Malvern Instruments is a UK-based provider of materials characterization technology and expertise that enables scientists and engineers to understand and control the properties of dispersed systems. These systems range from proteins and polymers in solution, particle and nanoparticle suspensions and emulsions, through to sprays and aerosols, industrial bulk powders and high concentration slurries. Used at all stages of research, development and manufacturing, Malvern’s materials characterization instruments provide critical information that helps accelerate research and product development, enhance and maintain product quality and optimize process efficiency.

With over 300 million tonnes of cement produced in India each year, and global demand for cement set to grow, it is increasingly important that cement production processes are as efficient possible. Given the scale or production at many cement facilities, the cost of poorly monitored production processes can be very high.

Since it was developed in the 1940s, the Blaine method has been widely used to achieve an averaged value for cement permeability. Though a cheap method, the single value that it produces does not give a comprehensive understanding of cement quality. In order to increase production of this important substance whilst maximising quality we must use techniques that give a much more thorough understanding of this important substance.

As with any material, the behaviour of cement is dependent on its physical properties. The 28 day strength of the cement, for instance is heavily affected by particle size. Too many fines (< 2 microns) and the cement may crack, whilst too many coarse particles will adversely affect strength. Strength is also affected by particle shape and surface area, which determine how the particles pack during use. Clearly, the quality of this material cannot be understood by using a single-value technique such as the Blaine method. To understand and predict the behaviour of our cement we must adopt an orthogonal approach, using information-rich techniques to give a comprehensive picture of the particle size and flow properties of our cement.

This presentation will focus on Malvern’s solutions for cement analysis. The application of the Mastersizer 3000 Laser Diffraction system to acquiring detailed particle size distributions, giving accurate assessment of the proportion of fines and coarse particles in a cement, allowing prediction of cement behavior and rapid modification in order to improve behavior. The Insitec range of In-Line process analysis Laser Diffraction systems further improves manufacturing efficiency by giving direct real-time analysis. Insitec systems allow 24/7 control of cement production, minimizing the production of poor quality batches by allowing rapid corrective action to be taken as soon as a production problem is encountered.
Further information can be generated by Malvern’s Morphologi G3 image analysis system, which gives automated analysis of both the particle size and morphology of cement particles. The latter dictates how particles in a cement interact sterically, and therefore the setting speed and strength of a cement. Morphological analysis can be used to complement Laser Diffraction analysis, giving a useful means of researching new cements with lower water requirements and greater performance. A Raman spectroscopy add-on allows chemical identification, in addition to size and morphological analysis, allowing characterization and optimisation of the amount of different particle types (such as gypsum, clinker, quartz, calcite etc.) in a cement. This is extremely important information for cement developers. A blend containing too little gypsum, for instance, will set too quickly after mixing of water, leaving little time for concrete placing.

Finally, the flow properties, or rheology, of a material are also of importance. Rotational rheometry gives assessment of the microstructure of cement paste, for instance, allowing prediction of how the cement will behave during application. Malvern’s state of the art Kinexus range of dual action rotational Rheometer gives highly accurate and precise understanding of material behaviour under stress.

The energy intensive nature of cement development and the growing demand for building materials that a growing global population demands makes it more important than ever to ensure that production processes produce high-quality cement as efficiently as possible. Malvern Instruments provides the technology and expertise that allows such optimization.