



Thermodynamics and cement science

D. Damidot ^{a,b,*}, B. Lothenbach ^c, D. Herfort ^d, F.P. Glasser ^e

^a Université Lille Nord de France

^b EM Douai, LGCgE-MPE-GCE, Douai, France

^c Empa, Lab. Concrete & Construction Chemistry, Dübendorf, Switzerland

^d Cementir Holding, Denmark

^e Chemistry Department, University of Aberdeen, Aberdeen, UK

ARTICLE INFO

Article history:

Received 16 January 2011

Accepted 28 March 2011

Keywords:

Thermodynamic calculations (B)

Blended cements (D)

Fly ash (D)

CaCO₃ (D)

Solubility constant

ABSTRACT

Thermodynamics applied to cement science has proved to be very valuable. One of the most striking findings has been the extent to which the hydrate phases, with one conspicuous exception, achieve equilibrium. The important exception is the persistence of amorphous C–S–H which is metastable with respect to crystalline calcium silicate hydrates. Nevertheless C–S–H can be included in the scope of calculations. As a consequence, from comparison of calculation and experiment, it appears that kinetics is not necessarily an insuperable barrier to engineering the phase composition of a hydrated Portland cement. Also the sensitivity of the mineralogy of the AFm and Aft phase compositions to the presence of calcite and to temperature has been reported. This knowledge gives a powerful incentive to develop links between the mineralogy and engineering properties of hydrated cement paste and, of course, anticipates improvements in its performance leading to decreasing the environmental impacts of cement production.

© 2011 Elsevier Ltd. All rights reserved.

Contents

1. Introduction	680
2. Solubility data for cement hydrates	681
2.1. Available data	681
2.2. Determination of solubility data	682
2.2.1. Solubility data at standard conditions 25 °C, 1 bar	682
2.2.2. Solubility at other temperatures	682
2.2.3. Effect of pressure and crystal size on solubility	684
2.3. Maintenance of the thermodynamic database	684
3. Use of the thermodynamic approach	685
3.1. Saturation indexes	685
3.2. Phase diagrams	686
3.3. Stable hydrate assemblages	687
3.3.1. Influence of limestone	688
3.3.2. PC blended with SiO ₂ rich materials	689
3.4. Practical applications of thermodynamics applied to cement hydration	690
3.4.1. The sulpho-aluminate reactions	690
3.4.2. The carbo-aluminate reactions	690
3.4.3. The pozzolanic reaction	691
4. Conclusion	692
Acknowledgements	693
References	693

* Corresponding author at: EM Douai, LGCgE-MPE-GCE, Douai, France.

E-mail address: damidot@ensm-douai.fr (D. Damidot).