The Filtration Society:
The importance of testing and standards

Graham Rideal, Science Correspondent for The Filtration Society, shares an overview of the recent technical seminar and exhibition held by the Society, with a particular focus this year on the importance of standards and testing.

Of all the technical seminars hosted by The Filtration Society over the last 40 years, filter testing has always created the most interest and the recent one-day international seminar and exhibition held in the historic city of Chester was no exception.

It is not too difficult to see why there is such an interest. Filter Testing and pore size measurement in particular underpin the entire subject of filtration in all its diversifications.

Process or environmental improvements?

Traditionally, the driving force has been in the development of new filter media and filter processes but increasingly environmental issues are placing fresh demands on filter performance.

It's interesting that, in the formation of the United States of America, territorial disputes were predominantly based on access to water. Today, although we may think that nuclear proliferation is the single biggest threat to our world, the availability of fresh drinking water could easily be the catalyst for the next major human conflict.

For example, a country up stream could decimate the population of a downstream neighbour if they paid no regard to water pollution.

Similarly, the lack of adequate air filtration could pollute a country the other side of the world if the pollutants were allowed to escape into the atmosphere. An example here is the catastrophic disintegration of the Chernobyl nuclear power station in the 80's where radio active particles found their way several thousands of miles away in the mountains of Wales resulting in dangerous levels of radiation in sheep.

The lamb industry was devastated for several years until the radioactivity was eliminated from the food chain.

Filtration is unique in that it is one of the few scientific disciplines that has a direct correlation to the health of the planet.

Testing and standards

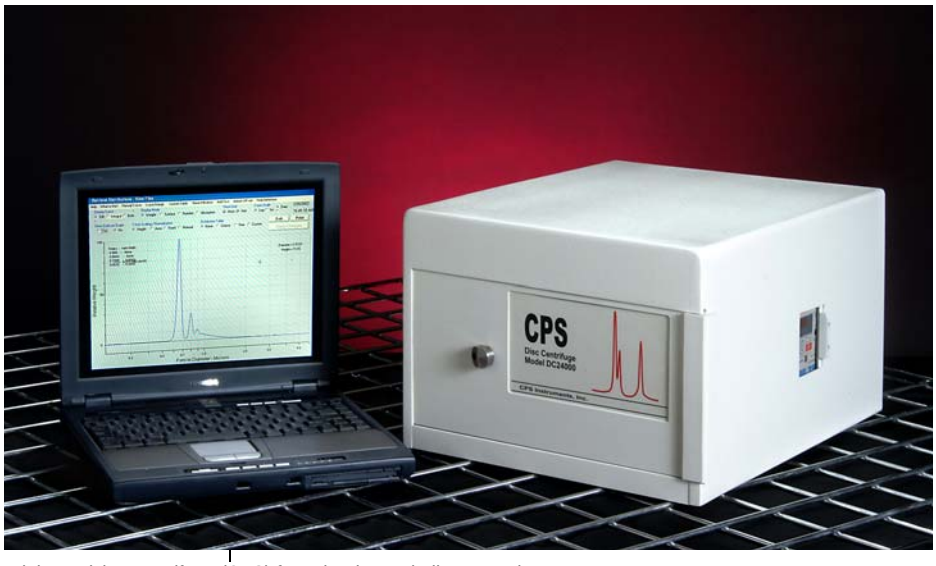
The mechanism of filtration depends largely on the application of the filter. For example, electrostatic precipitators in coal fired power stations have plates separated by hundreds of millimetres, yet can trap micron sized particles.

It is convenient therefore to split the study of filter testing into wet and dry applications.

In the Filter Testing seminar, Christophe Peuchot of IFTS, France and Stephen Smith of Parker Domnick Hunter (UK) reviewed the current ISO status for wet and dry applications respectively.

It was notable that in both areas, not only are the number of new standards are being increased year on year but within the standards, much higher precision is being demanded in the characterisation and measurement of the particulate contaminants.

Credit must be given to those sitting on the ISO committees for all the hard work, but their task is made even more difficult by the necessity to quantify the specifications laid out in the standards.



High precision centrifuge (CPS) for sub-micron challenge testing

The 140 micron '5 micron' filter

In the field of compressed air filters for example, standards were written many years ago for the performance of a 5 micron filter. Unfortunately at the time, the 5 micron target was more hopeful than metrologically precise. Nevertheless, the '5 micron' filter entered the nomenclature of the day.

