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GUEST EDITORIAL

Non-Conventional Cementitious Binders

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This special issue of Advances in Applied Ceramics features papers presented at the 31st Cement and Concrete Science Conference, held at Imperial College, London, in September 2011. Whilst many people consider cement science to focus on civil engineering applications, the conference and this special issue exemplify why the field encompasses so much more. The annual conference brings together materials scientists, civil engineers, chemists, artists and mineralogists to discuss the many facets of the science of cement and concrete. With over 120 delegates from across the world and almost 100 oral and poster presentations, the 2011 conference was a global affair. The conference presentations covered many materials and applications, ranging from traditional Portland cements to novel geopolymeric binders, and from civil engineering to waste management and biomedical applications. Consequently, to highlight both the traditional and the novel, two special issues have resulted from the conference; this issue of Advances in Applied Ceramics presents a selection of papers on non- Portland cement systems and non-engineering applications, whilst a special issue of Advances in Cement Research concentrated on more traditional applications.

The six articles in this special issue illustrate how cement science encompasses a wide range of materials other than Portland cement, and also show how these materials can be used for more than construction. Many of the articles also show how environmental concerns are driving many aspects of research in the field, with a continued drive to improving resource efficiency or reducing carbon dioxide emissions.

The papers by Tashima et al.[1] and Ferone et al.[2] both concern the development of geopolymers. These alkali-activated binders have widely been touted as potential alternatives to Portland cement,[3] and have been a regular feature at Cement and Concrete Science conferences in recent years.[4,5] Ferone et al. have taken an abundant waste material, reservoir sediment, and used it to produce a binder of similar performance to Portland cement, thus removing the need to manage the waste material whilst also reducing raw material consumption. However, they did require slightly elevated temperatures to achieve geopolymerisation. Tashima et al., meanwhile, have been able to overcome this common hurdle and produce a geopolymeric material at room temperature.

Continuing the theme of developing new binders, Guerrero et al.[6] have looked to immobilise difficult to manage wastes, cadmium and caesium, using a modified Portland cement. Using a belite-rich cement, nanosilica and a gismondine-type zeolite they have effectively immobilised these problem materials.

Moving from the novel towards more conventional materials, two further papers have considered the environmental impact of traditional Portland cement and attempted to reduce it. Khatib et al.[7] have taken pulverised fuel ash (pfa), a material commonly used in construction cements, plus gypsum and examined their interaction within a Portland cement matrix, to minimise porosity, thus improving durability. Maries et al.[8] have taken a somewhat different tack, combining the self-pulverising properties of gamma-C_2S with its activation in a carbon dioxide-rich stream to produce a material showing good strength-gain, but with a very low carbon footprint.

Finally, in this special issue, Li and Coleman[9] have taken a slight modification of a conventional white Portland cement, i.e. adding the radiopacifier bismuth oxide, to mimic 'mineral trioxide aggregate'; a material commonly used as a dental cement. By using a combination of advanced characterisation techniques they have shown that the bismuth oxide does not interfere with the hydration of the cement component.

As mentioned earlier, this Special Issue is complemented by another Special Issue, concentrating on more traditional cements and applications, in Advances in Cement Research. The five articles also reflect the breadth of cement science, considering the performance of Portland cement binders over timescales fromminutes to millennia. Early-age performance was the focus of two papers. The first[10] looked at the effects of prehydration, the interaction of anhydrous Portland cement with water vapour, where sulphate speciation appeared to play an important role. Meanwhile, Justnes[11] looked at the effect of removing sulphate entirely replacing it with calcium nitrate, formate or acetate.

Moving from early-age performance, Backus et al. looked at the durability of Portland cement concretes exposed to aggressive cyclic chloride exposure,[12] showing that bound chlorides might be freed upon carbonation of the concrete, with implications for durability. The next paper took durability performance to an extreme,[13] looking at cementitious binders for the encapsulation of nuclear waste, with particular consideration to the sorption of various radionuclides in the presence of chemical admixtures.

The final paper in the Special Issue of Advances in Cement Research returns to a theme common to the articles in this Special Issue; novel, low-carbon, waste-derived binders. Pontikes et al.[14] used stainless steel converter slag and pfa to produce a hydraulic binder with a composition similar to blastfurnace slag. Such an approach achieves three valuable aims; diverting waste from landfill, reducing abiotic depletion and lowering the embodied carbon.

These two special issues show the broad range of research presented at the Cement and Concrete Science conference, and whilst the papers represent a selection of the papers presented in 2011, it is indicative of the breadth of ongoing research in the field.

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