

THE IMPORTANCE OF SULFUR TRIOXIDE FOR THE TOXIC RELEASE INVENTORY

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Background

Recent action by the U.S. Environmental Protection Agency will require coal-fired power plants to report their annual release of toxic chemicals covered by the national Toxic Release Inventory (TRI), beginning with 1998 emissions. The Toxics Release Inventory was established by Section 313 of the Emergency Planning and Community Right-to-Know Act (EPCRA) of 1986. The TRI is a widely-reported public inventory of emissions to air, water and land which has had a major impact on the industries affected to date. Similar impacts can be expected for the utility industry. Utilities also will be required to develop and report on pollution prevention activities to reduce or eliminate TRI releases.

Role of Sulfur Trioxide

Sulfuric acid aerosol is one of the 600 chemicals listed as a toxic substance for purposes of TRI. Any listed chemical that is "manufactured" in amounts of 25,000 lbs/yr or more is reportable under TRI. For purposes of TRI, an acid aerosol is defined to include mists, vapors, gas, fog and other airborne forms of any particle size.

In a power plant flue gas, chemical thermodynamics predicts that sulfuric acid vapor will be formed from the reaction of sulfur trioxide with water vapor at typical flue gas conditions. The H_2SO_4 is typically measured and reported as equivalent SO_3 . Sulfur trioxide is formed in the combustion process in small amounts, with most of the sulfur in fuel converted to SO_2 . The U.S. Environmental Protection Agency (EPA) estimates the magnitude of SO_3 emissions from coal combustion at 0.7% of the total sulfur emissions. Additional data from the Electric Power Research Institute's PISCES Database shows roughly comparable levels as a median estimate, but with substantial variability across fuels of varying sulfur content. Thus, there is considerable uncertainty in current emission factor estimates of SO_3 emissions from coal combustion.

At typical flue gas temperatures of 400° F or less, all SO_3 is converted to gaseous H_2SO_4 at equilibrium conditions. At temperatures below the sulfuric acid dewpoint (typically 260-300° F, depending on moisture and SO_3 concentrations), H_2SO_4 condenses into liquid droplets, forming a true aerosol. For purposes of TRI, however, H_2SO_4 need not exist in droplet form to be reportable since gases and vapors are included in the definition of an acid aerosol. The same definition applies to hydrochloric acid, another TRI chemical reportable if the "aerosol"

form exceeds the manufacturing threshold of 25,000 lbs/yr.

Case Study Results

The EPRI PISCES Model was designed to quantify the emissions to air, land, and water of all chemical substances released from a fossil fuel power plant. The model recently has been enhanced to evaluate and report TRI releases, and is used here to present illustrative results for an average plant size of 650 MW (net) burning bituminous coal in compliance with the Phase I acid rain emission cap. The case study plant has an electrostatic precipitation, a zero discharge wastewater treatment system, and on-site disposal of solid wastes. Its capacity factor is 65 percent.

The table below summarizes the reportable TRI releases for this plant. Sulfuric acid emissions account for 25% of the plant total, second in magnitude only to HCl emissions. All trace metals combined account for only 17% of total TRI releases, and are found principally in collected ash. The magnitude of power plant SO₃ emissions, and the ability to neutralize or remove H₂SO₄, thus will play a critical role in TRI reporting. Further elaboration of these topics will be included in the full presentation of this paper.

Summary of Reportable TRI Releases (lbs/yr) for Case Study Power Plant (650 MW, 65% CF, Zero Wastewater Discharge)

Chemical	Air Releases	Land Releases	Total Releases
Hydrochloric Acid	2,000,000	0	2,000,000
Sulfuric Acid	890,000	0	890,000
Barium	910	250,000	250,000
Hydrogen Fluoride	160,000	0	160,000
Manganese	190	60,000	60,000
Zinc	470	58,000	59,000
Copper	220	55,000	55,000
Chromium	250	49,000	49,000
Nickel	200	43,000	43,000
Arsenic	1,100	25,000	27,000

^a TRI requires reporting to only two significant figures. Totals may differ from sum due to rounding.