

Dr Robert McCaffrey *Global Cement Magazine*

1st Global Cement Quality Control Conference & Exhibition - Reviewed

The Global Cement Quality Control Conference and exhibition 2009 has successfully taken place in Düsseldorf, with attendees from 13 countries. In total, 18 papers on aspects of quality control in the cement industry were presented over two days, covering the subjects of increasing profitability, analysis, alternative fuels, sample preparation and particle size analysis and the use of additives.

Following a pleasant evening reception on the Sunday evening, the conference itself got underway first thing on Monday morning with a short review of the current global economic situation by the conference convenor Dr Robert McCaffrey, who suggested that we are rapidly approaching the lowest point of the global financial crisis and that some aspects will start to improve in the second half of 2009 and into 2010. Financial markets dropped around 4% in value on the first day of the conference, indicating that we are not 'out of the woods' yet.

The first presentation at the conference was given by George Handley of MBA management consultants, who spoke on how to maximise profit from customers and products in cement plants. He firstly stated that "if you don't understand the problem, you can spend a lot of money trying to solve it and not get anywhere. In some ways, small cement companies have the advantage over their larger competitors, by being easier to change. All companies have bottlenecks, not just in machinery but also sometimes in personnel – you may not have enough engineers for example. You can only

make money as fast as the rate-limiting step of your company. Once you start to push through the most profitable products through your bottleneck, you can increase your profits by 10-50%." George suggested that one must first identify the bottleneck, then identify the customers which make you money the quickest: the company must then concentrate on making product for these people, even if these means ceasing the supply of material to the 'least profitable' customers (and those where you make a loss when you supply

them with product). Removing these least-profitable or loss-making customers will eventually lead to the removal of your bottleneck. For example, if you kiln is your bottleneck, you should find those customers with the highest added value per kiln hour, and then supply them rather than anyone else, if possible. The fastest way to make money from the cement industry is to tell your sales staff to try to sell the most profitable products. According to George, if you spend money on increasing the capacity at a non-bottleneck point, then you have wasted your money.

Global Cement conference stalwart Alexander Koshi of Star Cement, UAE, spoke next. He suggested that, although the cement capacity of the UAE is now 18Mt/year, by 2011 it will rise to 40Mt/year. This is partly due to the fact that Ras Al Khaima is one of the world's best limestone deposits, with both high purity and consistency. However, problems can arise for cement producers since the quarrying operation is controlled by the government, and cement companies get what they are given in terms of raw materials delivered to the crusher. The tendency for heterogeneity of the raw mix can lead to problems with ring and ball formation in the kiln, and consequent loss of production. This can be ameliorated by homogenising the raw meal, and by controlling the alkali to sulphur ratio with supplemental materials. Alexander went on to speak about the requirements for cement in the 21st century. He pointed out that – largely due to environmental attack and to poor choice of materials and faults in execution – around 60% of concrete highways and 40% of concrete bridges worldwide need some sort of repair, and that large cities can lose 30% of their water through leaks in concrete pipes. While suggesting that this would cost some US\$3.3trn over 19 years to put

Below: Happy smiles from the exhibitors on the stand of Sympatec GmbH, a company specialising in particle size analysis.





Left: Delegates from Lafarge and FCT enjoying the welcome reception.

right (a fabulous sum that made the cement producers in the audience salivate with anticipation), Alexander Koshi suggested that the focus for cement production should shift from pure strength towards gaining a design life of at least 50 years.

Mike Kearns from South Africa's Pretoria Portland Cement next detailed how the cartel that operated in the country until 1996 had distorted quality control to the extent that the cement industry association was tasked with avoiding a 'quality control war,' where cement producers would tend to make better cement to gain market share from their competitors. New specifications were brought in to coincide with the end of the cartel, but it was found that there could be significant differences in results between different testing laboratories. These differences were reduced with new standards and tests that were brought in after 1997. Mike pointed out that with normal standard deviations in test results on a 50MPa cement, the strength range could be as high as 5.9MPa, and he stated that your results must be accurate, otherwise you may be grinding to finer than required, leading to higher costs – and also possibly leading concrete customers to use a higher cement content to meet strength requirements, thus increasing their own costs (and reducing your cost-competitiveness versus your rivals).

