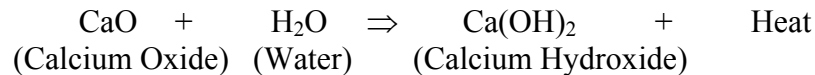


## Factors Affecting Lime Slaking

The lime slaking process and product quality depend on three primary factors: quicklime properties, water properties, and water to lime ratio. In most applications, water to lime ratio is the single most important factor in lime slaking; as this ratio is decreased, product quality increases.

### Lime Slaking

The term “lime slaking” refers to the reaction between calcium oxide (as a component of quicklime) and water to form calcium hydroxide. This process is represented by the following equation:



In this reaction, each 1.0 lbs of calcium oxide combines with 0.32 lbs of water to yield 1.32 lbs of calcium hydroxide. The reaction releases heat (490 btu/lb of CaO) and is the same as that which takes place in a lime hydrator to produce commercial hydrated lime. Commercial hydration processes typically yield a dry product, whereas lime slaking occurs with an excess of water to produce a slurry of hydrated lime solids in water.

### Quicklime Properties

Three properties of quicklime, *type*, *purity*, *reactivity*, and *particle size* should be considered in lime slaking.

*Type:* The grade of quicklime, high calcium or dolomitic effects the slaking rate. A dolomitic lime will slake at a slower rate than high calcium quicklime. In the United States, the most common form of quicklime is high calcium quicklime.

*Purity:* Purity describes of the amount of quicklime that is chemically available as Calcium Oxide (CaO). The purity of quicklime affects the reactivity and determines the purity of the hydrated lime product. The purity of commercially available high calcium quicklime in the United States typically ranges from 85% to 95% available CaO.

*Reactivity:* Reactivity describes the relative capacity of quicklime to reciprocate chemical change with water. Reactivity is a function of purity, particle size and other factors such as particle porosity. The slaking rate is a measurement of the time for the slaking process to reach completion. The reaction is considered complete when the temperature of a given sample reaches a maximum. As reactivity increases, the slaking rate, ultimate temperature rise, and surface area of hydrated lime increase also.

Standards exist to measure reactivity<sup>1</sup> of quicklime. As noted in Table 1 below, reactivity is characterized by the time required for the reaction temperature to reach a specific value.

**TABLE 1. Quicklime Reactivity Definitions**

Reactivity	Time for 40 deg C Temp. Rise <sup>2</sup>	Time for Complete Reaction <sup>2</sup>
High	3 minutes or less	10 minutes or less
Medium	3-6 minutes	10-20 minutes
Low	6 minutes or longer	20 minutes or greater

<sup>2</sup> Tests to be in accordance with ASTM C 110 slaking rate test procedure.

*Particle size:* Quicklime particle size and mixing methods have a significant affect on slaking rate. Commercial grade quicklime is available in a variety of sizes including pulverized (powder), granular (1/4" minus), pebble (1/4"-3/4" minus) and lump (2" minus). When adequately mixed with water, quicklime reactivity increases as particle size decreases. Ultimate temperature rise and product quality are not significantly affected by particle size with pebble or finer grades. The smaller the size of quicklime the more susceptible the lime is to air slaking.

### **Water Properties**

Two properties of water, *dissolved solids* and *temperature* should be considered in lime slaking.

*Dissolved Solids:* Water containing sulfites or sulfates in excess of 400 ppm should not be used for lime slaking as they inhibit the slaking process. Water containing bicarbonate hardness will not affect the slaking process, however it should be noted that bicarbonate ions will precipitate (scale) as calcium carbonate on contact with slaked lime. Softened process water or potable water is recommended for lime slaking.

*Temperature:* In general, higher incoming water produces better product quality. Water that is too cold may "drown" the quicklime and slow the slaking reaction down. Water that is too hot may boil during the slaking reaction. For reliable slaking with most lime types and slakers, water temperature should be between 55 deg F and 70 deg F.

