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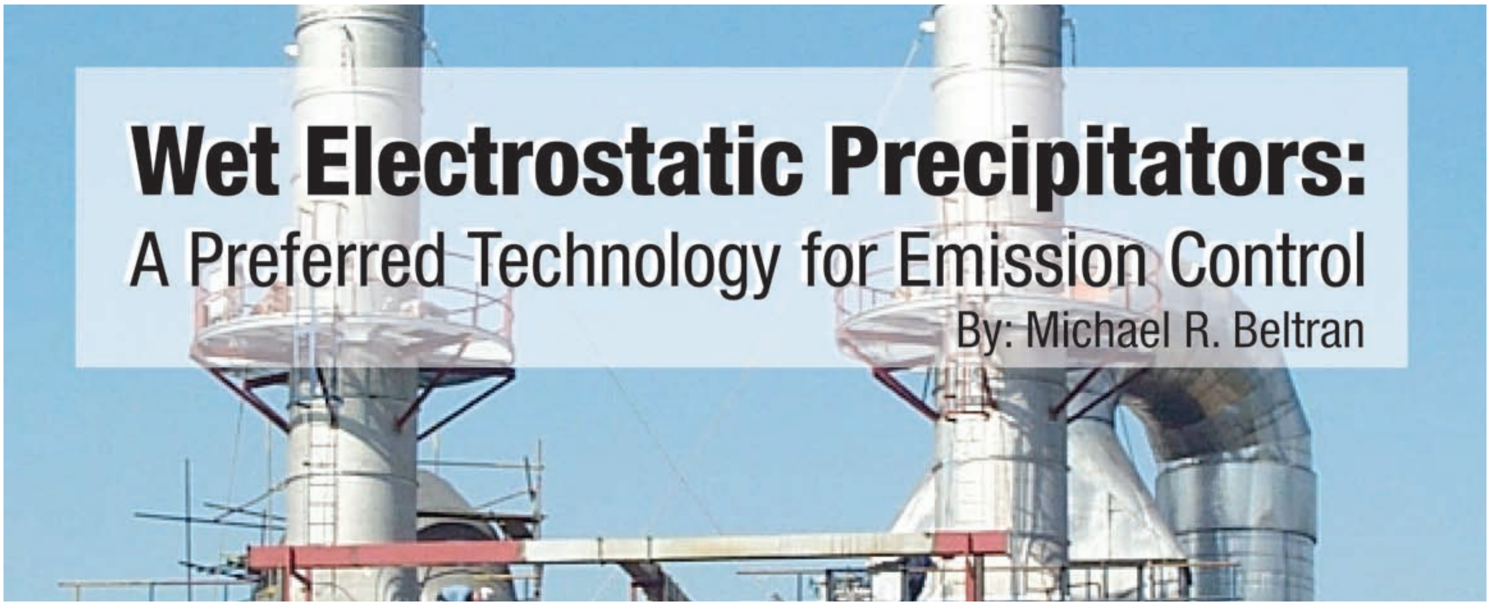
Several converging factors are driving the proliferation and expansion of global markets for precipitation technology, as well as the growth of far-reaching research and development in this field:

• the growth in the number and kinds of air pollution sources, and the volume of toxic materials emitted;

• the need for compliance with increasingly stringent and complex air pollution control regulations at all levels—international, federal, state and local; and,

• the rising demand and costs of all forms of energy, which is spurring the development of newly improved energy sources, such as waste-to-energy including biomass and coal gasification, which require more advanced emission control techniques.

Since the passage of the Clean Air Act of 1970, numerous pollution control technologies have emerged, each with its own set of specialized applications, advantages, limitations and costs. Among these are fabric filters, wet and dry flue gas desulfurization equipment (scrubbers), and wet and dry electrostatic precipitators (ESPs) to read more on this technology turn the page....



Wet Electrostatic Precipitators:

A Preferred Technology for Emission Control

By: Michael R. Beltran

The basic science behind electrostatic precipitators is as familiar and as simple as static cling. But today, this elemental force has been harnessed to a technology that is helping to remove millions of tons of toxic chemicals from our atmosphere; saving billions of dollars annually in pollution-related physical damage; and averting costly impacts on health and mortality rates for millions of people around the world.

Furthermore, the benefits derived from this versatile technology are multiplying every year, as new configurations are developed, new applications are found, and new systems are installed in industries ranging from agriculture to zinc smelting. In effect, an age-old scientific principle today finds itself on the leading edge of a technology that is being utilized by industries around the world.

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Wet precipitator technology was originally used to help clean the heavy plumes of smoke emitted by early 20th century industries. It was eventually superseded by dry ESPs and scrubbers. In recent decades, however, it was realized that *wet* ESP technology had a distinctly superior ability to capture certain types of emissions, especially: submicron particulates, sulfuric acid mists and condensed organic materials. The minute size of these particulates makes them extremely problematic for other emission control systems to capture and remove.
Electrostatic precipitators utilize the power of the flow of ionizing electrons from a charged electrode toward a grounded collection surface. When the potential gradient is strong enough, a corona is formed that can induce a like charge in adjacent molecules, propelling them toward the collector. When a stream of gas flows past this system, particulates of even submicron dimensions are captured and removed, and the cleaned gas is passed through.

Wet ESPs (WESPs) operate on gas streams that are saturated to near-100% water content. Particles that accumulate on the collector surfaces are removed by either an intermittent flushing or a continuous application of water, which can be recirculated after pollutants are removed. This wet technology offers several advantages over others.