Dr Hansjoerg Diller of MVW Lechtenberg then spoke about the use of alternative raw materials in the production of clinker and cement and pointed out that they can bring cost, process and product advantages. However, secondary raw materials also have limitations in terms of availability, costs (including transport and processing costs), technical issues (including the possible presence of heavy metals, storage/dosing problems or chemical limits) and/or limitations caused by standards and environmental constraints. Hansjoerg went on to say that when dealing with 'natural' raw materials, quality control really begins at the quarry, with a thorough analysis of the geology of the deposit using borehole sampling and the excellent software which is now available for chemical mapping. However, he suggested that the most important factor in ensuring quality from the quarry is the organisation of the quarry, including the systems used for blasting, storage, blending and transportation of the rock.

As the first speaker in the session on analytical options in the cement industry, Jerome Regad of Itca-Socadei, France, detailed problems at a French Holcim plant which was experiencing unstable kiln operation

and fluctuating free lime contents in the clinker. The plant installed a clinker sampling system, a sample transport system and a free lime analyser adjacent to the process stream, which provided an analysis every 20 minutes. The company was able to stabilise its process, to reduce overburning, to



Left: Overseas cement producers enjoying the hospitality at the conference.

produce smaller alite crystals due to the better burning conditions and to achieve both better grindability and higher reactivity. Having solved the free lime issue, the company wanted to address SO₂ emissions at its chimney, as well as the suggestion of some instability in setting times and some rheological problems in the concrete products made with cement from the plant. Itca provided an Eltra CS800 sulphur analyser downstream from the free lime analyser. Knowledge of the free lime and sulphur content of the clinker was used to optimise ettringite formation and to favour the cubic crystallographic form of aluminates in the clinker, thus controlling the balance between early and late strength gains in the product. This optimisation allows the producer to either decrease the Blaine value of the final product while maintaining strength, or to increase capacity at the clinker mill. The producer was also able to adjust the kinds of fuels being used and to optimise both fuel costs and emissions.

Industry legend Michael Mound, now working for FCT International, went on to point out that sampling produces around 60% in the variability in experimental results, preparation around 35% and only around 5% is due to analysis. Michael suggested that producers do not aim to produce the highest quality product – they aim to produce the most consistent product quality. The best way to do this, he suggested, was to measure, on-line, the material characteristics which control cement performance, including mineralogical composition. He pointed out that Bogue calculation errors are unpredictable for clinkers produced using alternative fuels, and that one should therefore use XRD analysis with the appropriate Rietveld calculations applied. FCT's COSMA (continuous onstream mineral analysis) can provide real-time

Below: George Handley of MBA Consultants explains the mindset required to increase profits from cement manufacture 'very quickly.'



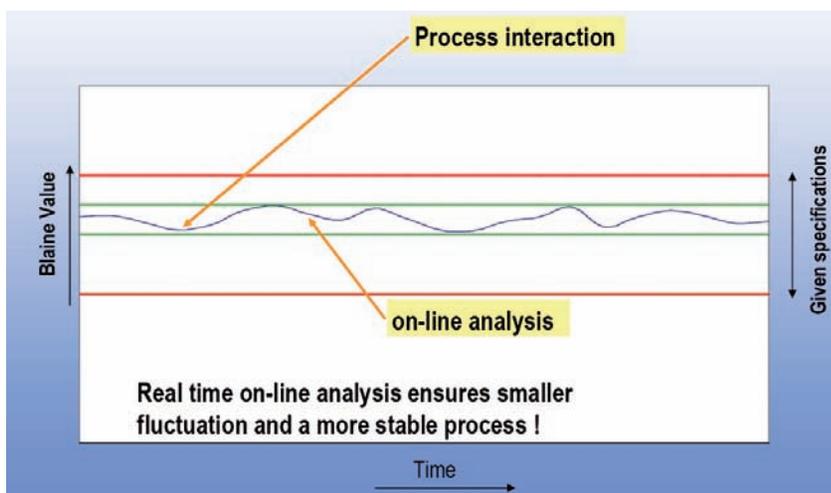
Right: Wise words from Albert Einstein, brought to the conference by Carsten Wiedmann of Thermo Fisher Scientific.

quantitative mineralogical information, allowing effective process control and mineralogical optimisation.