### **Water to Lime Ratio**

In most applications for slaked lime, surface area of the hydrated lime particles is of paramount

<sup>1</sup> Reference ASTM Standard C110, Slaking Rate Test Procedure

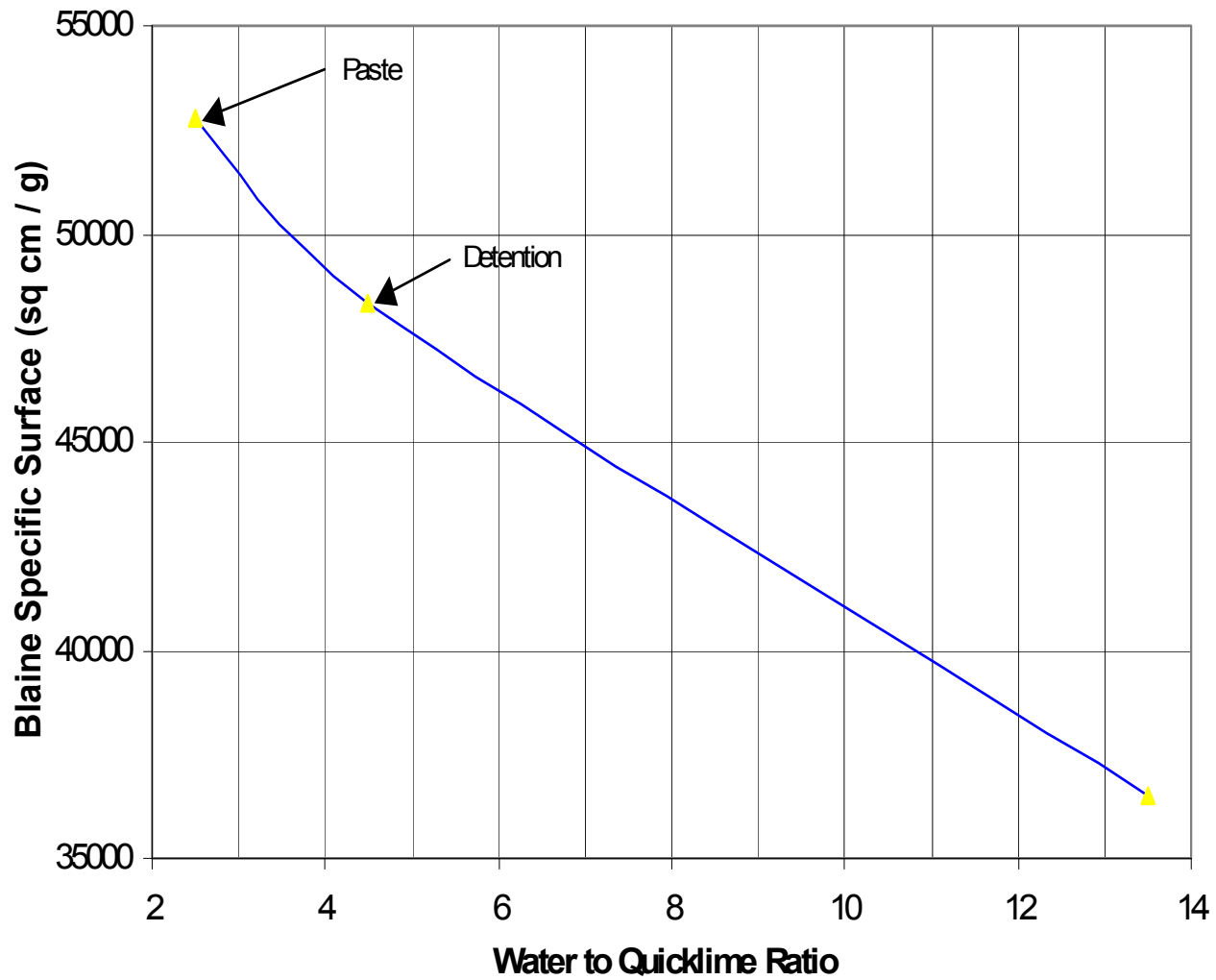
importance. Water to lime ratio is the principal determinant of product surface area; as this ratio is decreased, surface area increases.

The water to lime ratio is defined as the ratio of water mass to quicklime mass. This ratio does not include dilution or process water, which may be added to slaked lime downstream of the slaking compartment. In conventional lime slakers, water to lime ratio varies from 2.5:1 (for paste type slakers) to 6.0:1 (for detention type slakers). The water should be evenly distributed into the slaker. Surges or pulsating of the water flow may cause improper slaking.

As shown in Figure 1, specific surface area of slaked lime particles is highly dependent on the water to lime ratio, with surface area increasing as water to lime ratio decreases. As the graph shows, this increase is greatest when water to lime ratio varies in the region between 2.5:1 and 6.0:1.

November, 1997

**Figure 1. - Specific Surface of Calcium Hydroxide with Different Water to Lime Ratios [68 Deg. F Water]**



Source: [A Study of the Reaction Between Calcium Oxide and Water](#), T.C. Miller, Published by the National Lime Association