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Technology & Industrial Machinery

# Application of Quick Lime & Hydrated Lime

***Pulp and paper***

***Water & Sludge Treatment***

***Pulp and paper***

***Environment & Agriculture***

***Construction***

***Steel Metallurgical***

***Sugar Refining***

## 1- Calcium carbonate

Limestone is a naturally occurring mineral. it is essentially calcite, which is theoretically composed of calcium carbonate. Earth's crust contains more than 4 % of calcium carbonate. It is a chemical compound with the formula $CaCO_3$ and a common substance found in rocks as the minerals calcite and aragonite (most notably as limestone, which is a type of sedimentary rock consisting mainly of calcite). Also, Limestone is produced by the sedimentation of the shells of small fossilized snails, shellfish, and coral over millions of years.

### 1-1-Quick Lime

If limestone is heated to a temperature in excess of about 800 $C^o$, carbon dioxide is driven off and what remains is quicklime, calcium oxide.

Limestone decomposes into quicklime and carbon dioxide:

$$CaCO_3 \text{ --> } CaO + CO_2$$

by weight 100 --> 56 + 44

The process is called 'calcination'. If calcination is carried out correctly the lumps of quicklime are approximately the same size as the original lumps of limestone but much less dense, because of the weight loss of 44% arising from the removal of carbon dioxide.

### 1-2- Lime Hydrate

If a precisely controlled amount of water is added to quicklime, a (violent) reaction ensues with much evolution of heat. In the chemical reaction with water the lumps of quicklime break down to a dry fine white powder known as hydrated lime or lime hydrate.

**Quicklime +** (a controlled amount of) **water --> hydrated lime** (also called lime hydrate).

$$CaO + H_2O \text{ --> } Ca(OH)_2$$

If excess water is added the lime is said to have been slaked and the outcome is a slurry or paste of hydrated lime, such as might be used for lime-washing a wall or for spreading on acid ground to reduce acidity and improve soil structure. Quick lime was also spread directly on the ground and in the eighteenth century its use was often a requirement set down in farm leases.

## Applications of quicklime and hydrated lime

### 2-1- Iron and steel plant

The lime industry has developed a large range of products that are dedicated for their usage in different applications. The steel industry, beside its main processes, must also manage different utilities, leading to some specific needs, especially in environmental management.

Slag making is critical to steelmaking. Very pure lime (>95% CaO) is critical as a purifying agent or flux in steel making. Lime are the most economical and environmentally friendly fluxes, acting as an antidote to impurities, and helping to clean the steel and protecting refractories. The lime characteristics and requirements vary for each processing step during iron- and steelmaking. Lime fines act as cement in the agglomeration process; lump or injection lime helps to maintain the alkalinity and the removal of phosphorus during the BOF process.

Lime is commonly used in the flotation of sulphide ores to facilitate concentration of the desired metal. This application is largely practiced in the Copper, Zinc, Nickel, Gold and Lead mining industries. - Lime is used to boost and control pH of cyanide Gold and Silver leach solutions. By adjusting pH, the role of lime is to maintain the cyanide solution in liquid form, avoiding the formation and loss of cyanide gas into the environment.

High-calcium soft-burnt lime with the lowest possible level of impurities potentially improves the productivity, reduces cost, improves metallic yield, cleans the steel, improves safety, and provides better environment in the steel shop [3].

### 1-3- Construction and Civil Engineering

Lime is an important commodity for construction actives and for building materials, with an increasing use in innovative construction materials.

Lime can be used to treat soils in order to improve their workability and load-bearing characteristics in a number of situations. Quicklime frequently used to dry wet soil at construction sites and elsewhere, reducing downtime and providing an improved working surface. An even more significant use of lime is in the modification and stabilization of soil beneath road and similar construction projects. Use of lime can substantially increase the stability, impermeability, and load-bearing capacity of the subgrade. Both quicklime and hydrated lime may be used for this purpose.