Dr Thorbjørn Schoenbeck of PANalytical continued the analysis session by giving details of the solutions to analytical challenges posed by creating the MiniPal benchtop ED-XRF system. This compact machine analyses elements Na-U, with strong light-element performance, while using only a 9W tube and analysing the samples in either helium or in air. He pointed out that some drift in results can take place, due to both electronic and tube drift, but that both effects can be effectively corrected. The greatest challenge overcome by the instrument is analysis in ambient air. To overcome the problems, the machine uses fundamental parameters, empirical modifications of the results and an innovative third-generation method called AFEP – Advanced Fundamental Environmental Parameters. This includes the modelling of the tube spectrum and using the theoretical pressure absorption calculation for the entire optical path. This allows accurate analysis in air, eliminating the need for more expensive vacuum or helium.

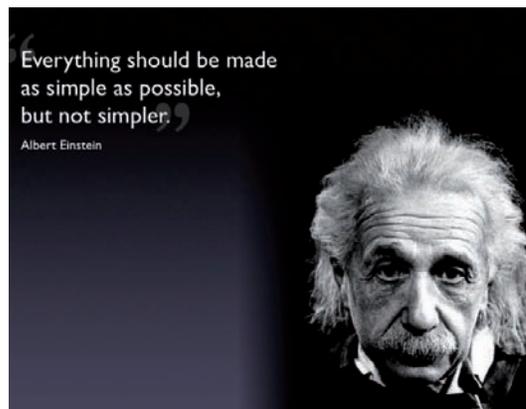
The eighth speaker at the conference was Ali Riahi from Scantech, a company which specialises in online analysis, including PGNAA (prompt gamma neutron activation analysis). This has been proved the world over to be an effective tool for the optimisation of stockpiles and for raw mix control. Scantech's new models can fit in between roller stations and have no contact with the belt. This leads to a situation of no wear and no maintenance.

Below: Sympatech points out the benefits of on-line (particle size) analysis, but the advantages could be applied to many of the techniques showcased at the conference.



Continuing the PGNAA theme, Carsten Wiedmann of Thermo Fisher Scientific pointed out that the technique has the advantage that it analyses the whole of the material stream. He made the analogy that seeing only one part of Germany might give the impression that it is a mountainous country, whereas the fact is that 90% of Germany is flat: one must see the whole to gain an accurate impression. To this end, Thermo has developed side reflectors

Right: The famous buildings designed by Frank Gehry, at the Medienhafen in Düsseldorf.



for its eighth generation CB OMNI PGNAA analysers, which 'provide optimal analysis uniformity,' leading to an improvement in repeatability of around 40%. Carsten suggested that the return on investment for a retrofit of this equipment in a 4500t/day plant would be only nine months, and for an installation on a new 5000t/day plant only three months.

Vince Flahaut of EADS Sodern then put the case for using PFTNA (pulsed fast and thermal neutron activation analysis), which has the advantages of being insensitive to belt loading variations and very accurate for alkali elements. The technique uses a electrical neutron generator rather than a radioactive source. New tubes, such as the company's Sodilog, offer extended lifetimes and better economics, and PFTNA analysers have evolved over the last 20 years to become lighter, cheaper and more modular. There is now no need for a separate electrical cabinet, and the new electronics employed mean that there is now lower noise, better electronic stability and higher reliability. Telediagnosics have also brought lower requirements for maintenance.

Completing the conference's core session on





Above: Delegates prepare themselves for the gala dinner at the Brauerei Ferdinand Schumacher, the oldest brewery in Düsseldorf.

Right: Delegates sampling the local brew, during the tour of the Brauerei Ferdinand Schumacher.

