

Single Particle Optical Sizing



Key Features:

- Sample-to-sample analysis time of ~45 seconds
- Uses less than 1 mL of lubricant sample per analysis
- Smallest automated particle counter footprint in the industry
- Hyphenates seamlessly with ICP-OES for elemental analysis

LPC 500 Liquid Particle Counter

Introduction

The LPC 500™ Liquid Particle Counter is a single particle optical sizing (SPOS) system designed to count and size particles individually with high resolution. SPOS technology is engineered to detect individual particles passing through a very thin “optical-sensing zone”. When used for in-service oil samples, only 3 to 4 mL of 10x diluted samples are typically needed, offering reproducible results between high- and low-viscosity samples, while minimizing washout requirements and solvent waste.

LPC 500 Hardware

The LPC 500 system consists of three components: optical sensor, multi-channel pulse analyzer (MPA), and software controller. During an analysis, liquids are passed through the optical sensor for detection leading to the output of voltage pulses that are converted by the MPA to a particle size distribution (PSD). The resulting high-resolution PSD is displayed in real time in the LPC 500 software: absolute counts versus diameter for each channel (8 to 512), logarithmically spaced over the total size range covered by the optical sensor (0.5 to 400 microns). Additional derived distributions (both differential and cumulative) – based on number, area and volume weighting – are calculated from the measured population distribution.



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LPC 500 Optical Sensor

The LPC 500 optical sensor uses the technique of single particle optical sizing (SPOS). This technique is used to detect individual particles in a certain size range as each passes through a very thin "optical-sensing zone". There are two physical methods that traditionally have been used to implement the SPOS technique – Light Extinction and Light Scattering:

- Light Extinction (LE) Method: This method is based on a measurement of the decrease in the intensity of light transmitted across a flow channel carrying particles suspended in a fluid, caused by the momentary passage of an individual particle through the light beam.
- Light Scattering (LS) Method: This method is complementary to the LE method. It measures the increase in the intensity of light caused by scattering from particles which pass through the optical-sensing zone.

Combination Method – Light Extinction PLUS Light Scattering: A newly developed, hybrid design (U.S. patent US5835211A) combines the advantages of the LE method (large size range and relative insensitivity to particle composition) with those of the LS method (high sensitivity – lower diameter limit). This is achieved by electronically combining the LE and LS signal responses, so that a single "summation" signal pulse is produced when a particle passes through the optical sensing zone of the sensor.

LPC 500 Multi-Channel Pulse Analyzer

The MPA is used to detect each pulse produced by the optical sensor, measure its height (whether in Extinction or Summation mode), and determine the particle diameter associated with this value by fast interpolation between points in the sensor calibration curve. An additional "count" is then added to the diameter "channel" which contains this particular particle size. The processing electronics perform this task at a high rate of speed, permitting particle counting/sizing rates in excess of 10,000/sec.

Available Configurations

The LPC 500 is offered in two configurations: A hyphenated configuration coupling the LPC 500 with the Avio® 500 ICP-OES Oils system for combined wear metals and particle counting as well as a standalone LPC 500 for particle counting only.

Hyphenated Configuration

The LPC 500 Liquid Particle Counter coupled with the Avio 500 ICP-OES Oils system enables the same diluted sample volume to be analyzed for both wear metals, particle counting and sizing. This technique provides sample-to-sample measurement times averaging 45 seconds and requires less than 1 mL of sample to be diluted using the same diluted sample prepared by the OilPrep™ Oil Diluter as for metals analysis without particle counting. All features and data outputs for the LPC 500 system have been integrated into Syngistix™ for ICP software. Particle counting can be enabled or disabled from method to method, and various reporting formats and particle count sizes can be selected for added flexibility.

