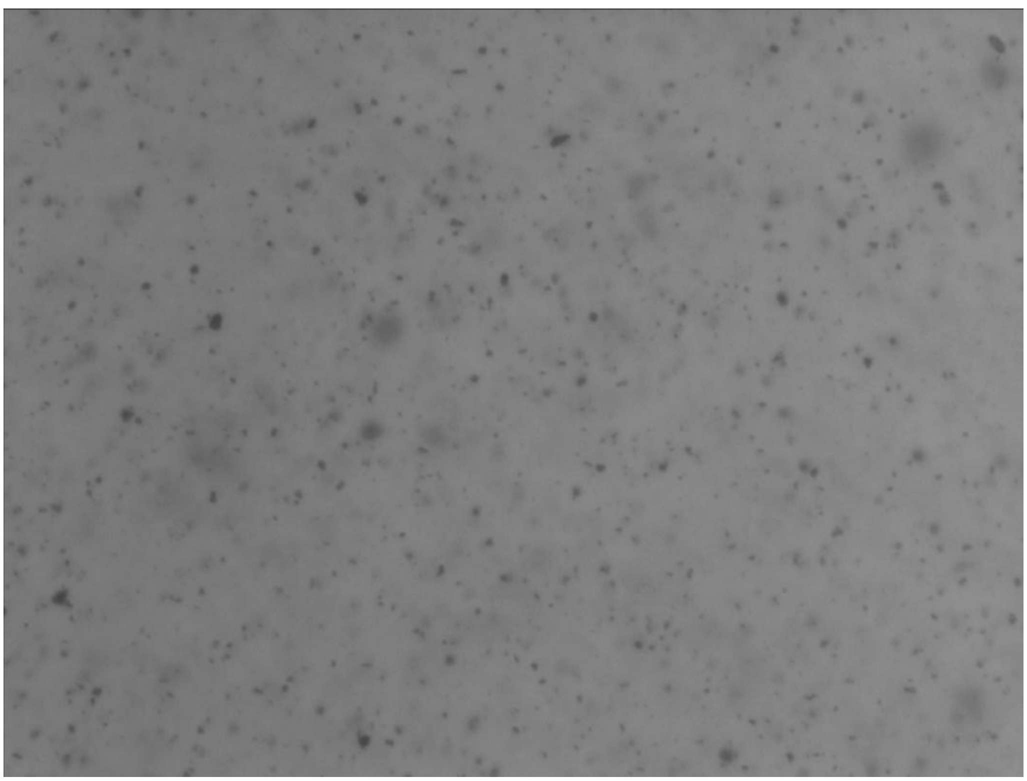


Figure 12 Live image of redmud particles (approx 2% wt.) Pixel Scale Factor 0.48mpp

