EnviroCare

**MicroMist ML Micro-fine Lime™**
**Semi-dry Injection Systems**
**Patent Numbers 6,060,030 and 6,142,388**

# $SO_2$ Removal and Secondary Plume Abatement

*Acid Gas Removal*

## *Proven Process Advancements for Abatement of Reactive Plumes and Reduction of $SO_2$*

The MicroMist ML Micro-fine Lime semi-dry injection system is a proven, cost-effective $SO_2$ removal and reactive plume abatement technology. The MicroMist ML system (patent pending), has been shown to reduce $SO_2$ by more than 90 percent, while eliminating the secondary plume resulting from the condensation and reaction of chemicals in the gas stream after leaving the stack.

While many plants have shown they can achieve opacity and mass emissions particulate limits, a secondary or "reactive plume" can form after release to atmosphere, leading to a violation of ambient opacity and visibility limits. This is the case for many pyro-processing applications where reactive chemicals are a by-product of combustion or are present in unstable form in the raw materials.

### Benefits of MicroMist ML Micro-fine Lime Injection Systems

- Proven $SO_2$ emissions reduction and compliance
- Abatement of secondary or reactive plume
- Low capital costs
- Low maintenance cost
- Low energy consumption
- Excellent once-through sorbent utilization
- No slurry recirculation
- Easily retrofitted in existing GCT
- No plant downtime to install

***"We believe that use of calcium-based adsorption to reduce $SO_2$ in cement plant plumes and the prevention of the accumulation of ammonia in the preheater and mill system is unique and the only viable mechanism for secondary plume abatement. The method can be applied to any preheater or precalciner kiln and is expected to be accepted as BACT for $SO_2$ removal and plume opacity control."***

*Ronald L. Hawks—Director, Compliance & Engineering, Environmental Quality Management, Inc.*

**MicroMist™ Engineered Systems**

## *EnviroCare MicroMist $SO_2$ Control Technology*

Various industrial processes produce $SO_2$ and $SO_3$ by oxidation of sulfur in the fuel and by decomposition and oxidation of sulfides and organic sulfur in raw materials. Conventional dry dust collectors are not able to collect these sulfur compounds and, if not removed, they are released to the atmosphere.

### *Reactive Plume Phenomenon*

Many other gaseous components in the process gas stream (eg. ammonia, chlorides, etc.) can combine with these sulfur compounds as they cool in the emitted gas plume to form a fine, but very visible, particulate. Although this phenomenon may not register as a reportable particulate violation, it may violate other Clean Air laws and affect "good neighbor" policy.

### *Conventional Approach*

The conventional approach to $SO_2$ reduction has been to install a wet scrubbing system—typically, a forced oxidation limestone scrubber, with its high capital and maintenance costs, and its associated high energy use. Many of these conventional scrubbers require a separate scrubbing vessel, complete with slurry pumps, forced oxidation compressors, slurry recycle loops, mist eliminators and a dedicated control system. Moreover, these systems suffer from corrosion, increased maintenance and plugging due to large slurry particle size.

Another solution has been to scrub the gases with conventional dry adsorption and spray dry systems, but, due to their low once-through chemical utilization, it requires recycling large quantities of dry material to be cost effective.