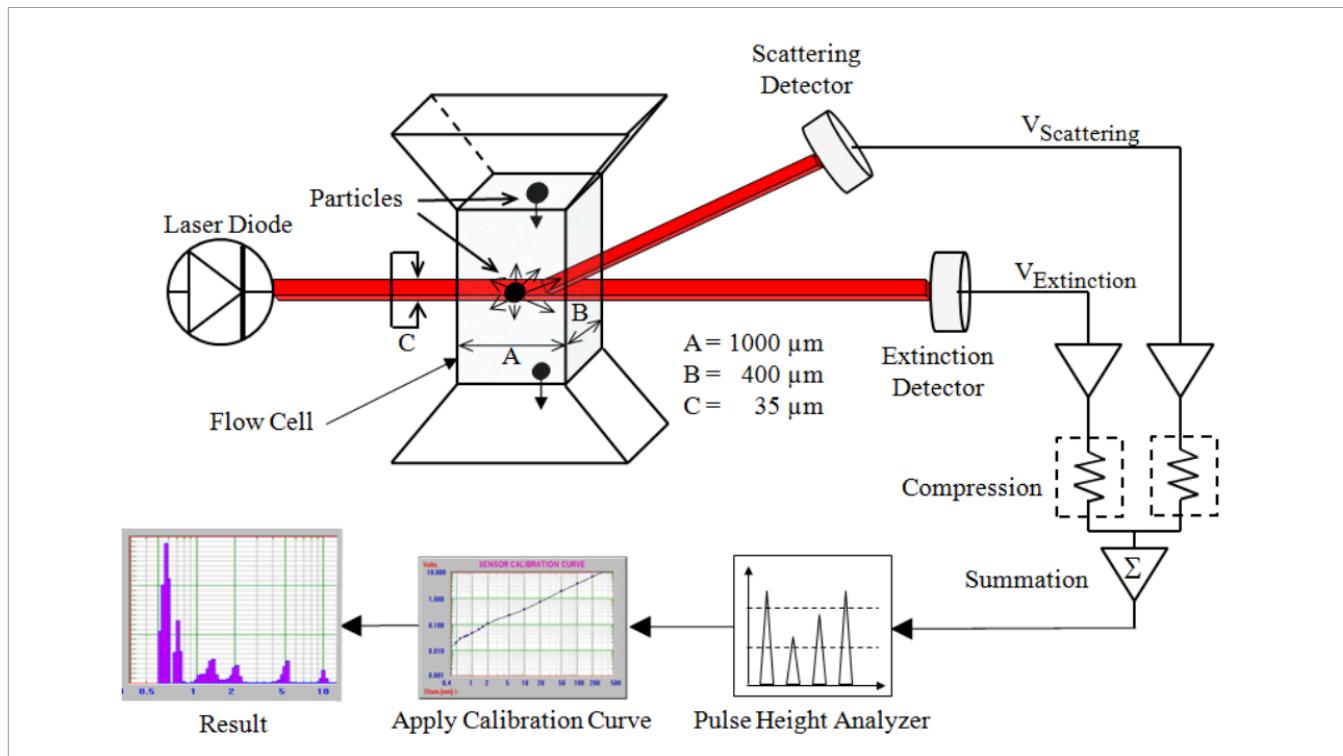


Figure 1. Schematic demonstrating the summation method of particle counting.

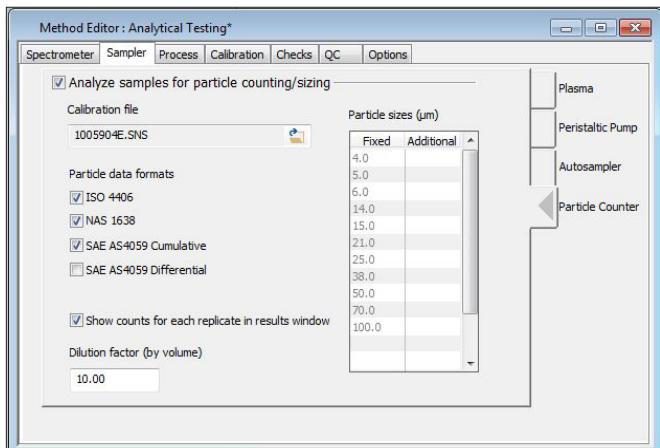


Figure 2. Particle counter parameters tab within Method Editor.

Results			
Particle Count Data: PQC			
Sample Dilution Factor: 10.00	Flow Rate: 20.00 mL/min		
Replicates: 2	Extinction Voltage: 5.8 V		
Time Per Replicate: 3 s	Analysis Time: 5/26/2019 7:31:14 AM		
Replicate Data			
Size/Class	Repl 1	Repl 2	
>4.0 μm (c)	1182	934	
>5.0 μm (c)	623	597	
>6.0 μm (c)	367	350	
>10.0 μm (c)	68	65	
>14.0 μm (c)	20	24	
>15.0 μm (c)	18	17	
>18.0 μm (c)	5	9	
>21.0 μm (c)	3	6	
>25.0 μm (c)	2	1	
>38.0 μm (c)	0	0	
>50.0 μm (c)	0	0	
>70.0 μm (c)	0	0	
>100.0 μm (c)	0	0	
Mean data			
Size/Class	Mean Counts	Concentration #/100mL	ISO4406 SAE AS4059 Cumulative NAS1638 SAE AS4059 Differential
>4.0 μm (c)	1058.0	1058000	21 11
>5.0 μm (c)	610.0	61000	
>6.0 μm (c)	358.5	358500	19 11
>10.0 μm (c)	66.5	665	66500
>14.0 μm (c)	22.0	22000	15 9
>15.0 μm (c)	17.5	175	17500
>18.0 μm (c)	7.0	70	7000
>21.0 μm (c)	4.5	45	4500
>25.0 μm (c)	1.5	15	1500

Figure 3. Results window showing particle counting results output.

As with other devices that couple with the Avio 500 ICP-OES, the LPC 500 Liquid Particle Counter is fully integrated into Syngistix software to provide real-time feedback. A separate wizard also provides easy export of particle data. This wizard is a quick and easy-to-use template for particle data export that can be used for automatic export at the end of the analysis sequence.

LPC 500 Counter Standalone Configuration

The LPC 500 can also be operated as a standalone particle counter offering sample-to-sample analysis times of 95 seconds, with the same reduced sample size and sample preparation. Unlike the hyphenated configuration, the standalone LPC 500 is controlled by a separate software package that allows for more customizability of the particle counting parameters. And last but certainly not least, the standalone LPC 500 counter boasts the smallest footprint of any automated standalone particle counter used for in-service oils analysis.

Summary

The LPC 500 Liquid Particle Counter provides sample throughput of approximately 45 seconds per sample, with less than 1 mL of sample used for diluted sample preparation. Plus, with its compact design, it is easily coupled with an Avio 500 ICP-OES Oils system, optimizing the use of valuable lab space.