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Application Note

Particle Sizing to Understand Filtration Performance

Introduction

Filtration processes are widely used in many industries, for example, waste, water treatment, oil and gas, automotive, food and pharmaceutical industry. Monitoring particle size distribution allows understand better filtration performance. Filtration efficiency can be determined by comparing particulates before and after filtration. The number of particles removed as a percentage of the particles present before the filtration process gives the percentage of efficiency.

Using the Coulter Principle, also known as Electrical Sensing Zone (ESZ), the Coulter Counter provides particle size distribution in number, volume and surface area in one measurement, with an overall sizing range from 0.4µm to 1600µm. The measurement is unaffected by particle colour, shape, composition or refractive index.

The Coulter Principle

Particles suspended in a weak electrolyte solution are drawn through a small aperture separating two electrodes through which an electric current flows. The voltage applied across the aperture creates a “sensing zone”. As each particle passes through the aperture (or “sensing zone”) it displaces its own volume of conducting liquid, momentarily increasing the impedance of the aperture. This change in impedance produces a tiny but proportional current flow into an amplifier which converts the current fluctuation into a voltage pulse large enough to measure accurately.

Each aperture can be used to measure particles within a size range of 2 to 80% of nominal diameter. For example, a 30 µm aperture can measure particles from about 0.6 to 18 µm in diameter. A 100 µm aperture can measure particles from about 2 to 60 µm. If the particles to be measured cover a wider range than a single aperture can measure, two or more apertures must be used and the test results can be overlapped to provide a complete particle size distribution.

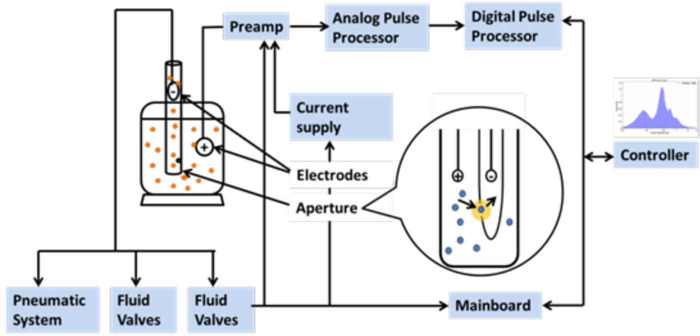

Figure 1: Schematic of a Coulter Counter

The Coulter Principle states that the amplitude of this pulse is directly proportional to the volume of the particle that produced it. Scaling these pulse heights in volume units enables a size distribution to be acquired and displayed. In addition, if a known volume of the particle suspension passes through the aperture, a count of the number of pulses will yield the concentration of particles in the sample.

Significance

In the Oil & Gas industry, a reliable filtration system is critical to the operational performance that process petroleum products. Optimising the filtration system can increase process performance, decrease downtime, lower maintenance costs and improve operating efficiencies. The Multisizer 4 Coulter Counter can be used to conduct analysis of filters to evaluate filtration effectiveness by determining the size distribution of particulates.

Examples

Figure 2 shows the size distribution of different filters samples. The results are represented as the number percentage. Comparing all the filters in Table 1, filter D

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shows the best performance which provides the smallest particle size distribution after filtration.

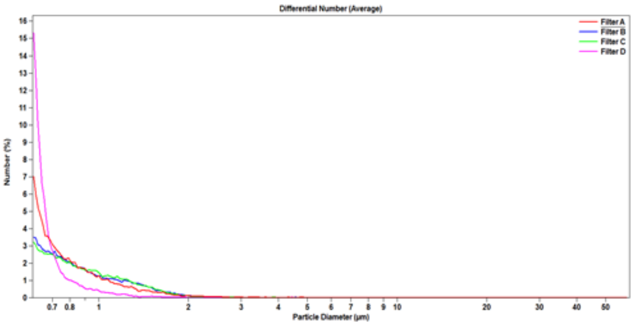

Figure 2: Comparision graph for different filter samples

Filter	D10 µm	D50 µm	D90 µm	<3µm
A	0.617	0.715	1.260	99.4%
B	0.631	0.820	1.396	99.5%
C	0.634	0.838	1.388	99.5%
D	0.607	0.646	0.876	99.5%

Table 1: Particle size distribution of different filter samples

To evaluate filter efficiency, Figure 3 shows particle size distribution of filter inlet and outlet. Particles larger than 3µm were removed effectively after filtration (Table 2).

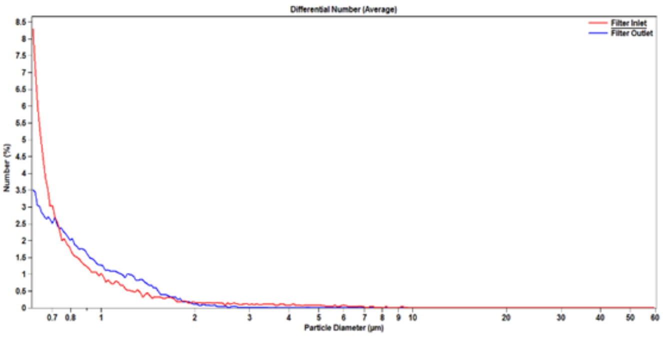

Figure 3: Particle size distribution of filter inlet and outlet

Filter	D10 µm	D50 µm	D90 µm	<3µm
Inlet	0.614	0.733	1.590	95.6%
Outlet	0.631	0.820	1.396	99.5%

Table 2: Particle size distribution of filter inlet and outlet

Conclusion

As the Coulter Principle is the highest resolution technology available for sizing and counting particles, it is an excellent tool for evaluating filter performance. Filtration process may also be monitored for specific size range and filtration efficiency may also be evaluated.

References

Beckman Coulter, The Coulter Principle (1954 - 1955).

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