Book review

Cement chemistry, 2nd edn

H. F. W. Taylor

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Books on cements and resulting concretes and mortars are numerous. Some are technological with engineers in mind; others are scientific and address the fundamentals. Such books have, perhaps, a more restricted audience such as those chemists, materials scientists and physicists who have made cement and concrete their particular specialism. It is important if new advances are to be made and understanding developed of issues such as durability and strength that rare books such as this are encouraged and made widely available.

Rare because the competency and thoroughness that pervades this book leaves one both impressed and reassured that there are those that can not only do but do it. Professor Taylor is owed a debt of gratitude for producing this worthy successor to the first edition (first published in 1990).

The reader benefits from the author's direct involvement in research related to Portland cements and others.

Chapters 1–4 deal with the chemistry of Portland cement and contain detailed descriptions of the various mineral phases in Portland cement coupled with the high-temperature chemistry together with that of its manufacture and the Portland cement clinker from which it is derived.

All this allows one to build up a very detailed chemical and physical appreciation of the material.

The very relevant point is made that rates of reaction in a solid/liquid system are all dependent upon the solution chemistry and that of the solid phase, important if we are to understand phenomena such as accelerated and retarded hydration.

Chapters 5–7 are all concerned with the consequences of reaction with water, starting with the calcium silicate phases, through the aluminates, ferrite and sulfate phases to Portland cement itself.

Of particular interest is the detailed description at the nanometre scale of calcium silicate hydrate gel and

related materials and the importance of the calcium/silicon ratio.

The nature of surface groups and the multiplicity of species in solution make some of the simplistic visual representation that we (I) attempt to use, seem superficial and rather crude. It is reassuring to know that some have such detailed knowledge, although to others it may seem esoteric. Throughout the book the emphasis is on the underlying science, and in that regard it is not for the faint-hearted or the concrete dilettante.

Chapter 6 in particular deals with hydrated aluminate ferrite and sulfate phases, and contains a very detailed chemical/physical picture of the various interactions, although in terms familiar to the crystal physicist rather than the cement technologist, but worth persevering with. For instance, Fig. 6.4 displays the crystal structure of ettringite. How often do we come across this material and use the term rather loosely. It is essential that we extend our understanding to the level of detail that Professor Taylor presents. In a similar vein, Fig. 7.3 gives an excellent schematic of the hydration of Portland cement taken from Karen Scrivenor's thesis in 1984. The picture presented and the challenge it offers to the imagination are as pertinent now as then.

Chapter 8 deals with the structure and properties of fresh and hardened Portland cement pastes and starts with rheology and takes us through the hardening process. It is surprising how relevant the Powers–Brown–yard model for hardened and the hydrated and saturated Portland cement paste is even after some 50 years.

The relationship between water content, porosity, degree of hydration and strength is fundamental to optimizing the mix constituents and realizing durable concrete.

After Chapter 8 the book extends to composite cements including blast furnace slag, fuel ash, natural

pozzolanas and silica fume. Perhaps the latter warrants more than two and a half pages.

Calcium aluminates and other cement types are dealt with in the same painstaking way that typifies the previous chapters. Naturally the reader is then directed towards chemical admixtures, and it is good to see the interplay of chemical functionality and overall macroscopic effect. Again and again the author endeavours to identify the fundamental chemistry and align that with practical effects.

The final chapter of the book deals with 'concrete chemistry', and opens with a section on the interfacial transition zone between cement paste and aggregates. This zone is characterized by having different properties from the bulk cement paste. The zone allegedly extends to some 35 μm width, and could be fundamental to strength and durability properties of concrete. It is likely that such interfacing tends to occur whenever a discontinuity is imposed within the cement paste, be it aggregate or the surface of a mould.

This is something of a catch all chapter, giving comment on carbonation, chloride ingress, alkali-silica reaction, sulfate attack and a number of other interactions. Perhaps too many for detailed treatment, but since the section like all the others is well referenced, it acts as a beacon should you wish to take the matters further.

The twelve chapters of this book that are enhanced by an appendix covering X-ray powder diffraction patterns for tricalcium silicate and clinker phases, complemented by a huge index reference list (approximately 1500) and rounded off by a good subject index.

The book is unique and will be of considerable interest to those seeking a fundamental understanding of phenomena associated with Portland and related cements but may also serve as a detailed introduction to newcomers to the subject. I cannot recommend the book too highly, and it will stand as a reference work for many years to come.

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