Filter Testing

AccuSizer® SPOS System

Filtration is the removal of particles from a fluid. This application note will focus on the removal of solid particles from liquids. A common use of liquid particle counters is to asses the efficiency of filters to remove particles at various size ranges. Typical uses include upstream/downstream filter testing, laboratory testing of filtered fluids, and point of use (POU) monitoring. The Entegris AccuSizer® is used in many industries for all three purposes.

INTRODUCTION

Filtration is the physical or mechanical operation of removing solids from fluids (liquid or air) by passing the liquids through a medium (filter) that reduces the amount of particles present in the liquid. The fluid upstream of the filter is the feed, and the fluid that passes through the medium is called the filtrate, see Figure 1.

Many kinds of filter media including activated carbon, filter paper, cartridges, and diatomaceous earth are available for use. Different media have different efficiency at different size ranges, so the user must select the proper media for the desired particle removal.

One of the functions of hydraulic fluid power systems is to separate and lubricate the moving parts of the components. Solid particulate contamination produces wear, reducing efficiency, and component life. A hydraulic filter controls the number of particles circulating within the system, to a level required to match the desired system reliability. Testing of hydraulic filters is a common application for liquid particle counters such as the AccuSizer.

In the microelectronics industry CMP slurries are often filtered as part of their production process and during their use. It is believed that by using a filter the large particles that are formed during the process can be removed from the slurry, and the result will be no scratched wafers. In some cases, the lifetime of the filter is compromised and large particles form after filtration causing defects on wafers. Deciding when to change these filters based on actual particle count, rather than duty cycle or pressure, improves yield and can reduce filtration expense.

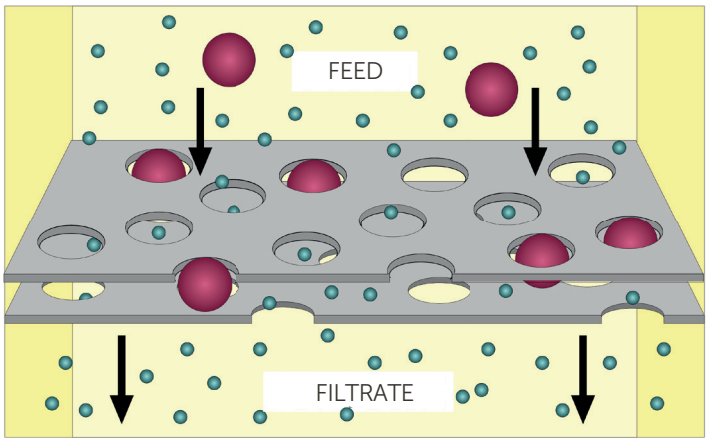

Figure 1. Simple filtration

The pigments formulated into inkjet inks are typically dispersed to small particle sizes (between about 50 and 200 nm, depending on the application) and need to be made colloidally stable. The size of the pigment particles is critical because large particles may plug the jets and channels, causing damage to the print head. Controlling the large particle content (>0.5 – 1.0 µm) requires having a technique that is sensitive to a small number of large particles – the tail of the distribution.

FILTER TESTING

Manufacturers and users of industrial filters routinely test filters during the design, manufacturing, and selection process to identify which filters best match a given application. A common approach to filter testing is to measure upstream and down-stream of a test filter, using two liquid particle counter sensors, see Figure 2. With the AccuSizer the customer can choose between a range of sensors depending on the size and concentration range of interest. The most common sensor for hydraulic fluid filter testing is the LE-400 sensor, with a range from 0.5 – 400 µm. The counter has up to 1024 size channels of resolution, far surpassing typical user requirements. Automatic dilution can be added to the feed sensor if required.