A recent application of lime is the use of hydrated lime in the cement filler which consolidates underground works such as tunnels. Hydrated lime also improves the performance of the asphalt mixes used for road surfacing. It increases their resistance to stripping, rutting and age-hardening.

Lime is a vital chemical used in building this infrastructure. From the addition of lime to control expansive clays in highway and airport construction to special hydrated dolomitic limes for increased masonry bond strength in buildings, lime has met this challenge and will continue to do so [4].

### 1-4- Agriculture

Lime is alkaline, while plant and microbial growth and nitrogen fertilizers produce acid. Adding lime to acidic soil causes the soil's pH to rise from acidic toward alkaline, or from pH 5 to pH 7, for example. Lime displays a number of advantages including the preservation of the chemical condition of the soil. Others are the improved drainage, increased aeration, and a stabilized soil structure. It also reduces some greenhouse gas emissions, but this has to be set against the emissions of $CO_2$ when lime reacts with soil acidity [5, 6].

### 1-5- Industrial Chemical

Lime has numerous applications in the chemical industry thanks to its natural properties and competitive price. It is used to produce citric acid, polyvalent alcohols and synthetic plasters. It is also used as a reactant in chemical synthesis or to change the pH value. Most of the process water in the chemical industry requires treatment with lime to correct its pH and mineral content.

### 1-6- Pulp and paper

Pulp and paper industry is a source of a wide range of solid inorganic and organic wastes generated during the various processes in bleached Kraft production .Lime is traditionally used to reconstitute caustic soda from the sodium carbonate left over from the pulp-making process. During this process, sodium hydroxide is converted to sodium carbonate. The pulp mill then adds calcium oxide, also known as quicklime, to convert the sodium carbonate back to sodium hydroxide in order to use it again. The resulting reaction produces a very fine precipitated calcium carbonate ($CaCO_3$). This filler is used in paper production to enhance the paper's whiteness, opacity and texture. Lime is also used as a reagent to soften process water in paper factories [7].

### 1-7- Food industry

Lime is reacted with crude sugar juice for the production of both cane and beet sugars. Lime is an ingredient in baking soda and helps keep fruit and vegetables fresh [4].

### 1-8- Environment

The use of lime to solve environmental problems is one of the fastest markets for lime products. lime has found key uses in almost every area of prevention and reduction of pollution, including treatment of air emissions, treatment of both drinking water and wastewaters, and radiation of hazardous wastes. Lime is unique characteristics, coupled with its low cost, make it an attractive choice for these applications [8].

### 2-7-1- Clean air

The constant demand for power has led to an increase in the burning of fossil fuels. Many of these fuels contain sulfur and the releases of gases from them in the atmosphere are the main cause of acid rain. This can be devastating killing trees, providing sterile lakes and generally despoiling the environment. Utilities and other operators of coal-fired power plants and incinerators use lime to remove pollutants from their power-plant smokestack gases. Lime is used in processes designed to treat waste gas emissions, which significantly reduce the effect of damaging pollutants in the atmosphere.

### 2-7-2- waste water

Lime plays a crucial part in industrial waste waters treatment and that is both economic and effective. Lime products, that are hydrated lime and quick lime, can adjust PH and alkali in coagulation, flocculation and biological purification processes. Lime is therefore ensures that the potential hazards of toxic organic wastes, heavy metals pathogenic germs and bacteria and malodorants are largely removed [9, 10].

### 2-7-3- Sewage treatment

Lime reduces pollution by removing organic matter, phosphates and nitrogen from waste water. It prevents over vegetation in streams and lakes, controls odors from waste ponds and precipitates heavy metals [4,11].

## 1-9- AAC Panel (Autoclave Aerated Concrete)

In recent decades, the need for thermal insulation, fire-resistance and mold resistance building materials has grown significantly.

AAC panel with these characteristics can be resource efficient building methods that linked to energy efficient masonry construction. Quicklime is a key component of Autoclaved Aerated Concrete (AAC). AAC is produced by mixing quicklime with cement, sand, water and aluminium powder, resulting in slurry that rises and sets to form lightweight honeycomb structured blocks which have excellent thermal and sound insulation properties [12].