Below: Dirk Lechtenberg of MVW Lechtenberg speaks about the use of alternative fuels and their impact on quality control, in front of the logos of just some of the companies he has worked with.



analysis, Renaat Van Geel of Thermo Fisher reviewed his company's wide range of analytical solutions for the cement industry, from the ARL Quant'X to the ARL 9900 total cement analyser which incorporates both XRF and XRD in the same analyser. Renaat suggested that, past the requirement for measurement of free lime, the cement industry now requires a suite of more sophisticated measurements, including the measurement of the presence of langbeinite (which can indicate potential problems with clogging in cyclones), the determination of the ratios of cubic and orthorhombic forms of C3A (where cubic C3A provides good early resistance to cement), the determination of the content of periclase and the determination of the content of bassanite gypsum hemi-hydrate in cement. Renaat stated that the ARL 9900 provided solutions to all these requirements, alongside a variety of other analytical, process and economic advantages.

Gala Dinner

The first day of the conference was completed with a fantastically Germanic visit to the Brauerei Ferdinand Schumacher, the oldest brewery in Düsseldorf, where both the local cuisine and beer were quality controlled at length and with pleasure.

Second day

The second day of the conference commenced with a popular session on the influence of alternative fuels on cement quality. Dirk Lechtenberg of MVW Lechtenberg reiterated his colleague's sug-

gestion that the largest factor in the optimisation of alternative fuels in cement plants is down to organisation. Using a number of examples, he showed that long-term material availability, process flexibility, the availability of permits and local community good will, usage effects on clinker and the economics of the whole project will have an influence on the prospects of an AF project. Dirk stated that it was important to test every truck load of material, and that to further motivate your supplier, a series of (cash) penalties should be instituted for high chlorine and moisture contents, and a series of (cash) bonuses should be applied for lower chlorine and lower moisture contents.

Bernd Beyer of Powitec gave an overview of his company's capabilities for the improvement of process results when using alternative fuels. Powitec uses neural net technology, digital image processing, high temperature cameras and expertise in industrial com-



bustion processes to calculate dust-free images of the flame and other conditions in the kiln, and then uses permanent on-line prediction and closed-loop control (calibrated against laboratory standards) to steadily improve clinker quality, to stabilise kiln conditions, and to optimise alternative fuel use.

The next pairing of papers made it clear how important it is to have reliable, repeatable particle size analysis for your product, since around 1% of the world's electricity is used to grind clinker to the required fineness, and inaccurate or inadequate particle size distribution (PSD) information can therefore be extremely expensive. Firstly, Axel Pankewitz of Sympatec pointed out that laser diffraction has become the dominant technique over the last 20 years, since it is fast, reproducible and has a high resolution. Dry dispersal using compressed air allows the analysis of a large sample, without chemical interaction between the carrier (air) and the product, while also creating no waste, since the sample can then be returned to the product stream. Axel suggested that for optimum results, all areas in the process pipe must be sampled, and he detailed his company's Twister online sampler,

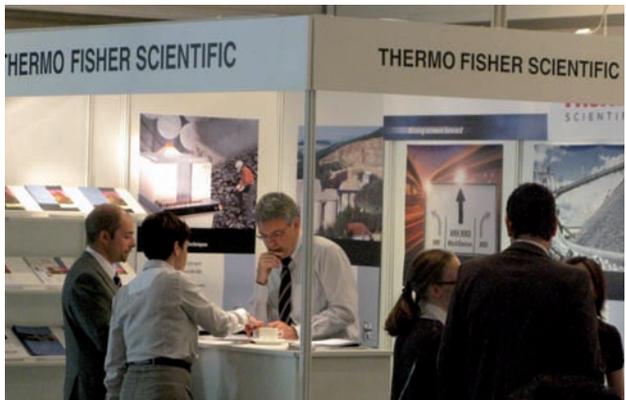


Above: Reinhard Kamphoff (left) collects Pfaff's prize for best exhibition stand.



Above: Dr Armin Schneider (left) collects his prize from conference convenor Robert McCaffrey

Below: Discussions continuing on the Thermo Fisher Scientific exhibition stand.



an elegantly-designed spiral in-pipe sampler which does just exactly that. The on-, in- or at-line particle size analysis allows close control of particle size distribution, and reduction in specific electrical consumption during grinding.

