THE AUTHOR
Dr Graham Rideal is managing director of Whitehouse Scientific and chairman of The Filtration Society.
T: +44 (0) 1244 332626. e: rideal@WhitehouseScientific.com

Shape analysis gets recognised

Image analysis is getting the attention it deserves by unlocking fine detail in particle metrology

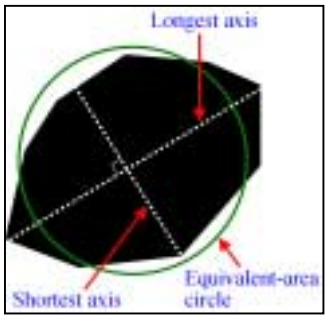

Figure 1: A particle has several different size parameters

IF you were asked to describe your physical characteristics to an interested party, the equivalent spherical diameter would not be very helpful, but in particle size analysis this is often exactly what we do. Height and weight give more information but even more detail is contained in the 'vital statistics', which attempts to describe bodily shape. A similar situation exists in particle metrology.

Powder properties are an amalgam of many different factors, which uniquely combine to determine not only the performance of the constituent particles, but the behaviour of groups of particles when stored, transported or ultimately react in the final purpose for which they were designed.

Particle size, particle size distribution and moisture content are well known for their ability to affect powder rheology, but particle shape is being increasingly recognised as an important parameter. The main reason is that a combination of computer power and the development of high performance digital cameras has enabled particle images to be captured, stored and analysed at hitherto unimaginable speeds. Indeed, most of the major players in the field of particle size analysis now offer some device for particle image analysis.

Viewing individual particles is the only absolute method of assessing particle shape and microscopy is traditionally the tool for the job. Counting fibres and measuring their length to thickness ratio (the aspect ratio) has been extremely important in the asbestos industry but manually counting and measuring sufficient particles to obtain statistically valid results has taken up to 8 hours to perform. A similar analysis today would take just a few minutes.

The aspect ratio of fibres is conceptually easy to understand but for irregular particles, the shape parameters can be much more subtle. For example, take the particle in figure 1. It can have several different sizes depending on the method of measurement. When passed through a sieve it is the 'shoulders' or breadth that determine its size. This is significantly different from the volume diameter as measured in a Coulter Counter. Instrument dependent variations are even more pronounced where high surface area platelets are concerned, for example in mica or metal flake used in paint finishes. Although the platelets can be laid flat and measured on a microscope slide, unless a three dimensional microscope is used, differences in particle thickness cannot be measured. The equivalent spherical diameter as measured by most particle sizing instruments has little relevance to the final performance of the platelet in reflecting light.

In addition to the asbestos and paint industries, particle shape is very important in the industrial diamond business. Diamonds are well known for their abrasion properties and are used, not only in cutting tools, but in abrasive suspensions for grinding or fine polishing.
However, unless the diamond is the correct polygonal shape, it can lead to extensive damage by scoring from any needle-like particles present.

In the past a purely subjective estimate of shape was undertaken; microscope images were compared, but this method proved contentious, unreliable and unable to recognise subtle differences in shape. Today, high speed image analysers can distinguish subtle differences in particle size and shape in minutes.

Although there are other methods of measuring particle shape, microscopy and image analysis are the most popular and there has been a sharp increase in the equipment available in recent years. It has the advantage of being the only technique capable of storing actual particle images.

Provided a representative sample can be taken, millions of particles can now be counted in minutes giving hitherto unheard of repeatability of measurement and with it high levels of confidence in the results.

Some instruments offer ultra-fast, megapixel cameras with highly sophisticated powder dispersion devices and fully automated data collection. Other systems may be low cost developments of the humble laboratory microscope, which although automated require more operator input. Prices vary accordingly from about £10,000 to £60,000.

Whatever the level of technology being used, it is right and proper that shape analysis is now getting the attention it deserves. It is beginning to pay significant dividends in the field of powder technology and is unlocking some age-old problems in the handling and reaction of powders.

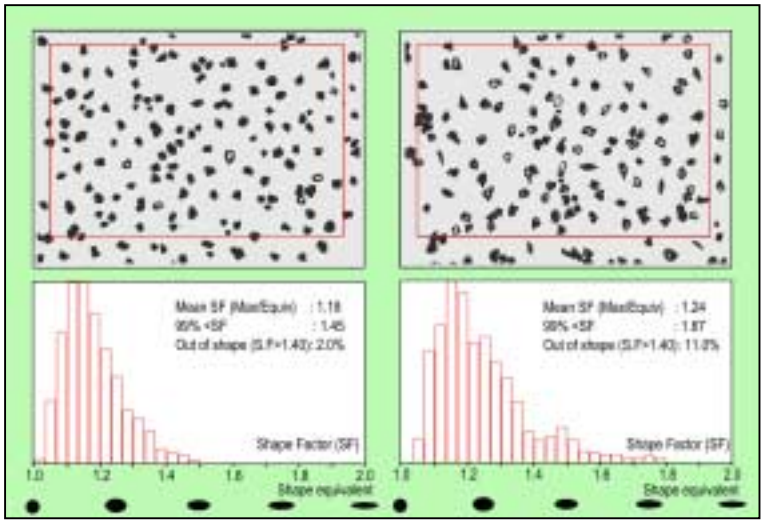

Image analysis can quantify the harmful elongated particle content in industrial diamond

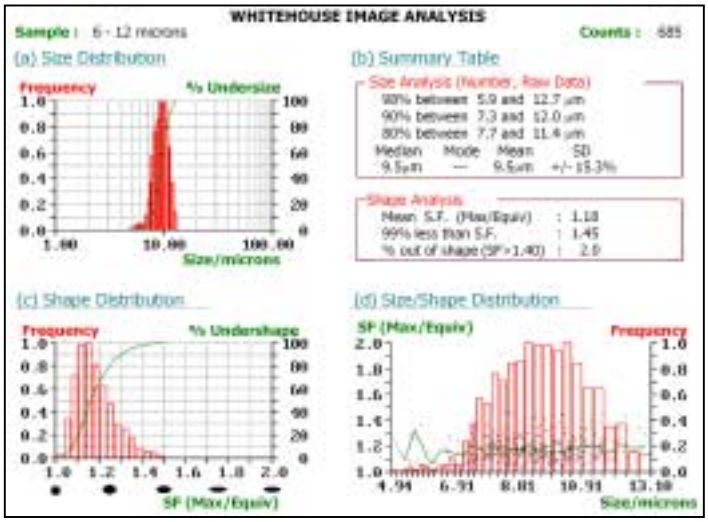

Image analysis provides details of size and shape in industrial diamond