13201 Bel-Red Road
Bellevue, Washington 98005
tel: 425.283.5070
fax: 425.283.5081

Improved Wet ESP Technology: Is It Time For Some New Ideas?

Introduction

Wet electrostatic precipitators were first employed to control acid mist emissions in 1910 by Frederick Cottrell at a smelting operation in Selby, California. Since then wet ESPs have been a mainstay of the sulfuric acid mist manufacturing industry, employed at pyrometallurgical smelters and acid regeneration plants worldwide.

In parallel, there has been a considerable amount of work in other process industries with wet ESPs particularly since the first Clean Air Act was passed in 1970. These efforts have led to many important developments in the technology which could be of benefit to the sulfuric acid industry.

Perhaps it is time for the sulfuric acid industry to look outside for new ideas in the design and operation of wet ESPs. The benefits in cost savings, performance and operability may come as a pleasant surprise.

State-of-the-Art

Presently, the most common embodiment of the wet ESP includes a housing made of a corrosion resistant industrial polymer with lead or lead-lined electrostatic sections. Polymeric electrostatic sections (e.g., PVC or polypropylene collecting tubes) are also used. More specifically, this means gas-exposed housings utilizing monolithic FRP or polymer lining of an outside structure (either carbon steel or FRP) with lead and/or lead-coated electrostatic internals. Typically, the wet ESPs are arranged two units in series, each in an independent housing. The high voltage power supplies used for energization have undergone only minor technology improvements over the past 50 years.

There are a lot of drawbacks with this version of wet ESP technology. First, it is costly to fabricate. As corrosion resistant as it may be, lead is a dated material- of- construction and the limited number of companies and people to work with it drives prices up. Also, because of the peculiarities of lead construction, installation costs are much higher than they need to be. Finally, as a result of its mechanical properties the operating life of lead wet ESP internals is limited and periodic major maintenance change outs are required. Plastic collectors are not much better; eventually spark damage necessitates tube replacements.

Clearly, the technology could benefit from a facelift.

OTHER APPLICATION AREAS

Such a facelift could come from other industries. Wet ESPs treating millions of CFM have been successfully installed and operated in other process industries in the past 30+ years. The know-how gained in these applications should be of great value to the sulfuric acid industry.

For example, wet ESP technology is now widely recognized as the state of the art in the manufacture of composite wood panelboard products such as plywood, particleboard and OSB. Wet ESPs are also extensively used for the control of emissions from waste incinerators, biomass dryers, pulp and paper and industrial boilers. In some of these applications sulfuric acid mist is specifically targeted; e.g., pulp mill NCG incinerators. Finally, there is growing interest in wet ESP technology in the power industry; several large units have been installed and there are several more in planning, engineering or fabrication.

The wet ESP technology employed by these industries has its roots in sulfuric acid manufacturing. Perhaps the mother could learn something from the children.

Wet ESP on Power Boiler

AREAS FOR IMPROVEMENT

Improvements in wet ESP technology in the sulfuric acid industry can come in several areas. A brief discussion of each follows:

Materials

There is a wide array of alloys available that can resist the typical wet ESP environment. Indeed, some of the highest-grade materials such as the high nickel alloys are very expensive and probably not economical. However, the nature of the process environment does not necessarily require such "bullet-proof" materials. In fact, published corrosion data show that much more economical materials such as the super-austenitic family of alloys (e.g., Allegheny Ludlum AL6XN® and Special Metals Corporation Incoloy® 25-6MO) or even the new, "super duplex" stainless steels can afford acceptable life for the high voltage components of a wet ESP.

Power Supplies and Controls

Recently, the electrostatic precipitator industry has seen a big change in the design of high voltage power supplies. Before the mid-1990s these units were exclusively based on 60 Hz, single-phase power. While robust and highly reliable, this type of high voltage supply had an inherent flaw; they could not operate continuously at the maximum possible voltage for a given electrode arrangement.

This problem has now been largely overcome with the advent of high frequency, threephase power supplies. Utilizing power and microprocessor technology adapted from other electrical applications, these units now make it possible for electrostatic precipitators to operate continuously at the peak attainable voltage. This results in a significant increase in achievable performance or, alternatively, a smaller wet ESP for the job.

Suppliers of wet ESPs for the sulfuric acid industry should look seriously at including high frequency power supplies for all of their new installations.