When the so-called '5 micron filter' was eventually calibrated by precision calibration microspheres, it was found to have a cut point of 140 microns!

Porometry and Challenge testing

The two main methods of measuring pore size are Porometry and Challenge Testing.

In the former, the pores of a filter under test are sealed with a wetting liquid and a compressed gas applied on the undersize at increasing pressures. The largest pore has the lowest surface tension and so will be the first to be blown free. This corresponds to the 'Bubble Point'.

As the gas pressure is gradually increased, smaller and smaller pores are cleared resulting in an increasing flow rate through the filter. By plotting flow rate against applied pressure, it is possible to derive a pore size distribution in the filter.

The technique is most suitable for quality control purposes but the theory assumes cylindrical pores so variations can occur depending on the shape of the pore. Furthermore, unless prescriptive operating procedures are employed, there can be variations in results between different manufacturers and in some cases, the same instrument manufacturer used on different sites.

The Challenge Test is more of a primary or absolute method, although it too is not without its limitations. As the name implies, a filter surface is 'challenged' with a variety of test dusts. The largest particle passing the filter corresponds to the maximum pore size.

As in Porometry, 'shape' can also be an issue. In this case however, it is not the shape of the pore, but the shape of the particle that is critical. The filtration through a filter then depends on the solution to a 3-dimensional 'jig-saw' puzzle, where particle shape and orientation as well as 'size' are all important to the efficiency of the filtration process.

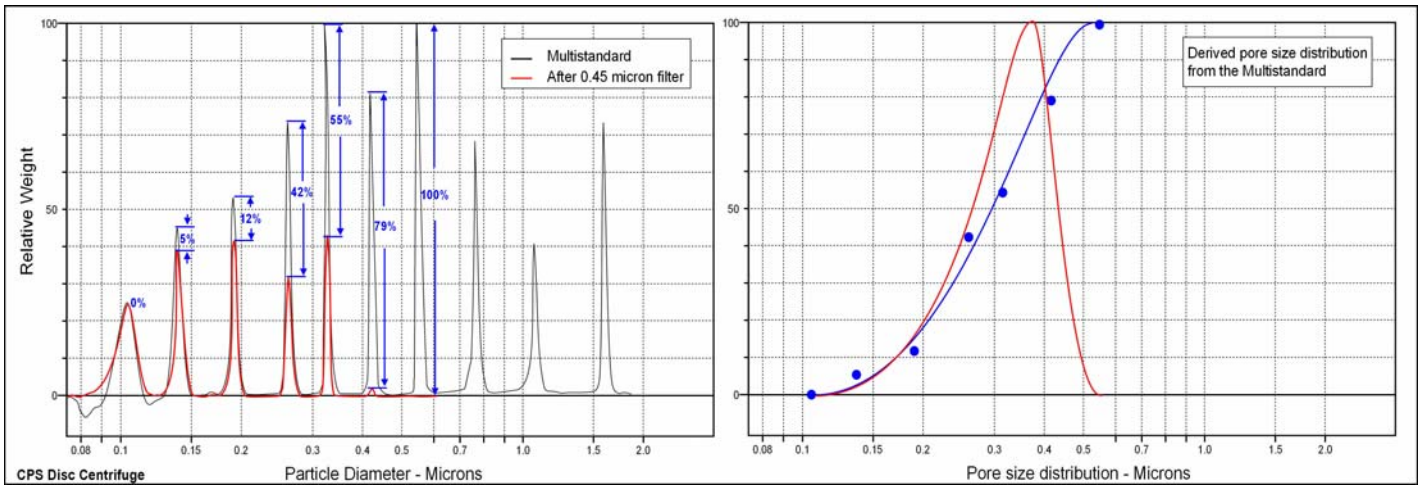
Fact or Fiction

A very enlightening paper from Keith Brocklehurst of LGC entitled 'Particle size – Fact of Fiction' investigated many of the misconceptions associated with particle size and shape measurements.

The only object with a single parameter is a sphere, so to minimise uncertainties, challenge testing is ideally performed with single size spherical particles. However, monodisperse latex particle size standards can be prohibitively expensive for challenge test applications.