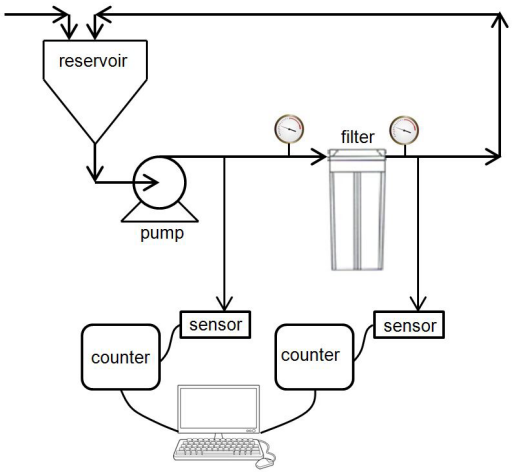

Figure 2. Filter test stand

The typical data interpretation of hydraulic filter testing, as defined in ISO 16889, is the filtration ratio (or Beta ratio) as defined in the equation below where x(c) is a specified particle size.

$$\beta\ x_{(c)} = \frac{\text{number of particles upstream @x (c) µm}}{\text{number of particles downstream @x (c) µm}}$$

Example: at 5 µm the filtration ratio can be expressed as a simple ratio or by subtracting 1 and multiplying by 100.

$$\beta\ 5\,(c) = \frac{6000}{200} = 30 \text{ or } \left(\frac{30 - 1}{20}\right) X\ 100 = 96.7\%$$

CMP SLURRY

The AccuSizer is used in labs and in processes around the world, to monitor CMP slurry health and to optimize filtration to minimize surface defects. Figure 3 shows AccuSizer particle count data upstream (blue) and downstream (red) of the filter.

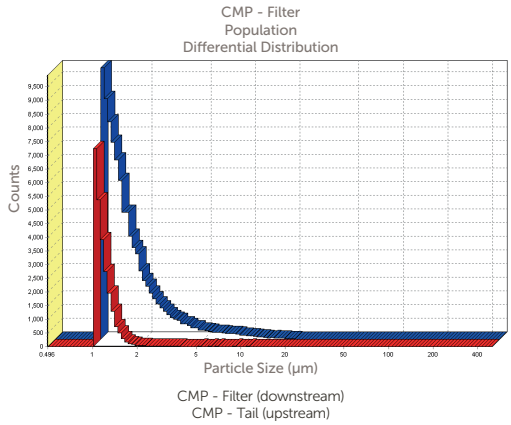

Figure 3. CMP Slurry upstream/downstream of filter

INKJET INKS

Figure 4 shows the results of a filtration test, in which an inkjet ink is filtered using a 2 micron and 5 micron filter. Both filters show an improvement in the concentration of particles >1 micron. The unfiltered sample contained >100,000 particles/mL greater than 1 micron, while the 5 micron and 2 micron contained ~70,000 and ~20,000 particles/mL respectively.

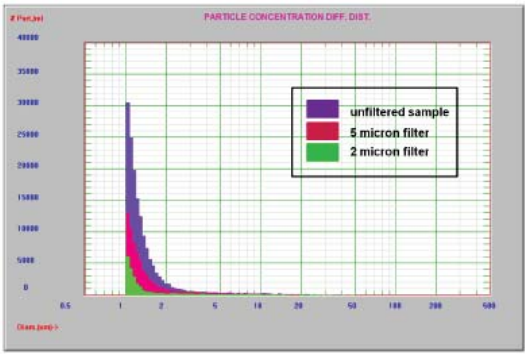

Figure 4. Inkjet ink unfiltered and filtered at 5 and 2 µm

CONCLUSIONS

The AccuSizer is an ideal system for testing filters and performing a wide range of filtration efficiency experiments. The sensors, based on single particle optical sizing (SPOS), have the widest size and concentration range specifications available. Contact your Regional Customer Service Center to see how we can match our technologies to your application requirements.

FOR MORE INFORMATION

Please call your Regional Customer Service Center today to learn what Entegris can do for you. Visit entegris.com and select the Contact Us link to find the customer service center nearest you.

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