It uses less energy than dry ESPs, which must use some power to drive mechanical rappers to dislodge accumulated particulates from collector plates. Washing versus rapping also reduces the risk of re-entrainment of particulates into the gas stream. Further, because WESPs operate on saturated gas streams, and at lower temperatures, they excel at capturing condensable particulates, which would otherwise pass through a higher-temperature system. Low-temperature operation also means lower gas volumes, enabling more efficient pollutant collection with smaller-scale equipment and reduced capital requirements. In addition, WESPs impede gas flow velocities only minimally; and, because they operate only on the particulates themselves, they require less energy input.

As demand increases for more efficient methods of gas cleaning, many companies have developed enhancements to the basic technology. Among these are:

• Multistage ionization, which facilitates stronger electric charges for a given configuration. This process helps counteract corona quenching and current suppression common to high-density submicron particulate streams. Multistage ionization also acts more effectively on particulates with high resistivity, resulting in more thorough particulate migration and collection.
• Advanced digital controls and regulators, which adjust operating parameters, gas flow distribution, input stream temperature, saturation, and corona gradient for maximum efficiency.

• Electrode and collector geometries, some of which capitalize on the intensification of the electric gradient emitted from sharp, star-shaped electrode points. Other electrode configurations in use include round wires, twisted pairs, barbed wires, rigid masts, rigid frames , rigid spiked pipes and spiral wires.

• Gas conditioning systems using sulfur trioxide and/or ammonia to overcome particle resistivity.,

WESPs are also more versatile, adaptable, and scalable compared to competing technologies; in fact, they are often used as adjuncts to such systems as wet scrubbers, and regenerative and catalytic thermal oxidation processors. The WESP increases the effectiveness of VOC control systems by preventing solids from plugging or binding regenerative thermal oxidation (RTO) heat recovery media.

New Challenges, New Solutions

One of the most promising uses of WESP technology is in the area of power generation from agricultural plant and animal wastes. Disposal, reuse and management of these materials has traditionally been problematic: Their chemical composition often varies too widely for uniform application as fertilizers; and, burgeoning production resulting from modern farming techniques has made storage and transportation of them more costly and difficult. The concentration of farming operations into agribusiness-scale facilities has exacerbated these problems.

The new approach to solving environmental problems emphasizes multipurpose solutions, with multiple end-results. In the case of farm animal waste, new technologies are simultaneously addressing the complex issues of compliance with stringent environmental regulations, the rising costs of waste management and disposal, and the growing demand for energy. This multiple-benefit solution is epitomized by the emerging new generation of systems that combine biomass gasification, WESPs for gas cleaning, and the production of combined heat and power (CHP) using the cleaned gas in various engine designs.

Biomass gasification units use a thermal destruction process to produce synthetic gas which can be used as fuel. However, various pollutants, especially sulfur dioxide and sulfuric acid mist, may also be emitted, depending on the biomass source material. Wet scrubbers are not as effective at capturing these materials, especially with large volumes of gas streams containing minute, submicron particulates, acid mists and condensed organics. Incorporating a downstream wet electrostatic precipitator into the system is a highly cost-efficient way to control emissions from a biomass gasifier, while producing clean, combustible fuel gas to fire the CHP generator. As a whole, the system is extremely efficient, and generates only minimal amounts of greenhouse gases compared to other energy generation sources.

Among other applications, WESPs are now being successfully implemented in metals and mining operations; pulp and paper making; and coal gasification. As demand for electric power continues to rise around the world, WESP technology has so far succeeded in meeting the emission control needs of both fossil and nuclear power plants.

For electric power suppliers, coal gasification will increasingly become the energy source of choice due to the relatively low price and abundant reserves of coal—combined with the prospect of increasing, widespread regulation of particulates emissions, as well as SOx, NOx, mercury and CO_2. Synthesis gas from coal gasification can be used in several innovative ways. It can be used to fire various energy-generating equipment, such as a gas turbine generator, boiler or internal combustion engine. It can also be incorporated into an integrated gasification combined cycle (IGCC) system, whose waste heat is used to drive a secondary steam turbine.

In these new, high-efficiency configurations, the WESP is fitted downstream from the gasifier, where it removes aerosols and particulates from the syngas. It is cheaper and easier to remove these pollutants from the syngas at this stage than it would be to capture the off-products of conventional coal burning. The cleaning process yields a fuel which burns cleanly, and with a far higher caloric output than the original, raw coal. And, because many of the ash components from gasification are highly corrosive chemicals, effectively removing them inhibits deterioration of costly downstream system components, resulting in a longer service life, lower maintenance costs and lower total cost of ownership. The conversion of coal to syngas, with its diverse range of practical end-uses, affords plant owners wider operating latitude in changing market conditions.

Another incipient application of WESP technology in the pursuit of clean energy relates to the treatment of high- and low-level wastes produced in nuclear power plants. The U.S. Department of Energy (DOE) is planning to encapsulate millions of gallons of radioactive waste in safe, glass-like form through a vitrification process using heated ceramic melters. The process offgases contain high densities of water vapor, acids and aerosols from dried melter feed and melter cold-cap reaction solids, among others. Thorough cleaning of this gas stream will be critical, since it will contain significant levels of radioactivity. Even advanced filtration systems would foul under these conditions. However, WESPs, which maintain an unobstructed gas flow while achieving near 100% efficiency, are destined to share the spotlight of this leading-edge solution to energy independence.

A Future of Promise

As WESP technology continues to evolve alongside other emission control methods, it will obviously remain the solution of choice for an ever-widening range of applications. Ensuring its longevity are: its elegantly simple scientific basis; its unmatched efficiency and cost-effectiveness over long operating life-cycles; its versatility as a primary or auxiliary pollution control technology, used alone or in combination with filters, scrubbers and other equipment, new or retrofit; and its ability to handle high-volume, high-density gas streams. When wet electrostatic precipitators are on the job, we will all be able to breathe easier for a long time to come.

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