

Particles or wear in lubricants are generally harmful

The ISO 4407:2002 states that the presence of particulate contamination in liquid interferes with its ability to lubricate and causes wear to the components. The level of contamination in the liquid has a direct correlation to the performance and reliability of the system, therefore particulate contamination should be held to an appropriate level in relation to the system concerned.

Enumeration and Size Detection of Particles with the Single Particle Explorer

A 100 ml hydraulic fluid was filtered through a 0.45 µm Cellulosenitrate Membrane. The filter was washed 3x with a 30 ml particle free (0.45µm pre-filtered) clean hydraulic fluid.

This membrane was evaluated by means of the qualified automated counting system, Single Particle Explorer (SPE) CSS, rap.ID Particle Systems. The integrated dark field and bright field illumination and imaging analysis were able to size and count 2 micrometer particles with a resolution of 10 Pixel/Particle. The shape / morphology of the particle was analyzed as well.

The SPE was designed to measure an Effective Filtration Area (EFA) with a diameter of 45 mm. The image thus provided information about the entire Particle Size Distribution. Data from 2µm up to several hundreds of micrometers were available and documented. The entire 45 mm Diameter was scanned with a resolution of 25 µm with 444 individual field of views. After this scan, the resolution was switched automatically to 2 µm and again 444 individual fields were scanned. Without further user interaction, the Particle Size Distribution software documented and generated reports based on the images of the largest 10 particles.

Results from the automated imaging analysis

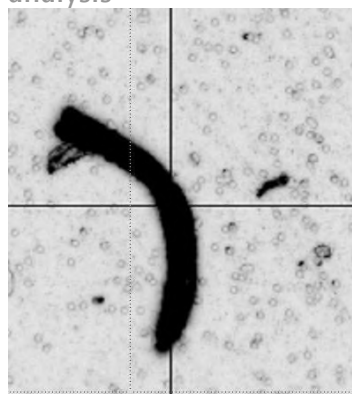


Fig.1: Image of a 175µm fibre, automatically documented separately as within the largest 10. (≥100µm)

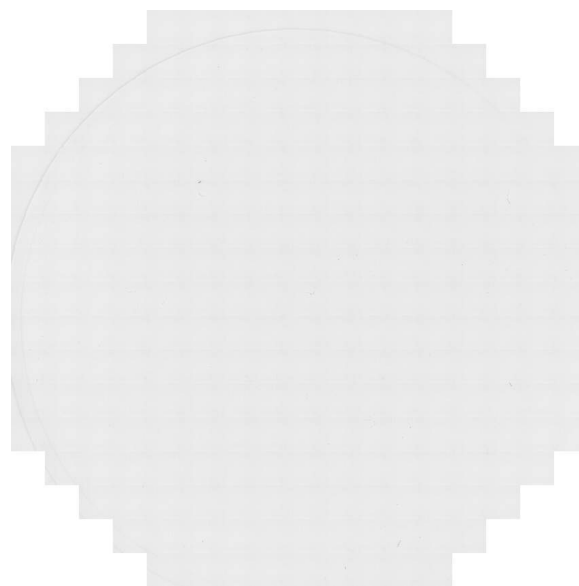


Fig. 1 shows a stitch image of the scan of the entire effective filtration area with a resolution of 25 µm.

The Single Particle Explorer scanned the entire EFA to find any particle larger than 25 µm in just 7 minutes finding 125 particles in that particular size range. Only a smaller area of 400 fields (10 x 10 mm) of the entire filter was scanned to determine the particles larger than 2 µm. Revealing the presence of 4158 particle in that size range.

The calculations were obtained in a fully automated fashion in order to create the following table. The report was written by the system and documented in an encrypted file format ensuring the validity of the raw data according to the Code Federal Regulations 21 CFR Part 11 of the US authorities.

Table 1: Particle count per 100 mL

≥ 2 µm	≥ 5 µm	≥ 15 µm	≥ 25 µm	≥ 50 µm	≥ 100 µm
4158	2154	478	125	31	9

Fibres: 1

Benefits

The Single Particle Explorer (SPE) CSS gives one fast and easy access to the total number of contaminants in a hydraulic oil sample. The total sample was characterized in just 14 minutes.

This mode of operation ensured that no large particle was lost. The statistical counting procedure minimized the chance of failure by assuring no overestimation of the number of large particles. By applying the statistical counting procedure on a smaller portion of the filter, one can ensure that the size limit of 2µm of the ISO 4407:2002 is met with a sufficient resolution of 10 Pixel / Particle within just 7 minutes. Fibres were recognized due to a customized elongation limit.

Overall the system delivers reliable reports according to the ISO 4406:1999 procedure within a short time.