



A physico-chemical basis for novel cementitious binders

Ellis M. Gartner^a, Donald E. Macphree^{b,*}

^a Lafarge Centre de Recherche LCR, France

^b University of Aberdeen, United Kingdom

ARTICLE INFO

Article history:

Received 28 January 2011

Accepted 21 March 2011

Keywords:

Novel cements (D)

Hydration (A)

Reactivity (A)

ABSTRACT

The drive towards sustainability in construction is shaping our attitudes towards alternatives to Portland cement. Although the cement and concrete industry is essentially sustainable with respect to raw materials supply, and concrete manufacture actually gives relatively low CO₂ emissions per unit volume compared to most competitive construction materials, the current focus on climate change has led to concerns about cement industry-generated CO₂. Thus, there is interest in developing alternative cements with lower associated CO₂ emissions. This paper seeks to provide a context for innovative development through a review of what is meant by a hydraulic cementitious binder, identification of key physico-chemical properties of successful binders and how novel systems generally rely on similar factors. Concepts such as reactivity, availability of reactive species and physico-chemical drivers for the formation of cementitious systems are discussed as a basis for introducing and reviewing recent developments in the search for ever more environmentally sustainable cements.

© 2011 Elsevier Ltd. All rights reserved.

Contents

1. Introduction	737
1.1. What do we mean by “sustainability” with respect to cement technology?	737
1.2. What do we mean by “cementitious matrix”?	737
1.3. What do we mean by “hydraulic binder”?	738
1.4. Outline of the hydration chemistry of oxide-mineral-based hydraulic binders	738
1.5. Outline of the manufacturing chemistry of lime-based hydraulic binders	739
1.6. Durability issues	739
2. Overview of key physico-chemical drivers	740
2.1. Chemical potential gradients in reactive cement systems	740
2.2. The importance of solubility	741
2.3. Surface reactions	741
3. New understanding pertinent to well-established cementitious systems	742
3.1. Hydrolysis and condensation mechanisms involved in “pozzolanic” reactions	742
3.2. Influences of polarising cations	742
3.2.1. Activation of aluminosilicates (SCMs and geopolymers)	743
4. Comparisons of novel cementitious binders systems	744
4.1. Belite–calcium sulfoaluminate–ferrite (BCSAF) cements	744
4.2. Partially prehydrated C–S–H-based binders	745
4.3. Magnesium oxy-carbonate cements	745
4.4. Calcium carbonate cements	747
5. Concluding remarks	748
Acknowledgements	748
References	748

* Corresponding author at: Department of Chemistry, University of Aberdeen, Meston Walk, Old Aberdeen AB24 3UE, United Kingdom.

E-mail address: d.e.macphree@abdn.ac.uk (D.E. Macphree).