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Production and storage stability of skin carbonated CaO

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Abstract: Calcium oxide, CaO, has a rapid and vigorous exothermic reaction in contact with liquid water; -104 kJ/mol. Such is CaO desire to react it will even capture water vapor at a low relative humidity from the surrounding atmosphere. This hydration reaction, however, can be considerably delayed if the CaO has a surface layer of $CaCO_3$ [1]. In dry atmospheric air at room temperature carbonation of CaO is extremely slow, but by exposure to pure CO_2 at elevated temperatures, such as 300 to 700°C a dense skin of $CaCO_3$ on the CaO particles can be produced in a matter of a few hours, see Table 1. Results of storage stability are given in Table 2.

Temperature (°C)	Time (h)	Carbonation (%)
700	4	36.8
500	5	22.4
375	4.5	9.1

Table 1. Examples of degree of carbonation by exposure of CaO to pure CO_2 gas in a tube furnace. The CaO is soft burned with an average particle size of approximately 10 µm. The degrees of carbonation are calculated based on weight changes and have been confirmed by QXRD.

RH (%) → Time (days) ↓	20		40		61		75		83		88		96	
1	54	**0**	87	**0**	88	**0**	90	**0**	90	**2**	92	**8**	93	**15**
3	70	**0**	88	**0**	89	**1**	90	**20**	90	**46**	91	**67**	91	**78**
7	89	**0**	90	**2**	90	**9**	91	**67**	92	**84**	93	**91**	94	**94**
14	90	**1**	90	**12**	90	**35**	91	**87**	93	**91**	93	**93**	93	**97**
30	90	**6**	88	**43**	91	**67**	92	**92**	94	**94**	94	**95**	97	**98**
90	90	**30**	91	**75**	92	**86**	93	**93**	97	**98**	-	**-**	98	**99**

Table 2. Comparison of degrees of hydration of unprotected non-carbonated CaO (non-bold) and 11.9% skin carbonated CaO (**bold**). Each measurement is based on 2 g of material which has been stored in a humid environment for different times at the shown relative humidities at 40°C. Degrees of hydration were calculated from simple gravimetric measurements.

It is clear that skin carbonation is a very effective method for delaying hydration of CaO. The measurements also indicate that an induction period for the hydration is created by the skin carbonation. This may correspond to the time for sufficient water to diffuse through the protective $CaCO_3$ skin and disrupt it by expansive $Ca(OH)_2$ formation.

Potential applications for skin carbonated CaO include shrinkage compensation and chemical prestressing of concrete. It is expected that it is possible to skin carbonate MgO and that it will possess properties similar to skin carbonated CaO apart from a slower hydration rate.

References

[1] H.S. Song and C.H. Kim, Cement and Concrete Research, 20, 815-823, 1990