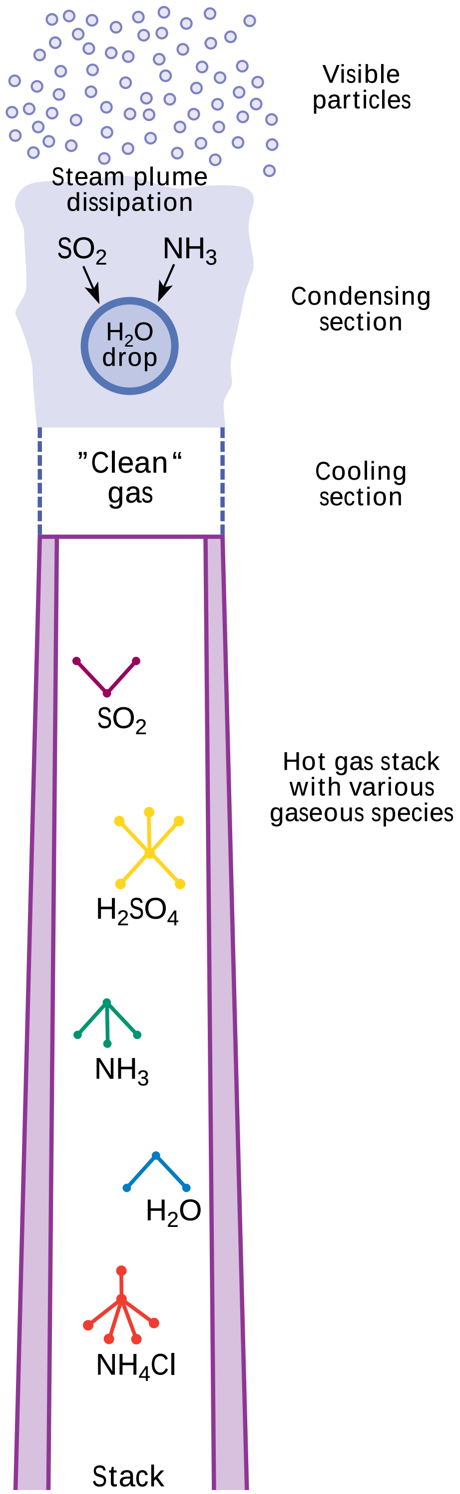
Because wet scrubbing is not able to prevent the combination of certain condensing gaseous chemicals, it cannot address the secondary or reactive plume phenomenon, which is a matter of concern due to stricter emissions regulations.

### *MicroMist Approach to $SO_2$ Control*

The MicroMist ML semi-dry injection system is a proven technology that uses a novel approach to $SO_2$ reduction. Simply put, it is a novel method of introducing micro-fine lime into the exhaust gas cooling or conditioning system to adsorb $SO_2$—along with other acid gases—thereby eliminating the secondary plume. It may be installed in a new or retrofit application, often without requiring a separate vessel.

The high $SO_2$ removal efficiency (>90 percent) rests in the implementation of a micro-fine lime system that relies on an emulsion of fine hydrated lime, which is introduced to the gas stream via a MicroMist delivery system. The size of the suspended lime particle allows it to dissolve into the water droplet at an accelerated rate, enabling efficient removal of $SO_2$ in the wet state, before the carrier water droplet has evaporated. Other versions of this technology utilize different chemicals such as potassium or sodium, which are naturally soluble and therefore fast reacting.

Secondary Plume Formation Diagram




## *Reactive Plume Theory*

Process exhausts contain gaseous components that, given the right atmospheric and stack gas conditions, will condense and/or combine to form a very visible reactive plume of fine particulate. This particulate is typically ammonium sulfate or ammonium chloride, but can exhibit itself in any one of many sulfate/sulfite/chloride compounds.

The process is simple. In a typical application, gaseous species in the gas stream absorb into the steam plume water droplets and react to form ammonium salts. These highly visible, sub-micron salt particles remain suspended in the atmosphere after the steam plume dissipates (when the water has evaporated).

In some cases, acid aerosols and ammonium salts can form directly, without the need for a steam plume. This can happen if the concentration of ammonium chloride ($NH_4Cl$), ammonia or sulfuric acid ($H_2SO_4$) is high enough to cause a reaction.

The important thing to note about many persistent, visible reactive or condensed plumes is that they can form in stack discharges that are relatively clear at the stack outlet. This is why secondary plumes—reactive or condensed—are often called "detached" plumes.

## MicroMist ML in actio


*This cement plant shows v ondary plume. Note how cl breaches the stack.*


*After adding micro-fine lim conditioning tower, the se peared. All that's left is the* on

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econdary plume has disap-
steam plume.

## $SO_2$ Reduction Methods

$SO_2$ is highly soluble in cool water and dissolved calcium ions react quickly with the $SO_2$, forming calcium sulfate. Conventional systems react $SO_2$ with calcium by injecting a slurry of lime and water into the gas stream. As the $SO_2$ combines with the dissolved calcium ions, more of the calcium in suspension dissolves into the water, combining with other dissolved $SO_2$ ions, highlighting the importance of dissolving as much of the calcium as possible before the water evaporates.

Conventional systems utilize lime with a particle size in the range of 50 microns. When the slurry suspension is atomized, the suspended particles make up a great percentage of the volume contained by the droplet. This results in the water evaporating faster than the lime can go into solution, making for an incomplete reaction, and resulting in high chemical usage and low $SO_2$ reduction efficiencies.