## 2- Marketing

The annual world-wide lime production amounts to approximately 350 million tons. The lime market is governed by the sales of two kinds of lime products including hydrated lime and quicklime. Figure 2 shows the world-wide use of lime in the main market segments [13].

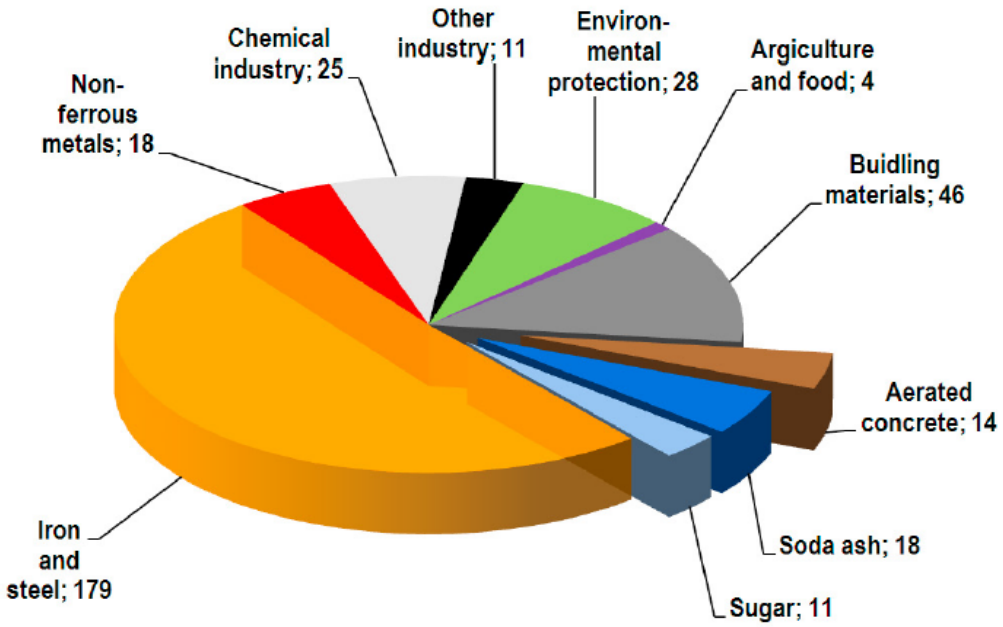


Figure 2: word-wide use of lime in the main market segment in millions of tons per year, (Source: USGS 2013 Minerals Yearbook).

As the consumption of lime has increased over last few years, the global lime market is expected to witness a steady upsurge. The reasons for this involve rapid urbanization in developed as well as emerging economies. According to a research report published by TMR, the global lime market had a value of US$44.84 bn in 2015, which is expected to rise to US$76.48 bn by 2024.

In the last few decades, there has been a tremendous migration of people from rural to urban areas, which caused a significant rise in demand for housing spaces. As lime is a prime element required for construction of housing spaces, rapid urbanization as well as migration factors, which lead to rise in construction scenarios, are prime drivers of the global lime market.

Lime is also is a key component for waste water treatment processes, and used for extraction of several metals as well as non-metals. In this way, rapid industrialization as well as improved water treatment processes are two prime reasons for causing an upsurge in the market. Lime is largely used in chemical feedstock for the production of engineering and building materials. The chemical industry is slated to experience a wide growth in the near future, thus proving to be a catalyst for the global lime market too.

Moreover, Approximately 50% of the overall lime production is used for the iron and steel industry and therefore the growth of the lime market is significantly influenced by the steel industry. Today, the market growth is low or stagnating. However, as the lime industry is an old historically grown industry all different types of lime kilns are used to produce quicklime. Many of these existing lime kilns do not meet the present product and / or emission requirements. Usually the thermal efficiency of older kiln types is also not good enough. These are important reasons why the industry still needs more modern lime kilns.

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