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Acid Earth ; Soil Pollution Due to Acid

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Acid Emissions: Acid pollution is one of the side effects of our addiction to fossil fuels. When coal, oil or natural gas are burned, sulphur dioxide and nitrogen oxides are released into the air and undergo a series of chemical processes in the air, in moisture and water, and inside living organisms; this turns them into acids that cause different kinds of damage. All precipitation is slightly acidic because of the presence in the air of naturally occurring sulphur, nitrogen,and carbon dioxide, but acidification has become much worse since the industrial revolution, with more toxic consequences.

The first signs of a widening problem were identified as industrial coal consumption grew in Europe and North America in the mid 19th century. Fossil fuel consumption then widened to oil and natural gas and continued to grow as demand from the residential and transport sectors expanded. Economic reconstruction and expansion in the 1950s and 1960s led to a doubling of demand for fossil fuels in Europe and North America, and new levels of consumption in Asia and Latin America. The world now relies on fossil fuels for 90 percent of its commercial energy supplies.

Meanwhile, rapid economic growth in the newly industrializing countries of Asia and Latin America has brought increases in sulphur and nitrogen emissions, and the promise that acidification will be associated less, in most people's minds, with countries such as Britain, Sweden, the United States and Canada, and more with China, India and Mexico. It has already taken more than a quarter of a century to encourage policy-makers in industrialized countries to address the causes of acid pollution; it is likely to take much longer in emerging states who place a premium on economic development.

The Sources of Pollution:

Acidification results from the emission and deposition of airborne primary pollutants such as sulphur dioxide(SO2), nitrogen oxides(NOx), volatile organic compounds(VOCs) and particulates given off by power plants, industry and vehicles, and of ammonia(NH3) produced by agriculture. Reactions among these can produce secondary pollutants such as nitrogen dioxide(NO2, formed mainly by a reaction between nitric oxide(NO) and oxygen). These primary and secondary pollutants can be converted in the atmosphere, on the surface of buildings, inside plants and animals, or below ground, into sulphuric and nitric acids. Depending on a variety of biological, chemical and metrological factors, soils, forests, lakes, rivers, animals, plants and buildings are susceptible in varying degrees to the effects of these pollutants, acting alone or in conjuction with other factors. Several of these pollutants also contribute to other environmentalizingcountries(NICs) such as China, Brazil, India and South Africa.

Acid Emissions Control

The need for emissions control units is becoming more pressing by the day. With the U.S. Environmental Protection Agency's (EPA's) new transport rule to take effect in 2011, many coal-fired power plants are looking to crack down on sulfur dioxide (SO2) and nitrogen oxide (NOX) emissions. The race is on to find the air quality control measures for medium-sized (100 to 500 MW) plants that currently have no flue gas desulfurization (FGD) units or selective catalytic reduction systems (SCRs).

According to a report by the Utility Air Regulatory Group, capital cost for FGDs escalated over the past six years. For example, a retrofit of wet FGD to a 500 MW plant between 2004 to 2007 cost an average of $342/kW. A unit of the same capacity retrofit with FGD between 2008 to 2010 cost $407/kW, a 19 percent cost escalation. However, with emissions regulations in place, companies must overlook costs and choose between two options: retrofit or rebuild.

Carl Weilert, principal air pollution control engineer in the energy division of Burns & McDonnell, said several processes exist that are capable of acid gas emissions control: wet FGD, semi-dry FGD and dry sorbent injection. Each process has a unique method of controlling emissions, enabling generators to reach emissions standards by the deadlines.

Weilert said control options should be evaluated by the pollutant that needs to be controlled, since the control issues for SO2, Hazardous Air Pollutants (HAPs) and mercury (Hg) are all different. Companies must keep in mind several regulations, such as Best Available Retrofit Technology (BART), Weilert said. BART regulations affect facilities built or reconstructed between Aug. 7, 1962, and Aug. 7, 1977, that have the potential to emit more than 250 tons a year of visibility-impairing pollutants and fall into one of 26 categories. These include utility and industrial boilers and large industrial plants such as pulp mills, refineries and smelters. The EPA's presumptive BART emission limit for SO2 is 0.15 lb/mmBtu, or 95 percent removal. SO2 historically has been the biggest emissions control concern in the U.S.; therefore, most acid gas control processes focus on SO2 removal.

Removing SO2 to comply with BART "favors use of a semi-dry FGD as a lower-cost alternative to wet FGD," Weilert said. For low-sulfur coal, a conventional spray dryer absorber technology or a circulating fluidized bed dry FGD (also known as circulating dry scrubber (CDS)) technology may be used. For higher-sulfur coal, CDS technology can be used as an alternative to wet FGD.

The market seems to be moving to favor FGD systems with a low capital cost and especially so for medium-sized power plants, Weilert said. "The added advantage of the CDS technology is its capability for high percentage SO2 removal efficiency, even on higher-sulfur coal," he said.

In the case of a typical wet scrubber, the flue gas coming from the boiler is saturated with a slurry containing limestone reagent. This type of SO2 control is characterized

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by high capital cost, low operating cost and high performance. On the opposite end of the spectrum is dry sorbent injection (DSI), which involves injecting a reagent in dry powdered form (hydrated lime, sodium bicarbonate or trona) into the flue gas upstream of existing particulate control equipment. DSI technology is characterized by high operating costs, low capital costs and limited performance. In between the two extremes are the semi-dry FGD processes using a circulating fluid bed (CFB) dry scrubber or a lime spray dryer.

The lime spray dryer technology sprays a slurry of slaked lime reagent into the flue gas. The flue gas is cooled to 30 to 40 degrees above its saturation temperature as the slurry droplets are dried. As a result, when flue gases come out of the spray dryer, they are present as a dry powder product that is collected in a bag house. The CDS technology operates at similar temperatures, but is based on separately feeding dry hydrated lime and water into a fluidized bed reactor. Here the SO2 removal takes place in a bed of moistened powder. The semi-dry FGD technologies are characterized by capital costs that are about half that of wet FGD. They have higher operating costs than wet FGD, but lower operating costs than dry sorbent injection.

Several companies have developed dry FGD technology, including Allied Environmental Solutions. Spokesperson Mike Dunseith said Allied's CFB scrubber technology is "next-generation dry FGD."

With a "semi-dry" FGD, lime and water are injected into the flue gas at the same time in a slurry form. The CFB scrubber technology separates the two into separate streams: the water is injected through high pressure nozzles and the lime is injected in a dry powder form.

As a result, the CFB dry FGD has an advantage over a conventional spray dryer semi-dry FGD, Dunseith said. With both semi-dry and all-dry FGD technologies, the amount of water injected into the flue gas is limited by the scrubber inlet and outlet temperatures. With a spray dryer semi-dry FGD, once the amount of water injected has been fixed, there is a limit on the amount of lime that can be injected as the water carries the lime into the system. This limits the maximum acid gas removal performance of the technology. Because the CFB dry scrubber puts in the lime independently, there is no limit to the amount of lime that can be injected and thus the technology offers significantly greater acid gas scrubbing performance capability.

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