### The MicroMist ML System

The ML system introduces a micro-ground lime and water suspension to the gas stream. The $Ca(OH)_2$ micro-fine lime emulsion allows the calcium to dissolve and react as fast as the $SO_2$ is absorbed into the water droplet, resulting in high $SO_2$ removal.

Due to the size of the micro-fine lime particle (3-10 microns) and the fast reaction time (less than 2 seconds), the system is easily implemented in standard hydraulic or air atomized gas conditioning towers and in-duct spray systems. Residual aggregates of "dried" micro-fine lime continue to react in the dust collector with any remaining $SO_2$, adding to the overall $SO_2$ removal efficiency (>90 percent).

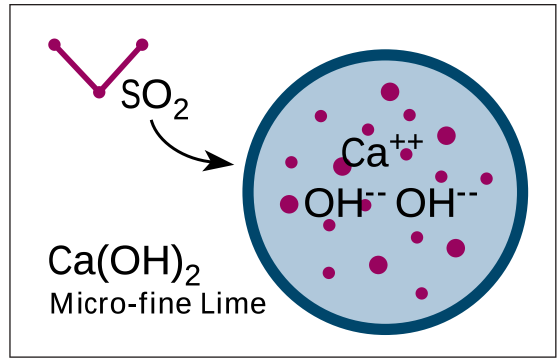



***Fig. 1**—$SO_2$ gas is absorbed into water droplets. $Ca(OH)_2$ ionizes in the water droplet.*

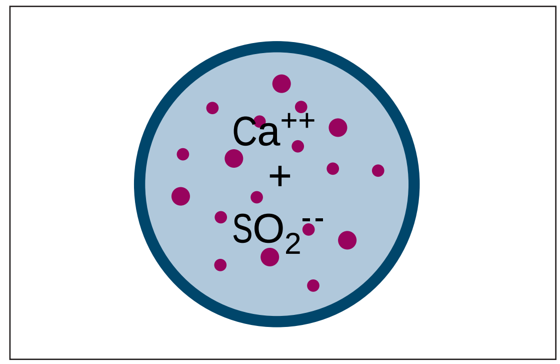



***Fig. 2**—$SO_2$ reacts with $Ca^{++}$ ion inside water droplet.*

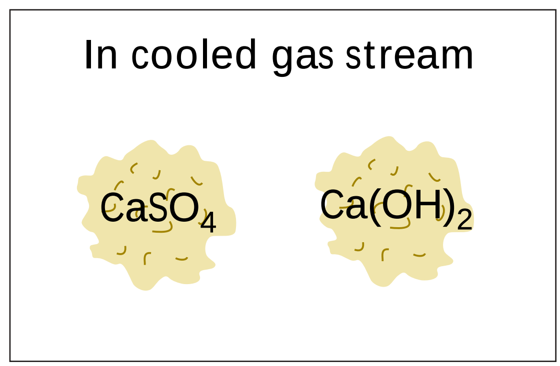



