CASE STUDY

FlowCam®

FlowCam for Manufacturing and R&D Fluid Cleanliness Measurement

THE CUSTOMER

Hunting Energy Services (HES), Subsea Technologies Division, is a manufacturer of subsea hydraulic products for the oil and gas industry. Their suite of hydraulic valve products includes applications for drilling control, production control, and Intervention Workover Control Systems (IWOCS).

As part of their commitment to excellence in manufacturing, HES uses SAE standard AS4059 to assure the cleanliness of testing and flushing fluids to improve the overall quality of their equipment. While adherence to this standard is not mandatory, it is accepted and often demanded by their customers. This in turn helps ensure that their products function properly to avoid costly malfunctions during subsea operation.

PARTICLE ANALYSIS CHALLENGES

There are times during qualification testing when HES would intentionally contaminate test fluids with extreme levels of ISO 12103-1 Test Dust, per customer requirements, to see if valves or couplings would malfunction. During one of the qualification tests, they sent out fluid samples for testing at a local lab using laser diffraction technology. When they received the results back from the outside lab, they were not convinced that the data was entirely correct. They suspected that the laser diffraction analysis was missing some of the larger particles.

HES then decided to try FlowCam's particle imaging technology. They were curious to know how the laser diffraction results compared to the FlowCam results. Initial results, shown in Table 1, showed that laser diffraction recorded no particles >65 µm, while FlowCam detected particles at that size range and even >100 µm.

Bin Size (um)	Laser Diffraction (p/ml)	FlowCam (p/ml)	% Diff
> 6	18,963	21,484	13.3%
> 14	3,152	9,575	203.8%
> 21	1,526	6,644	335.4%
> 38	390	3,011	672.1%
> 70	0	748	Undefined

Table 1. Initial comparison of laser diffraction and FlowCam data for HES test fluids

"FlowCam has provided us much better particle information on our fluids analysis over laser diffraction and manual microscopy methods."

Chris Roy, Engineering Manager

The technology used in laser diffraction (like other non-imaging technologies) converts all particles to an equivalent spherical diameter (ESD). In certain cases, long fibers would be counted as small spheres. And in other cases, translucent particles were missed entirely. Laser diffraction is not a reliable source for registering and sizing particles with a low aspect ratio. HES realized that the technique they had been using was vastly undercounting some kinds of particles and missing others entirely. Their outsourced technique of laser diffraction could not differentiate between solids, fibers, and air bubbles. Additionally, this technique required considerable dilution, rates up to 100:1 to function properly. FlowCam could run the sample without any dilution.

One of the advantages of using FlowCam is that HES could implement size bin filters to count and categorize particles of different sizes in conjunction with the AS4059 requirements. FlowCam was able to immediately provide count data for particles in each of the size bins (Table 2). Additionally, they could create a filter to recognize and exclude air bubbles in the wash water that would skew the particle count unnecessarily.

Based on the data in Table 3, laser diffraction revealed no particles above 70 µm in size. Without images to back up the data, operators who rely solely upon laser diffraction might never know what they're missing.

Summary Stats | Filters | Cumulative Stats | Context Summary

Filter	Count	Count %	Volume %	P/ML	PPM
> 6 um	1508150	78.8715	99.9319	21484	725
> 14 um	672170	35.1524	99.3059	9575	721
> 21 um	466367	24.3895	98.1929	6644	713
> 38 um	211344	11.0526	91.7237	3011	666
> 70 um	52490	2.74506	69.2928	748	503

Table 2. HES's FlowCam results show 748 particles greater than 70 µm.

Bin		Size	Total counts /cc	Counts percent	Surface area percent	Volume percent
1	>	4(c)	23,900.00	100.00%	100.00%	100.00%
2	>	6(c)	18,963.60	79.35%	98.73%	99.88%
3	>	14(c)	3,152.45	13.19%	76.28%	94.49%
4	>	21(c)	1,525.85	6.38%	64.21%	88.35%
5	>	38(c)	390.33	1.63%	33.15%	57.21%
6	>	70(c)	0.00	0.00%	0.00%	0.00%
ISO 11171		Class:	22/21/19			

Table 2. HES's laser diffraction results show size bins of particles as required for SAE standard AS4059. Indications show no particles greater than 70 µm.

THE ADVANTAGES OF FLOW IMAGING MICROSCOPY

Particle imaging with FlowCam provides a more accurate analysis of the particles because it is a direct measurement technology. FlowCam does not make any assumptions about the spherical shape of any particle, nor does it take any indirect measurements of any particle based upon shadows, diffraction, or reflection. In addition, all particles can be verified directly since all particles can be viewed individually. FlowCam particle imaging is thus a more trustworthy particle measurement technology for use in mission critical particle cleanliness applications.

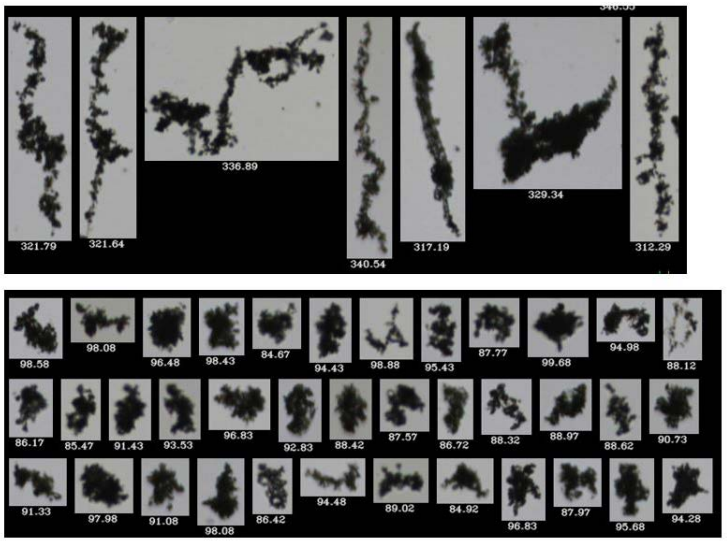

Figure 1. HES's FlowCam digital images of particles greater than 90 µm (bottom) and greater than 300 µm (top) that were missed entirely by laser diffraction