



Review

Review—calcination and carbonation of limestone during thermal cycling for CO₂ sequestration

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Abstract

Some aspects of using lime from limestone to sequester CO₂ from combustion systems are examined in this review of the literature. A typical sequestration technology would consist of two circulating fluidised beds, one operated in the temperature range 600–700 °C and acting as a carbonator, and the other in the temperature range 750–950 °C acting as a cracker. The processes involved in calcination, sintering, and carbonation are summarised, including the relative rates of reaction. The physical properties of the calcined products after sintering and reaction are reviewed. The loss of active calcium due to the competitive formation of sulphates and other calcium compounds is noted. Prolonged residence times in fluidised bed systems will lead to extensive loss of surface area and porosity in the particles. The likely extent of particle fragmentation is discussed, and some cost figures for avoided CO₂ emissions from power generation systems are presented. The need for a realistic model of the processes taking place in the particles is emphasised.

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Keywords: Calcination; Carbonation; Limestone; CO₂ sequestration; Sulphation

Contents

1. Introduction	1708
2. Calcination	1709

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2.1.	The properties of limestones and their calcines	1710
2.1.1.	Comment	1712
2.2.	The kinetics of calcination	1712
2.2.1.	The effect of carbon dioxide and water vapour on calcination rate	1715
2.2.2.	The effect of particle size on calcination rate	1717
3.	Sintering	1719
3.1.	Sintering rates.	1719
3.2.	Sinter properties.	1723
3.2.1.	Comment	1724
4.	Carbonation	1725
4.1.	The kinetics of carbonation	1727
4.1.1.	Comment	1728
4.2.	The behaviour of calcium silicates and OCCs	1728
4.2.1.	Comment	1729
5.	Sulphation	1729
5.1.	Sulphate formation	1730
5.2.	Sulphate decomposition.	1732
5.2.1.	Comment	1734
6.	Particle fragmentation and attrition.	1734
6.1.	Summary	1736
7.	Application to CO ₂ sequestration in circulating fluidised beds	1736
7.1.	Modelling the process.	1737
7.1.1.	Random pore model (RPM)	1738
7.1.2.	Grain model	1738
7.1.3.	Homogeneous particle model (HPM)	1738
7.2.	Economics	1739
	Acknowledgements	1739
	References.	1740

1. Introduction

There is considerable pressure on industries which rely on combustion to minimise their emissions of carbon dioxide. This has led to proposals to capture the CO₂ in the combustion gases, and then release it separately in a concentrated stream, which is able to be fixed more efficiently and economically than the dilute combustion gas [1]. One vehicle being proposed to accomplish this separation is lime, i.e. CaO, which will be carbonated to CaCO₃ at a lower temperature in the flue gas, removed from the process (carbonation) vessel, and then decomposed in a separate (cracker) vessel at a higher temperature. The regenerated lime would then be returned to the carbonator [2,3].

This process can be economical because the raw material is limestone and circulating fluidised beds are suitable process vessels. This review will be restricted to limestone, although dolomite CaMg(CO₃)₂ and dolostones, which are mixtures of calcium and magnesium carbonates can also act as sorbents. Magnesium carbonate decomposes at a much lower temperature than calcium carbonate, so that in the

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