***Fig. 3**—"Dried" $CaSO_4$ salt and residual $Ca(OH)_2$ left over after $H_2O$ evaporates in GCT.*

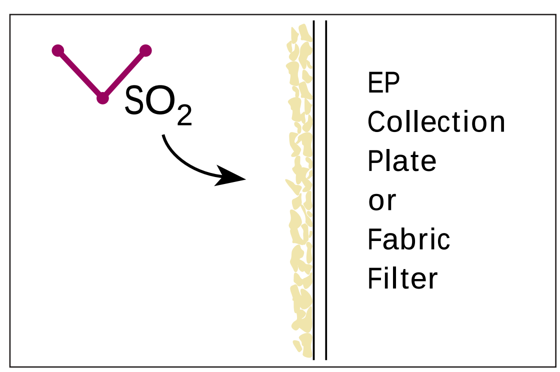
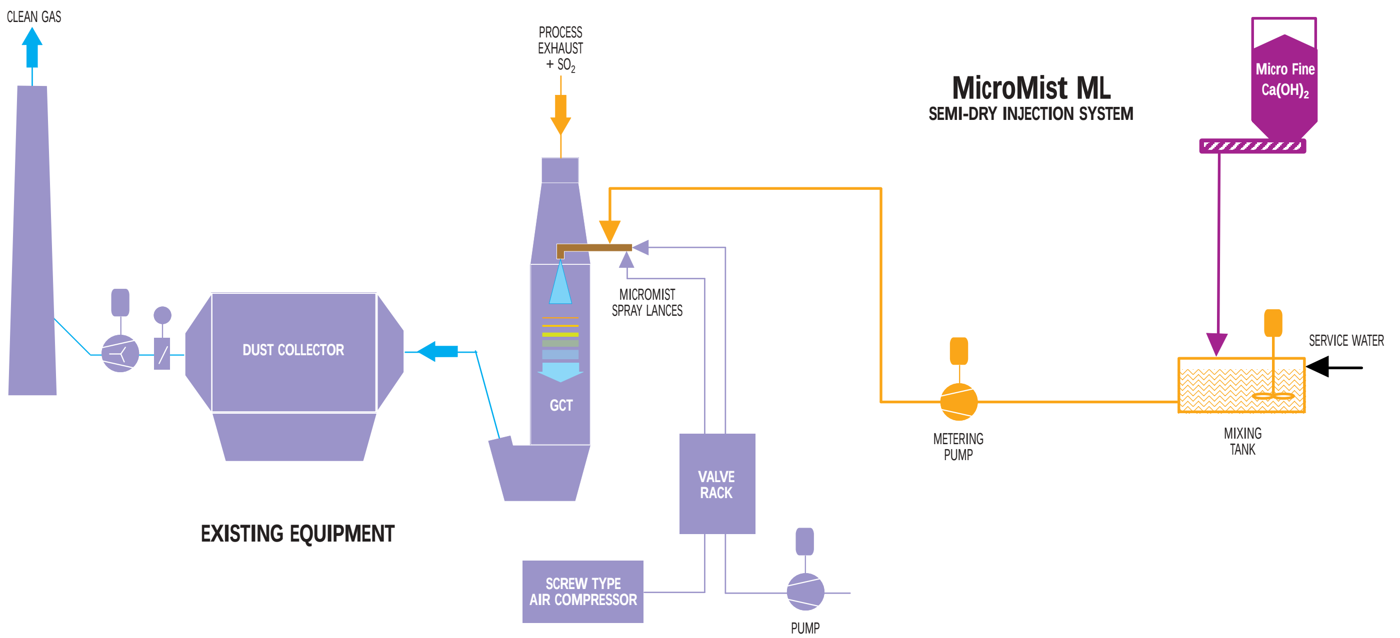


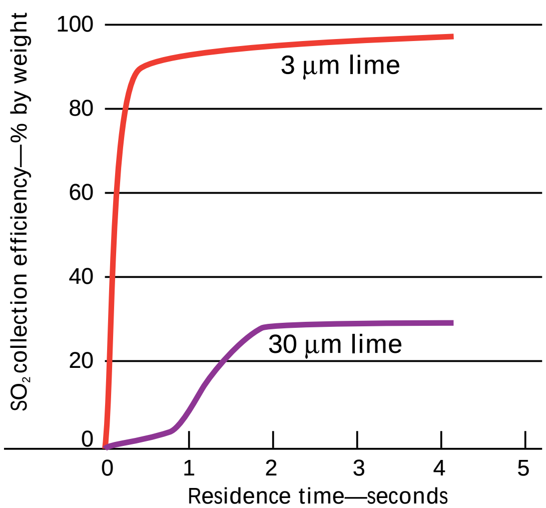

***Fig. 4**—Residual fine $Ca(OH)_2$ is captured in the dust collector and continues to react with remaining $SO_2$ gas.*

## MicroMist ML Micro-fine Lime Process & Instrumentation Diagram (Typical)

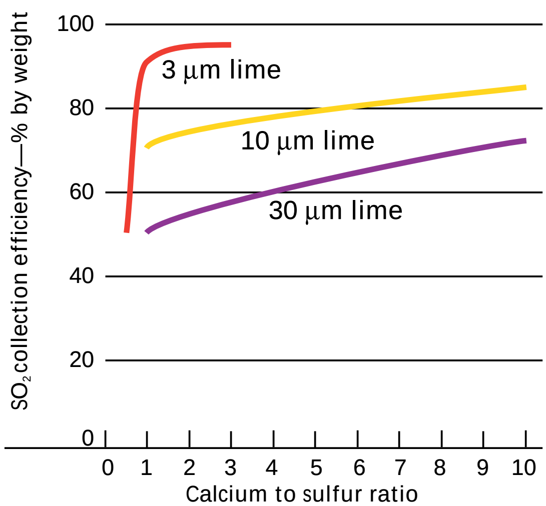



*A typical MicroMist ML installation follows this schematic. The setpoint for injection of emulsion is based on the production rate or on emissions sampled at the stack CEM. The setpoint is compared against the flow of micro-fine lime emulsion and a signal to increase or decrease the flow is transmitted to the control system. The emulsion is then injected into the gas conditioning water supply to remove the $SO_2$. Alarms and interlocks are utilized to ensure efficiency and prevent unnecessary plant downtime.*

