Lime

What is Lime?

Lime is a generic term, but by strict definition it only embraces manufactured forms of lime – quicklime (CaO) and hydrated lime ($Ca(OH)_2$). It is, however, sometimes used to describe limestone products, which can be confusing.

The raw material for all lime-based products is a natural stone: limestone, which is composed almost exclusively of calcium carbonate ($CaCO_3$). When limestone contains a certain proportion of magnesium, it is called dolomite, or dolomitic limestone ($CaMg(CO_3)_2$). It is widely geographically available all over the world, (the Earth's crust contains more than 4% calcium carbonate,) and it is used for many different purposes.

In the lime or dolime production process the blocks of limestone or dolomite from the quarry are blasted, crushed and sorted by size in screening plants. At this stage part is used directly as aggregates for road construction, for concrete or other applications. Part is ground to lime fertiliser or pulverised into limestone powder, used in applications such as for cleaning flue gases, for animal feed or for fillers in many products (concrete, asphalt, carpet-backing etc.).

The rest of the high quality limestone, with a defined particle size, is calcined in a lime burning plant at a temperature of 900-1200°C, at which temperature it is decarbonised in either vertical shaft or horizontal rotary kilns fired by gas, oil, coal, coke or other fuels. During that process, carbonate is converted into oxide (CaO or $CaMgO_2$) and CO_2 is released. The combustion phase is essential for obtaining a quality of lime that satisfies the required characteristics. It is important to adjust the reactivity, because the various applications require reaction times (reaction of oxide with water) that can vary from a few seconds to more than thirty minutes. The products must possess precise physical and chemical characteristics for the different standards required for certain applications. The quicklime obtained can be used as such, or can be crushed, finely ground (even to micron size), depending on its intended use.

Quicklime can be hydrated, i.e. combined with water, in a hydrating plant. The quantity of water added is more than the amount required for the hydration reaction. The excess water is added to moderate the temperature generated by the heat of reaction by conversion to steam. The end product is hydrated lime or slaked lime ($Ca(OH)_2$) in the form of a very fine powder, suitable for a variety of applications.

Milk of lime and lime putty are produced by slaking of quicklime with excess water.

Slaking is done in both batch and continuous slakers. The term milk of lime is used to describe a fluid suspension of slaked lime in water. It may contain up to 40% by weight of solids. Milk of lime with a high solids content is sometimes called lime slurry. Lime putty is a thick dispersion of 55% to 70% by mass of slaked lime in water. Lime paste is sometimes used to describe a semi-fluid putty.

Multiple properties – many uses

Lime can be used for a wide range of purposes because of its different characteristics:

- alkaline reaction of lime with water (neutralization, coagulation, flocculation)
- forming of water insoluble calcium salts (precipitation of heavy metals and sulphates)
- re-carbonation reaction with CO_2 (hardening of plaster, increase of acid capacity)
- pozzolanic reaction with silicates (forming of calcium silicates)
- heat generation by contact of quicklime with water (drying, pasteurisation, disinfection)

While lime is one of the earliest industrial commodities known to man, its production and uses have grown with the times, and it continues to be one of the essential building blocks of modern industry.

- **Iron and steel:** Quicklime is used to form slag with the acidic impurities of ores and other raw materials. It purifies iron in the blast furnace and steel in the converter. Dolime addition to slag extends the life of (dolomitic) refractory linings in converters, protecting them from the aggressive effect of certain impurities present in the hot metal. Lime is used as well for hot metal desulphurisation and is also essential to producing metals other than steel, such as copper, aluminium and magnesium.

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- **Flue gas treatment:** In power stations and industries, most sulphur dioxide (SO_2) emissions come from the combustion of fossil fuels (coal, lignite and petroleum products). Other processes, such as the incineration of household or industrial waste, generate SO_2 and other acid gases (HCl, HF) which, if they are not captured, contribute to an increase of acidity in the atmosphere and the formation of acid rain. Lime is used to capture SO_2 and other acid gas out of the flue gas

- **Water treatment:** The use of lime for *industrial waste water* to adjust pH levels can precipitate most heavy metals in the form of hydroxides, sulphates and phosphates as insoluble salts. For *municipal waste water,* lime increases the acid capacity, avoids the acidification of the biological process and stabilises the biocenosis. In *drinking water* and *process water* treatment lime eliminates undesirable organic matters and metallic trace elements. Lime is used for softening or re-mineralising drinking waters.

- **Sludge treatment:** Lime is widely used to coagulate and to stabilise industrial residual sludge or dredging sludge and for treating urban bio-solids before agricultural re-use or incineration. Lime is also used for sanitising sludge.

- **Civil engineering:** The addition of lime to clay containing soil improves soil properties (i.e. better densification). Its reaction with water enables it to dry out damp soils. Lime is increasingly used to recycle excavated material from sites in urban areas. Hydrated lime improves the performance of asphalt mixes used for road surfacing. It increases their resistance against stripping, and also against rutting and age-hardening. In tunnel construction, hydrated lime is used to improve the quality of mortars. Quicklime dries out the mud from the excavation and therefore improves its handling. It is also used in the deep soil stabilisation process (lime treated columns) to improve soft soils, reduce settlements and increase stability. Hydrated lime is one of the components used to produce injection binders.

- **Construction materials:** Builders have made use of the binding properties of lime. For example, lime-based mortars are often used in masonry and in plaster mixes for building facades. In addition, lime is being used increasingly in modern building materials, such as for aerated concrete blocks, for hemp-lime blocks and for sand-lime bricks. These materials are highly valued because they have excellent thermal and acoustic insulating properties and they are easy to use.

- **Agriculture:** Various mixtures of lime, limestone and dolomite are used in agriculture and forestry, both for correcting acidity in the soil and for adding nutrients which contain magnesium and calcium. These nutrients are essential for healthy plant growth and for increasing crop yield. In forestry, dolomite-based products stimulate photosynthesis and, by lowering the degree of acidity in the soil, ensure a better assimilation of nutrients, resulting in a significant increase in forest productivity.

- **Environment and soil protection:** Lime is used to combat acidification and control pH of soil, ground and surface waters. It is used for soil remediation i.e. treatment of soils polluted with hydrocarbons and heavy metals. Systematic liming of rivers and lakes (mainly in Scandinavia) has been carried out for more than 20 years to maintain their rich ecological system.

- **Food and feed additives, pharmaceuticals:** The human food, animal feed and pharmaceutical industries use lime as a neutralizing agent, to absorb excess moisture and carbon dioxide, as a preserving agent, as a filler, as an acidity regulator and as a source of calcium.

- **Others:** Lime is known as the most economical and most widely used alkaline reagent in the chemical industry. It is also used for the glass, leather, paper and sugar industries.

Lime is the only material that can perform so many functions. In most cases lime could only be replaced, if at all, by expensive synthetic materials. There is lime production in almost all EU countries which means that most users can find a nearby source, keeping transportation costs and also, therefore CO_2 emissions for transport, to a minimum.

Lime Standards

European standards exist for a number of lime products:

- EN 459, Parts 1, 2, 3 for building lime
- EN 1017 for half-burnt dolomite
- EN 12485 for test methods
- EN 12518 for calcium lime products used in drinking water treatment

For more information, please contact:

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