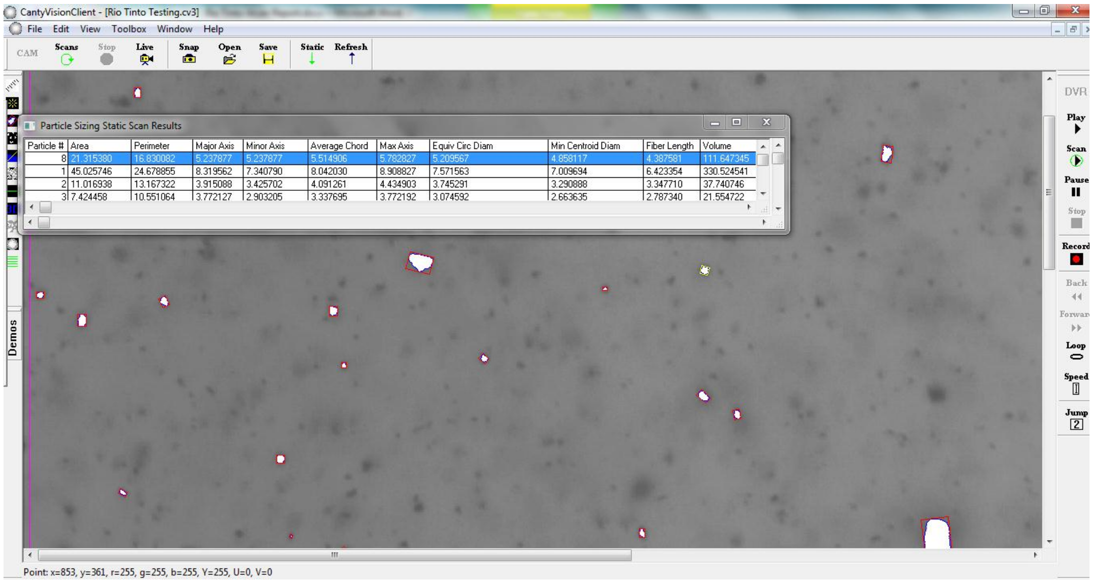



Figure 13 Snapshot image of software interface analyzing particles

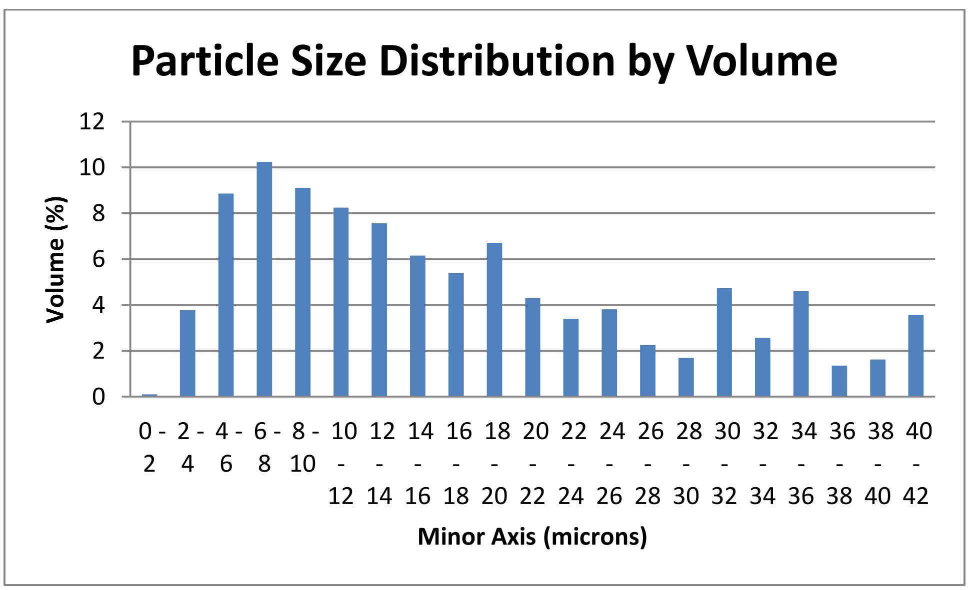



Figure 14 Particle size distribution of redmud (all under 0-45 micron bin)

| Redmud | |
|---|---|
| Dv10: | 5.38339 |
| Dv20: | 7.34099 |
| Dv30: | 9.48691 |
| Dv40: | 11.9094 |
| Dv50: | 14.7473 |
| Dv60: | 18.0249 |
| Dv70: | 21.5332 |
| Dv80: | 27.8933 |
| Dv90: | 34.74 |
| Dv100: | 41.3408 |

| Redmud | Size (microns) |
|---|---|
| Mean Major Axis (Particle length): | 6.88722 |
| Min Major Axis: | 0.978772 |
| Max Major Axis: | 63.615 |
| Mean Minor Axis (particle width): | 5.05014 |
| Min Minor Axis: | 0.489386 |
| Max Minor Axis: | 41.3408 |

## 4. Discussion

The dynamic imaging based technique for particle sizing supplied high quality images of the numerous samples suspended in water.

The Portable InFlow Particle Sizing System coupled with the CantyVision Client software shows the ability to accurately measure particle size correlating to manual sieve analysis. Data can also be plotted based on major axis, average chord length in order to correlate with other existing lab methods used. The Canty imaging system outputs a true measurement (length and width) of the particles, filtering out air bubbles and allowing to view shape parameters such as aspect ratio and circularity that can be crucial to a process.

This vision based technique provides the operator with an unparalleled view into the process, which allows the user to better understand what is happening within the pipeline. Both the laboratory TruFlow, portable InFlow and online InFlow systems are optically identical, allowing for consistency between results in the laboratory, at-line and on-line.