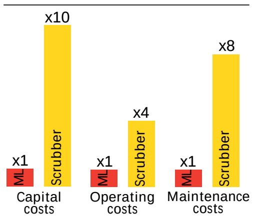
### $SO_2$ Removal Efficiency as a Function of Time




### $SO_2$ Removal Efficiency—Stoichiometric Ratio



Cost Comparison—MicroMist ML vs. conventional $SO_2$ scrubber



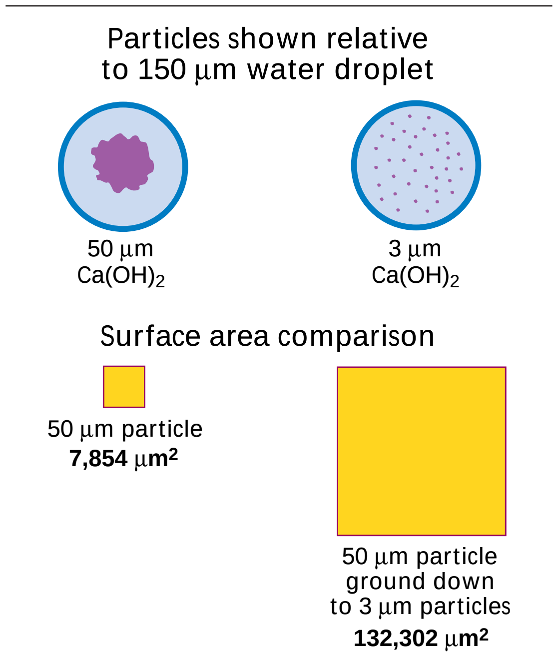

## *Consulting Services*

EnviroCare understands that investigating the sources of pollution and evaluating the potential solutions are complex undertakings. If you require on-site evaluation of your application, we will visit your site, make a determination of the problem and provide suggestions for a solution.

## *Engineering Assistance*

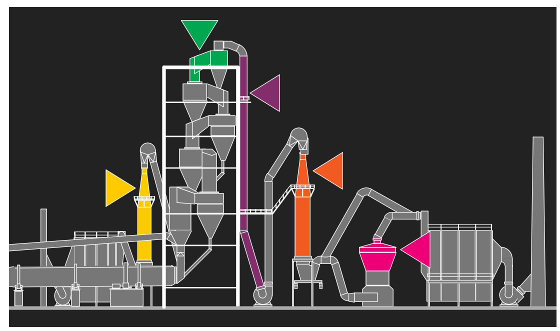
EnviroCare offers technical assistance and engineering analyses required for evaluating, planning and budgeting. This service is carried out directly from our offices in a timely manner. By providing us with your process data, we can supply you with the information required for planning and evaluating.

Lime Particle Size vs. Surface Area

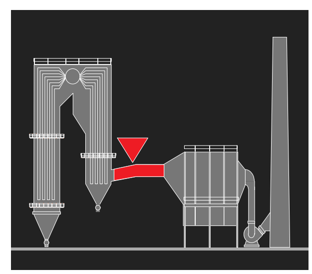



## *Typical MicroMist Applications*

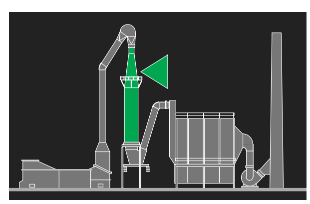
Processes that can profit from MicroMist ML micro-fine lime semi-dry injection systems include cement works, power plants, municipal and hazardous waste incinerators, non-ferrous metals, lime plants, iron reduction kilns, sintering lines, electric arc and basic oxygen furnaces, glass plants, mining and processing operations and more.



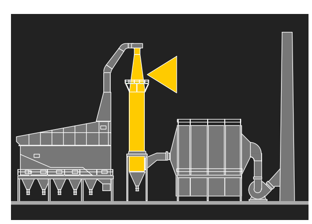
CEMENT DRY PROCESS



POWER PLANT



NON-FERROUS METALS



INCINERATION

EnviroCare

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