

The influence of various common ions on the slaking of some South African limes

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Abstract

The rate of transformation from CaO to Ca(OH)₂ during the slaking process is influenced by a number of factors. In this investigation the effects of common ions normally encountered in the slaking water were investigated. It was found that chloride and nitrate ions enhanced the slaking rate, while carbonate, sulphate and phosphate ions retarded the hydration of various limes used in the investigation. The increases and decreases in the degree of hydration correlate with the solubilities of the anions forming more soluble compounds than Ca(OH)₂, as well as the solubility constants of the anions that formed less soluble compounds than the hydrated lime. The geological origin of the lime also influenced the slaking of the limes.

Keywords: lime, slaking, geological origin, accelerating anions, decelerating anions

Introduction

Lime is one of the most important industrial chemicals and its slaking from the quicklime (CaO) form to the hydrated lime (Ca(OH)₂) species is of importance in a number of practical applications, such as potable water treatment, neutralisation of acidic effluents and flue gas desulphurisation, to name but a few. The rate of transformation from CaO to Ca(OH)₂ during the slaking process is influenced by a number of factors, for example the production and storage conditions of the lime (Potgieter et al., 2002) the water and material composition (Gheeverhese et al., 2002; Potgieter et al., 2003a) and calcination temperature (Moropoulou et al., 2001).

Recently the authors described the effect of different agitation methods on the hydration rate of lime (Potgieter et al., 2003b) and concluded that this, together with the geological origin of the lime, greatly affects the amount of slaking occurring in each particular case.

This investigation further explores the influence of common ions, which can be encountered in water used for slaking quicklime, on the hydration rate of various limes. An ultrasonic agitation procedure was employed, as it is a faster way of slaking lime than the mechanical method used in the previous investigations by the group.

Experimental procedure

The experimental detail and set-up have been described comprehensively in previous papers dealing with this topic (Gheeverhese et al., 2002; Potgieter et al., 2003b). In this investigation ultrasonic agitation was used to induce hydration of the various lime samples in the different solutions of interests. The chemical compositions of the various lime samples are given in Table 1. A description of

TABLE 1
Chemical composition of the various limestones investigated

| Element expressed as relevant oxide | Pienaars-river limestone % (m/m) | Lime Acres limestone % (m/m) | Beeste-kraal limestone % (m/m) |
|-------------------------------------|----------------------------------|------------------------------|--------------------------------|
| SiO ₂ | 18.95 | 0.54 | 4.42 |
| Al ₂ O ₃ | 2.40 | 0.26 | 0.80 |
| Fe ₂ O ₃ | 1.12 | 0.05 | 0.28 |
| MnO | 0.08 | 0.54 | 0.86 |
| TiO ₂ | 0.13 | 0.01 | 0.02 |
| CaO | 42.37 | 55.34 | 49.47 |
| MgO | 1.23 | 0.80 | 3.30 |
| P ₂ O ₅ | <0.01 | <0.01 | <0.01 |
| K ₂ O | 0.30 | 0.04 | 0.40 |
| Na ₂ O | 0.17 | 0.14 | 0.05 |
| LOI | 34.09 | 42.99 | 40.93 |
| TOTAL | 100.84 | 100.71 | 100.53 |

their sources of origin can be found in previous work described in the literature (Gheeverhese et al., 2002). All slaking percentages were normalised to the total amount of available lime contained in each limestone after calcining.

Results and discussion

The effect of a 1 M NaCl and a 1 M NaNO₃ addition to the slaking water on the hydration rate of pure lime and three other different natural limes is shown schematically in Figs. 1 to 4. It can clearly be seen from all the curves in Figs. 1 to 4 that the nitrate enhanced the slaking rate in the initial stage of the hydration reaction.

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