HORIBA Scientific

Application Note

Surface Area of Calcium Hydroxide

AN252

Calcium hydroxide, also called slaked lime or hydrated lime, is typically a white, odorless powder which is widely used in the chemical industry. An inorganic compound with the chemical formula $Ca(OH)_2$, it is produced by a chemical reaction when calcium oxide (also called quicklime) is mixed with water and forms calcium hydroxide.

Introduction

Calcium hydroxide and lime products have been in use for centuries. Going back to ancient Egypt and Roman cultures, it was used in construction. In modern times, many more uses were developed. The surface area of calcium hydroxide plays a key role in determining the manner and rate at which it reacts in chemical processes.

Common Uses

- Water Treatment: Calcium hydroxide is employed in water treatment processes as a flocculant. It aids in the removal of smaller particles from water, resulting in a clearer product. It is also used to reduce water hardness.
- Construction: In masonry, calcium hydroxide is a component of mortar and plaster. When mixed with sand and water, it can create a paste that hardens over time.
- Agriculture: As a soil conditioner and pH regulator, Calcium hydroxide can help improve soil quality.
- Chemical Manufacturing: Calcium hydroxide is used in various chemical processes, including the production of calcium-based chemicals.

Other Applications:

- Food industry
- Dental industry
- Environmental
- Paper industry

Gas Adsorption Technique

Surface area in this case is measured by a technique known as gas adsorption or physical adsorption (physisorption). Surface area is typically reported as meters squared per gram.

Figure 1. Example of calcium hydroxide (slaked lime) powder.

Adsorption takes place on the surface of a material. Gas molecules of known cross sectional area are carefully inventoried as they adhere to the surface. By knowing the number of moles of gas adsorbed and their cross section, the total surface area under test can easily be calculated.

The adsorption process occurs due to surface energy typically described as Van der Waals forces. Left alone, most materials will adsorb water or other vapors to satisfy this surface energy. Thus, to take advantage of these surface forces for measurement, the adsorbed impurities must be removed. This is accomplished through a process known as degassing, whereby a sample is placed in a holder and an inert flow of gas passes through the sample powdered bed as it is gently heated. The applied heat causes the adsorbed impurities to break free of the surface of the material and the flow of gas sweeps them away.

Cleaned in such a way, the sample holder may now be placed on an analysis station where it is cooled (typically to liquid nitrogen temperatures) in a cryogen Dewar as a gas mixture (typically nitrogen in a carrier gas of helium) flows across the surface. As the sample and gas cool, nitrogen molecules in the flowing gas mixture lose energy and are adsorbed onto the sample surface.

Again, monitoring the number of moles of gas adsorbed as a function of gas concentration allows us to calculate several adsorption data points. For more rapid analysis a single point may be collected.

The most common calculation method applied to derive specific surface area is the Brunauer, Emmett and Teller (BET) method.

Experimental

A commercially available calcium hydroxide powder sample was sent to the HORIBA Instruments Incorporated applications lab in Irvine, California for analysis. The sample was analyzed using the new SA-9650 surface area analyzer. Three separate aliquots weighing between 0.2 – 0.3 g were placed in sample tubes. Degassing was performed on the 3 integrated degas stations of the SA-9650 at 300°C for 3 hours. Samples were then transferred to the 3 analysis stations and separate analyses were performed for single point and multi point surface area. Each type of test was repeated 3 times. The results are shown in the tables below.

Single Point*

	Channel 1	Channel 2	Channel 3	Average of 3 Channels	CoV (%)
Test 1	13.02	13.42	12.53	12.99	2.80
Test 2	13.08	13.45	12.54	13.02	2.87
Test 3	13.05	13.4	12.55	13.00	2.68
Average of 3 Tests	13.1	13.4	12.5		
CoV (%)	0.19	0.15	0.07		

Multi-Point*

	Channel 1	Channel 2	Channel 3	Average of 3 Channels	CoV (%)
Test 1	13.42	13.83	12.91	13.39	2.81
Test 2	13.38	13.83	12.92	13.38	2.78
Test 3	13.23	13.76	12.91	13.30	2.64
Average of 3 Tests	13.3	13.8	12.9		
CoV (%)	0.61	0.24	0.04		

*The difference between single point and multi point analyses are linked to assumptions made in the single point calculation. Multi-point results are typically more accurate. However, in terms of repeatability and reproducibility, either measurement is quite robust and single point measurements are extremely fast – supporting high throughput, production, or quality control environments.

Conclusion

The HORIBA SA-9650 surface area analyzer proved to be an ideal instrument for measuring the surface area of calcium hydroxide both by single and multi-point analysis. The analyses were fast, repeatable and the instrument is robust. The methodology described in this document should be useful as a guide to customers using the SA-9650 for calcium hydroxide or other powdered samples.