LimeCure 50 Polymer Behaviour

An explanation of the science behind LimeCure 50

This document helps to explain what is currently known about how **LimeCure 50** works and explain the reductions in lime consumption associated with its use.

We have analysed numerous lime slurry samples (in excess of 43) for particle size distribution and surface area. This was done in a variety of slurries to get a large cross sectional view of the slaking process. This testing was also done in separate laboratories with different equipment.

Because we had taken lime slurries from a large number of different geographies of the United States, we were able to confirm that limestone source had no effect on the final size of the individual particles in the slurries produced.

Our intent was to see what differences occur when the polymer is introduced into any of these conditions. The results were surprising and not completely what was expected.

In all cases (treated and untreated) the lime slurry individual particles were all the same size and had the same size distribution range (see chart). As such, it seemed as if all the final products were compositionally the same particle. This size ranged from 0.02 to 0.8 microns with a peak occurring at 0.18 micron. This size analysis was then confirmed by SEM (scanning electron microscope) determination.

At this point some necessary detail needs to be provided the term “agglomeration” that will be used in this document and it is critical to the overall understanding of what will be described. As used herein, agglomeration would describe small distinct individual particles physically sticking together to make larger distinct masses. The particle size distribution analysis shows the individual particles to be primarily the 0.18 micron size while the agglomerate’s sizes varied.

In performing the laser shadow method particle size analyses, it was discovered that the **LimeCure 50** treated slurries’ agglomerates will easily and freely disperse into the individual particles without any significant energy application. While the untreated slurries’ agglomerates require (ultra-sonic) energy input for these to break into their individual particles (submicron individual particles). In all cases, the agglomerated particles were found to be primarily in the 10 to 44 micron range. Once the untreated slurry that had been sonically dispersed was left, the particles immediately started to

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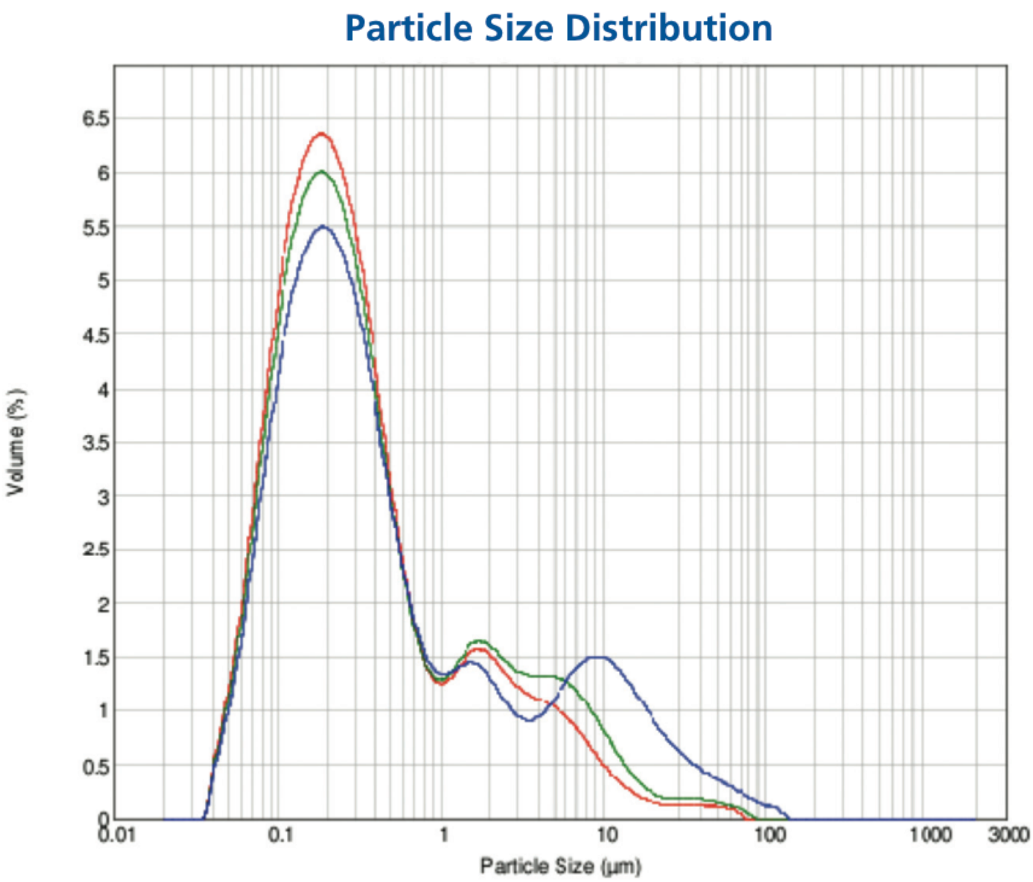
agglomerate. The re-agglomeration of the **LimeCure 50** treated slurries was much slower, more random and none of the agglomerates seems to retain integrity when compared to the untreated agglomerates. By this, the treated agglomerates would form, break up and reform with other agglomerates with only the light energy used for magnification. This indicated a rather low bonding energy within these agglomerated masses of the treated slurry. This was not the case with the untreated samples. Once formed, the untreated slurry agglomerates remained as a stable mass that required a distinct input to disperse.



