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LIME IN ENVIRONMENTAL USES
FLUE GAS DESULFURIZATION

Harry Francis, Technical Manager
National Lime Association

In the late 1970's the U.S. Environmental Protection Agency passed the Clean Air Act. The Act specifically addressed the control of emissions from utilities and coal burning power plants. It also affected industrial boilers and incinerators.

In 1978 the lime industry was led to believe that there would be a tremendous demand for lime over the next four years, 1978 - 1982, with demands reaching as much as 4 - 5 million tons of lime for flue gas scrubbing - the removal of SO_2 from flue gasses. This demand never developed.

The original law required removal of specific amounts of sulfur from the gasses based on the percent of sulfur in the coal.

In the evaluation for suitable sorbents, lime and limestone were determined to be the most suitable materials.

Wet Scrubbing

Lime - calcium hydroxide reacts with SO_2 to form calcium sulfates and calcium sulfites, requiring about 1 ton of lime to remove 1 ton of sulfur.

Limestone also reacts with SO_2 to form calcium sulfate and calcium sulfite, but is much less reactive than lime, requiring 2.5 to 3 times as much material to remove the same amount of sulfur.

In pilot projects we soon found out that lime systems often caused scaling problems, and that the addition of a small amount of magnesium hydroxide helped to prevent scaling. As a result of this research, mainly done by Dravo Lime Company, Dravo introduced into the market "Thiosorbic" lime - magnesium enhanced lime. Several Thiosorbic lime systems have now been up and running for over 10 years with better than 95% SO_2 removal.

Most of the SO_2 scrubbing, about 60%, has been done with pulverized limestone. The use of limestone vs lime in scrubbing is an interesting story.

I mentioned earlier that 2.5 to 3 times of limestone over lime is needed to be used for comparable SO_2 removal. Limestone use also requires much larger scrubbers, pulverizing equipment, 2-3 times material storage space and 2-3 times the capital investment. After treatment, the sludge disposal problem is also 2-3 times the volume of the lime scrubbing sludge.

So, you ask, what happened? Frankly, at first we thought there was no way that lime would not be the preferred material. But soon we learned!

Several things occurred that affected these early decisions.

One was simple acid neutralization experiments. In the laboratory, if one digests limestone (finely ground) in acid, it takes about 2 times as much limestone as lime to neutralize the same amount of acid. However, this does not occur so efficiently in the scrubber.

So, using these figures the Electric Power Research Institute (EPRI) developed computer models with parameters including capital costs, SO_2 levels, operating costs, sorbent costs, and sorbent availability.

At that time (late 1970's) there was almost 700,000,000 tons of limestone being mined in the United States and about 20,000,000 tons of lime. Limestone was valued at about $3.50/ton at the mine face, and lime was about $40/ton at the mine face. Limestone prices had remained fairly stable for the last 10 years or so; and lime prices had escalated greatly during the same period due to the energy shortage - oil embargo, etc.

As a result, EPRI projected extremely high price escalations for lime, upwards of $100-$150/ton and relatively stable prices for limestone.

Even though the projected operating costs, capital costs, and disposal costs were much higher for limestone scrubbing over that for lime systems; the escalating projected lime costs overrode these other costs, and limestone became the choice for scrubbing.

As the 1980's developed in the United States there was considerable problems and extensive down time with limestone scrubbers vs lime scrubbers. In Europe and Japan much progress was made and lime scrubbers were much more prominent.

In 1990 when the latest Clean Air Act was passed, we again had renewed hope for increased lime usage.

In Phase III, 1990 - 1995 of the Act, 114 plants were affected and required to install efficient scrubbers or elect to burn an alternate low sulfur fuel.

This new law requires a specific percentage of sulfur removal with an objective of 10 million tons of sulfur removal by the year 2000. After 2000, there will remain a cap on the total sulfur emissions of 9.8 million tons/year.

In order to meet these targets, utilities may trade allowances from an efficient plant to cover one not so efficient. This plan has established a market for allowances. One allowance credit equals one ton of sulfur.

As a result, many utilities are again looking for more efficient scrubbers and are taking a second look at lime scrubbing systems.

Limestone systems requiring more capital, operating and disposal costs find it difficult to meet 95% removal even with expensive organic acid additives such as adipic acid, etc.

In lime scrubbing, we have plants that are effectively removing 95-98% SO_2 with an on line record of over 90%! This is quite an impressive record.

CO_2

One other area that until recently has not been addressed is that lime scrubbing also removes CO_2! It's true we produce CO_2 as we make lime so the net CO_2 level is the same. But as a point source, ie power plant locations, the total emissions are important, especially in a non-attainment area.

Dry Lime Scrubbing

The law also requires all boilers - 25mw and above to be controlled after the year 2000. This includes all industrial boilers, waste to energy plants and municipal waste incinerators, to control SO_2, HCl, other gases and heavy metals (especially mercury).

As these plants are small and have little space for equipment, Dry Lime Scrubbing is likely to be the system of choice.

Dry lime scrubbing is accomplished by injecting lime slurry into the hot flue gasses where the neutralization occurs and the water flashes off. The lime/sulfur, gypsum particles are captured in electrostatic precipitators and bag houses as a dry powder.

Waste Disposal and Utilization

The waste products from both wet and dry lime/limestone scrubbing are treated with lime and fly ash to form non-leaching materials, often placed in landfills.

This material can also be used as engineering fill materials and as a raw material for light weight aggregate and building blocks.

Summary

In limestone scrubbing, several new plants are oxidizing the sulfite to sulfate, recovering the gypsum as an economic material. This has some promise, but natural gypsum is so available in North America that the economic utilization of artificial gypsum is questionable. The story sounds good though and many utilities are apparently exploring this course of action.

We believe the utilization of waste products in construction projects has a much better economic outlook, and is a viable beneficial use.

Currently in the US we use about three million tons of lime in scrubbing. We expect this to grow to some 6-8 million tons per year by the year 2000. Lime is the natural solution to pollution.

References:

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