Process Adaptations

In sulfuric acid manufacturing, multi-pass wet ESPs are necessary to achieve the gas cleanliness necessary for the downstream gas processing. At most plants, this process requirement results in two independent wet ESP modules operating in series. Thus, for a single process step, two machines each with its own inlet/outlet ductwork and plenums, foundations and structural supports are required.

A more economical way of achieving the same performance would be to have the multipass wet ESP integrated into a single vessel. This is presently being accomplished in other industries and the benefit to the sulfuric acid industry is obvious.

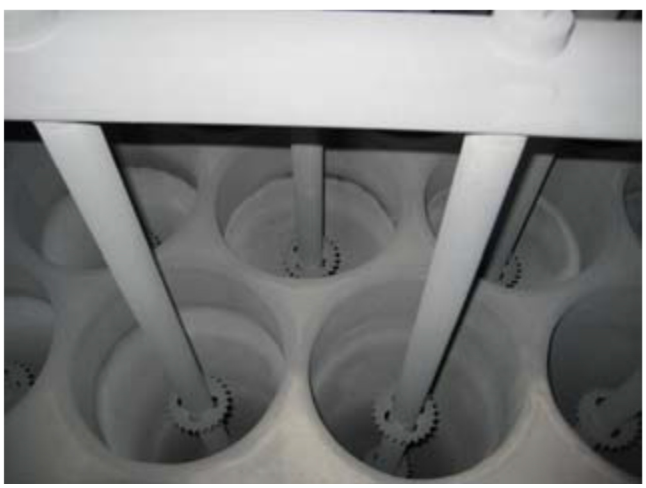
Mechanical Design

There are a wide variety of wet ESP design improvements that could be adapted. If alloy construction is accepted in lieu of lead, rigid mast discharge electrodes can be used. Electrodes of such construction can be arranged without the requirement for bottom supports or connections. This eliminates a source of operating problems and, of course, reduces cost.

In addition, alloy construction allows shop fabrication to a much greater degree. More shop fabrication means less field labor. The resulting project cost savings can be significant.

Finally, wet ESP performance could be greatly enhanced by improved discharge electrode emitter design. The lead coated wires normally used do not allow operation at the maximum possible voltage, for a variety of reasons. Adapting a better emitting electrode design used in many other applications will, once again, improve performance and reduce cost.

Rigid Mast Electrodes



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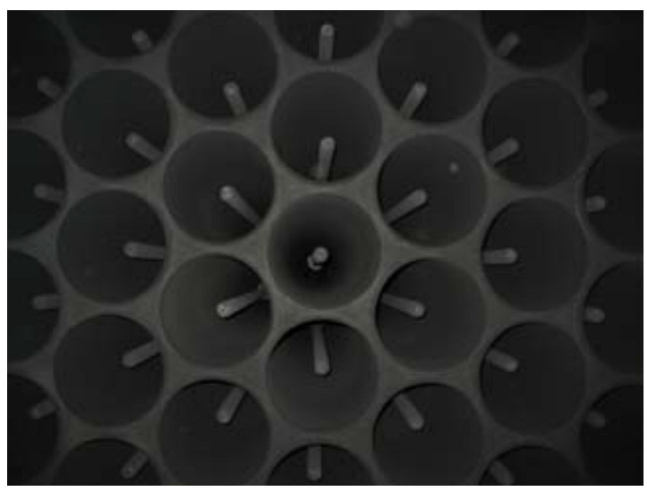

Below

	Current Design	Improvement	Benefits
Material of Construction	Lead	Alloy	Mechanical stability, longevity, shop fabrication
Discharge Electrodes	Weighted wire	Rigid mast	Simplicity, performance
Power Supplies	Single phase, 60Hz	Three Phase, High Frequency	Performance
Arrangement	Independent units in series	Single, muti-pass unit	Reduced cost

POSSIBLE IMPROVEMENTS IN SULFURIC ACID WET ESPS

Many of these improvements can also be applied to existing installations. Such upgrades can yield lower operating costs, improved flow capacity and lower maintenance expense.

CONCLUSION

The thoughts presented above are just a sampling of the existing opportunities to improve the sulfuric acid plant wet ESP for both new installations as well as aftermarket upgrades. We believe that the time is right to explore newer, less expensive and more effective wet ESPs as utilized and proven in other industries.