SEM confirmed that these larger agglomerates were made up of these smaller particles regardless of being treated or untreated slurry.

Next, particle surface area measurements were made using helium adsorption; this confirmed that the polymer treated slurry was made up of many smaller disassociated particles while the untreated slurry was larger with more well-formed and stable agglomerates.

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The surface area measurements would seem to have validated prior work by others in particle sizing (10-44 micron) of slurries. What it also showed was that agglomeration was very influenced by lime used, slaking temperature and slaking preparation for untreated slurries. Untreated lime slaked at elevated temperature had far more smaller agglomerates (10-20 micron) while colder slaking favoured the larger size (25-44 micron) agglomerate formation.

Unlike the untreated slurry, the **LimeCure 50** treated slurry maintained a uniform surface area independent of lime used, slaking equipment and temperature.

EDAX measurements of the particles, over 1 micron that do not disperse with applied sonic energy showed these particles to be primarily composed of aluminium, magnesium and silica. The larger the particles the lower the calcium concentration became and the higher the other elements became such as iron, manganese, silica and aluminium. This would suggest these large particles/materials to be the grit components of the lime. The EDAX of the submicron particles showed these to be primarily calcium and oxygen while the treated particles also contained carbon with a higher oxygen to calcium ratio. This suggests the presence of the associated polymer since the carbonate was not found to be present.

One added physical change with the treated slurries is the decrease in viscosity. Typical untreated lime slurry in the 35% solids range will have a viscosity well over 30,000 cps while the treated slurry will be 1000 cps or less. The bonding energy between the particles obviously impacts the attraction between the individual particles and their agglomerates.

How this affects polymer use

The polymer must be dispersed into the slaking water prior to slaking because it must be available for the early stage formation of the calcium hydroxide molecule. As the CaO is hydrated, the individual molecules of $Ca(OH)_2$ form in solution and then super saturate from the solution as calcium hydroxide hexahydrate precipitates. The polymer then holds these particles off one another, preventing their rapid and stable agglomeration into larger more tightly bound particles. This would be an action similar to that seen in typical scale inhibition, scaling or fouling of the slaking equipment is not seen or grossly reduced.

The fact that the **LimeCure 50** treated slurry has a larger surface area makes it easy to understand its more reactive nature. This also explains the faster reaction of the treated slurry over the untreated. With the addition of the alkali solutions

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LimeCure 50 into the water prior to slaking, the polymer becomes fully incorporated into or onto the surface of the calcium hydroxide hexahydrate as it forms. The **LimeCure 50** would seem to disturb the binding force of particle to particle and in turn lowers the agglomerated force between the larger agglomerates. Because the agglomerates still form, it would indicate this energy is not completely eliminated.

It is now understandable that regardless of the lime source, slaking method or water source the **LimeCure 50** treated slurries will be more reactive than untreated. Reduced consumption would be expected in all kinetically controlled applications due to the ease at which the much smaller particles are released and the gross increase in surface area which results.

The role and function of the **LimeCure 50** is also clear. It must be able to withstand the slaking conditions and must be able to neutralise the binding charge of the individual calcium hydroxide molecules.

In actual plant applications, these physical-chemical properties have resulted in operational benefits. In spray dry absorber applications (SDA's), this reduced viscosity will enable the same pumping energy to handle more volume and create better atomisation. When this is combined with a smaller particle and a greater surface area, a significant reduction in lime usage has resulted. This reduction has been in the average range of 30%

In lime softening applications, the smaller faster dispersing particles with a much greater surface area has resulting in lower lime use and better water produced. Here the reduction has been similar at around 30%.

This technology is covered with 2 (two) current US patents, one pending US patent and a pending PCT for worldwide coverage. Alkali Solutions Ltd has the UK rights to this technology from the owner of this intellectual property and would be happy to demonstrate how it will save your operation money while reducing maintenance problems.

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