Non-spherical, polydisperse reference standards will always introduce errors and therefore uncertainties, both in their analysis and use in challenge testing. This was exemplified by Christophe Peuchot, who prepared a liquid suspension of a test dust and, after careful subdivision into bottles of several hundred millilitres, sent them off to a leading international standards laboratory for certification.

Rather than accurately sub-sampling the large bottles using a precision subdivider, the bottles were simply shaken and sampled using a pipette. The uncertainty of measurement was then greater than that proposed in the ISO standard to which it was to be applied.



Old is new

Accurate size analysis is critical as the pore sizes descend into the sub-micron and especially into the nanometre size range. There are few analysers that can span these ranges with high precision, but the revision of an old centrifugal method now offers groundbreaking resolution.

Hiran Vigad (Analytic) introduced the CPS Disc Centrifuge, capable of measurements from 80 microns down to 3nm. In combination with a new 'multimodal' standard comprising of 10 individual peaks from 1.5 microns down to 0.1 microns, Whitehouse Scientific was able to obtain pore size distributions as well as the traditional cut points from this new 'Multistandard' using the challenge test method.

Scintillating

The most recent revolution in submicron particle analysis was presented by Bob Carr of NanoSight. In this novel technique, particles in suspension are scintillated by laser light on a microscope stage and their movements individually tracked.

The technology of laser-Doppler particle tracking has now been enhanced to a high- resolution technique using advanced software and offers a new solution to submicron challenge testing. It is of particular interest in the pharmaceutical industry because of its ability to detect extremely low levels of contaminants.

A review on particle counting and measurement in air was provided by Philip Wilson of PMT who described a range of both portable and laboratory based instruments capable of precision analysis of particle size and concentration down into the sub-micron region.

Calibration standards

The recent advances in Challenge Testing have enabled much more meaningful comparisons to be made with Porometry. Whitehouse Scientific presented an interesting review on the latest spherical filter calibration standards and compared the results of challenge testing with Porometry. As indicated above good comparisons were only possible when there was rigorous attention to detail in each of the methodologies.

It was encouraging to see three of the latest Porometers represented at the conference: from Topas, Benelux Scientific and Porvair. These instruments are a welcome addition to Porometry measurements and give the end user a much greater level of sophistication and choice.

The next stage in their development is the very important subject of calibration. Tecan, a leading manufacturer of Electroformed sieves, discussed the manufacture of single size square pores in 25mm discs. With apertures down to 3 microns and variations of less than 0.5 microns, these standards represent a significant advance in the certification of Porometers, which will enable absolute comparisons to be made between the pore size measurements obtained from various instruments.

Attractive filters

While the physical size of pores in a filter may relate to filter performance, this is not always the case as indicated above, it therefore was very informative to have a number of companies presenting an investigation into the performance of filters and filtration systems.

The electrostatic characteristics of a filter can often be overlooked. In dry filtration, the mechanism of particle capture may be a function of particle attraction to the filter medium rather than the geometric size of the pores. The selection of the material of construction can therefore be of paramount importance.

One of the first quantitative solutions to this problem was through an instrument developed by Anton Paar capable of measuring the Zeta Potential of filter surfaces. This new technology will undoubtedly play a major role in filter media selection in the future.

What contaminants?

IMAS specialise in the automatic scanning of contaminants on a filter surface and showed a very powerful system for particle recognition, counting and shape analysis. Understanding the type, size and nature of particular contaminants or pollutants is very important in formulating the correct filtration systems for their capture.

Proof of the pudding

Designing a filter to capture or trap specific particles or contaminants is just the first stage in building a functioning filtration system. The ultimate question is, 'Will the filter medium work in real life situations'? To answer this question, test rigs must conform to specific designs laid out in the relevant standards.

To conclude the conference, a very comprehensive coverage of filter test rigs, which comply with the various ISO standards was presented by Palas, TSI, IFTS and Topas.

Given the comprehensive range of subject matter presented, it is perhaps not surprising that the conference and exhibition attracted record numbers of attendees. The plenary speakers (Christophe Peuchot and Stephen Smith) were ably supported and exemplified by other leading experts in their field but one of the most stimulating sessions was the Poster presentations where there the 5 minute 'bursts' of highly relevant information produced a 'standing room only' level of attendance.

With such powerful tools at our disposal, filtration will undoubtedly take major technological steps forward in the next few years, not only for the benefit science and industry but the world and our environment as a whole.

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Notes from the seminar are available via www.filtsoc.com