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Equipment Selection for Lime Slaking and Their Impact on the Slaking Process

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There are essentially three types of lime slaking equipment used for the lime slaking process. They are:

A. Slurry Slakers
B. Paste Slakers
C. Ball Mill Slakers

A. SLURRY SLAKERS

Available sizes: 150 pounds per hour to 50,000 pounds per hour

These slakers are the most common type of slakers used throughout the world. They operate with a water to lime ratio of 4 or 5 to 1. The dry CaO and water are vigorously mixed in the slaker by a specially designed agitator. The final result is fine lime slurry with approximately 20% of solid. The non-lime impurities in the slurry must be removed from the resultant slurry. This is done by a size classifier such as vibratory screen or by gravity-assisted separation of larger and heavier particles of grit.

Typically, in this type of slaker, the slaking process temperature is controlled at a preset temperature to within ± 2°F. This temperature control is achieved by varying the quantity of slaking water to maintain the constant temperature. This type of slaker can be used either for pulverized quicklime without the need for a grit classifier or pebble lime with a grit classifier.

Advantages of Slurry Slakers

- Lowest initial investment cost
- Low operating cost
- Highly reliable equipment due to minimal moving parts
- Low spare parts costs
- Ten to thirteen minutes retention time within the slaker at maximum feed rate
- Small particle size of hydrate (typically D/50 = 6 to 8 microns)
- Low power consumption

- Small foot print
- No special foundation required

Disadvantages of Slurry Slakers

- Not suitable for hard burned lime
- Typical maximum capacity is about 25 ton per hour. For larger capacities, multiple units should be used.

B. PASTE SLAKERS

Available sizes 1,000#/hour to 8,000#/hour

Paste slakers operate with a water to lime ratio of 2 to 1. The resultant slaked lime is in a paste form. If pebble quicklime is used, the paste must be diluted with water to a water to lime ratio of 5 to 1 to allow grit separation and removal. These slakers operate at a higher slaking temperature than slurry slakers (about 190°F to 200°F). They operate based on a water to lime ratio; therefore, the slaking temperature could vary widely based on the quality of lime or ambient temperature of the lime and slaking water.

Advantages of Paste Slakers

- Smaller size – fits in small areas particularly in retrofit applications
- Can produce higher percentages of solids - over 30% is used with pulverized quicklime.

Disadvantages of Paste Slakers

- Develops hot spots when large particles of lime enter the paste causing high temperatures of 212°F or higher. This excessive high temperature will cause agglomeration of lime particles which reduces the surface area of hydrate for reaction.
- Must operate based on the water to lime ratio; therefore, cannot operate at a constant temperature.
- Retention time is three to five minutes.
- Too many moving parts which result in excessive wear.
- Costly spare parts
- Limited sizes available

C. BALL MILL SLAKERS

There are two types of ball mill slakers

- Horizontal ball mills
- Vertical ball mills

The slaking process is the same for the horizontal and vertical ball mills. In both cases, the lime and water are mixed in a pre-feed chamber and then fed to the mill. The mixture is agitated and ground by the action of the mill producing hydrated lime slurry.

The vertical ball mill slakers are the most common type of mills used for lime slaking. The water to lime ratio for the ball mill slakers is 5 to 6 parts water to 1 part lime by weight. This is a higher water to lime ratio as used in the slurry type slakers.

The action of the media in the mill grinds the grit and impurities; therefore, eliminates the need for grit and impurity removal and disposal. The grit and impurities are finely ground and fed to the process with the lime slurry. To assure 100% grinding of coarse grit and impurities, hydrocyclones must be used with the ball mill lime slakers.

Advantages of Ball Mill Slakers

- Large throughput capacities of up to 100 ton per hour and larger are available.
- Eliminates the need for grit and lime impurity removal and disposal.

Disadvantages of Ball Mill Slakers

- Very high initial investment
- About 40% higher power consumption compared to slurry and paste slakers.
- Much larger foot print and equipment height.
- High operating costs compared to slurry and paste slakers.
- Spare parts are very expensive and replacement requires long down time.

GENERAL COMMENTS

Both pebble and pulverized quicklime can be used in all the slakers listed above; however, some precautions must be taken when using pulverized quicklime.

Pulverized quicklime is not as flowable as the pebble quicklime; therefore, the design of the silo must take into consideration this aspect of the pulverized quicklime. Pulverized quicklime is more prone to bridging and rat holing within the silo which could cause interruptions in the lime feed as well as potential of flooding; therefore, the use of a positive displacement feeder is essential when using pulverized quicklime.

On the positive side, fresh pulverized quicklime will slake faster and reach the operating slaking temperature quicker than pebble lime, as long as the lime is not air slaked. Furthermore, use of pulverized quicklime in slurry or paste slakers will eliminate the need for grit separation and disposal.

The other important factor that affects the slaking process is the chemistry of the slaking water. The best slaking water is potable water; however, this quality of water may not be available in all cases.

Industrial water generally contains different chemicals that impact the slaking process. The following is a list of chemicals that impact the slaking process positively or negatively:

Chlorides – Chlorides in slaking water will accelerate the slaking process and have a positive impact. The slaking water can contain up to 10,000 PPM of chlorides without concerns about corrosion; however, the piping for the raw water must be plastic or FRP. Sea water with chlorides of up to 30,000 PPM can be used for slaking; however, the slaking equipment must be protected from corrosion by rubber lining or other coatings.

Sulphates, sulphites and phosphates – Presence of any of these chemicals in the slaking water over 2500 PPM will retard hydration, which can increase lime consumption in the flue gas desulfurization. However for neutralization of industrial water, the impact of these chemicals are nil for concentrations of up to 10,000 PPM. The reason for this is the fact that in water neutralization the contact period between acid water and lime slurry is very long, between 1 and several hours.

Hard Water – If the slaking water has calcium carbonate hardness over 300 PPM, the hardness will result in calcium carbonate hard deposit in the system. This hardness will result in plugging spray nozzles on the slaker as well as the grit screen and cause operational problems.

The last but not least important factor that affects the slaking process is the temperature of the slaking water. Very cold water near 32°F will slow down the temperature rise of the slaking process limiting the final slaking temperature to below 180°F. On the other hand, slaking water with temperatures over 70°F would result in slurry with less percentage of solid than desired. Assuming a 180°F slaking temperature set point, the higher the slaking water temperature, the lower the percent of solids in the slurry and vice versa.