The second paper in the session was given by Bernd Looser of Malvern Instruments, who suggested that small differences in particle size distribution can result in large changes in cement

performance: the same Blaine number can be used to describe radically different products. Malvern uses an auger to sample 100kg/hour from a 100t/hour process stream, and then uses a secondary sampling stage before the laser diffraction analyser. Bernd mentioned that the analyser is quite capable of supplying a complete particle size distribution every second, but it has been found that averaging the results out over at least a minute, or over up to 10 minutes, give a more useful measurement. Using the information gained from particle size distribution analysis, Bernd suggested that production increases of around 5% are typical for new installations, alongside specific energy consumption decreases.

Reinhard Kamphoff of Pfaff, an FLSmith company, next gave a fascinating presentation on his company's Centaurus automatic sample preparation unit for x-ray analysis. The Centaurus grinds and pelletises samples in one compact housing, and then cleans itself, preparing up to 10 samples per hour. The unit can be used in stand-alone or manual mode and with a robot (such as RoboLab). The company uses a proprietary grinding additive pill named C20 to increase grinding effectiveness, to avoid sticking of the sample to the grinding vessel and to support sample stability in the pelletising process. Reinhard presented experimental results which showed that the Centaurus gave highly repeatable results

(standard deviations were lower with the automatic sample preparation than with manual preparation). Beautifully designed and thorough cross-contamination experiments showed that there was negligible (statistically insignificant) contamination between samples. As conference convenor Robert McCaffrey remarked, "If I had

had one of these machines while I was doing my PhD, I could have finished my degree a year earlier, and spent that year on the beach."

The last two presentations at the conference were on the crucial subject of additives and cement quality. Armin Schneider of Kronos presented important information on the influence of the dosing point of ferrous sulphate monohydrates (FSM) on the long-term reduction of chromium (VI). FSM is a by-product of the manufacture of TiO₂, and is fast-replacing other reducing agents due to its cost, shelf-life and temperature stability and its good handling characteristics. Armin's experiments showed that the longest-lasting and strongest effect on chromium (VI) reduction was provided by dosing the FSM into the mill (where the FSM seems to be activated in some way by the grinding process). To gain the same effects with dosing at the dispatch point, higher dosage rates need to be used. Dosing at the separator was found to be the least effective point in this study.

The final paper at the conference was given by Jorg Schrabback of Sika Deutschland GmbH, on the role of polycarboxylate grinding aids in improving cement quality. Cracks are formed in clinker particles during the grinding process, which have electrostatic attraction forces on their surfaces. Grinding aids can be used to neutralise these electrical charges and to increase the effectiveness of grinding, while at the same time reducing the coating of mill equipment, improving the disagglomeration of particles and improving the efficiency of the separator. Sika's polycarboxylate polymer grinding additive provides higher production increases and greater strength development than traditional glycol or amine grinding aids. SikaGrind-820 also has the additional benefits of allowing the adjustment of powder flowability, the reduction of carbon bleeding (which is important with cement made with carbon-rich fly ashes) and improved workability of the resulting concrete.

During the conference programme there were many questions from the floor, and much interesting (and revealing) debate incorporating the wide experience of the conference attendees.

Conference prize-giving

At the conference prize-giving, Pfaff was awarded the prize for the best exhibition stand. In the best presentation category, Bernd Beyer of Powitec was fourth, close behind Armin Schneider and his paper on dosing points for ferrous sulphates. Jerome Regad of Itasca Socadei was awarded second prize for his paper on on-line free-lime analysis, while the best presentation award went to the ever-eloquent Dirk Lechtenberg for his paper on the optimisation of cement quality with alternative fuels.

Delegates were highly complimentary about the organisation of the event. They suggested that the subject matter was important and that the focus of the conference was 'just right.' As one delegate from Lafarge commented, "We really appreciate the excellent organisation, the atmosphere created and the beautiful gala dinner." With this ringing endorsement, the conference will be repeated on a two year cycle, and will next take place in 2011. 