

# Sulfur Dioxide

Ninety-five percent of pollution related sulfur oxide emissions are in the form of sulfur dioxide (SO<sub>2</sub>), a heavy, colorless gas with an odor like just struck matches. This gas combines easily with water vapor, forming aerosols of sulfurous acid (H<sub>2</sub>SO<sub>3</sub>), a colorless, mildly corrosive liquid. This liquid may then combine with oxygen in the air, forming the even more irritating and corrosive sulfuric acid (H<sub>2</sub>SO<sub>4</sub>).

## **Emission Sources of SO<sub>2</sub>**

Sulfur is present in all raw materials, including crude oil, coal, and ore that contains common metals like aluminum, copper, zinc, lead, and iron. Sulfur oxides are formed when fuel containing sulfur, such as coal or oil, is burned, and when gasoline is extracted from oil, or metals are extracted from ore. Some sources are:

- from coal-burning electrical utilities (over 65% of SO<sub>2</sub> released to the air, or more than 13 million tons per year, comes from electric utilities, especially those that burn coal).
- from pulp and paper mills.
- from natural sources.
- from other human-generated sources.

Note: The amount of SO<sub>2</sub> released depends on the sulfur content of coal, normally 0.7% to 2% by weight. High sulfur coal sometimes contains as much as 6% sulfur by weight.

## **Other Sulfur Sources**

Other sulfur-containing compounds, with their typical unpleasant odors, are pollutants as well. Several examples are:

- Hydrogen sulfide (H<sub>2</sub>S) gas - rotten eggs.
- Mercaptans - skunk spray or decayed garbage. (Added in trace amounts to natural gas, providing a leak-detecting warning odor.)

## **Health Effects**

Sulfur dioxide not only has a bad odor, it can irritate the respiratory system. Exposure to high concentrations for short periods of time can constrict the bronchi and increase mucous flow, making breathing difficult. SO<sub>2</sub> can also aggravate existing heart and lung diseases. Children, the elderly, those with chronic lung disease, and asthmatics are especially susceptible to these effects. Sulfur dioxide can also:

- Immediately irritate the lung and throat at concentrations greater than 6 parts per million (ppm) in many people.
- Impair the respiratory system's defenses against foreign particles and bacteria, when exposed to concentrations less than 6 ppm for longer time periods.
- Apparently enhance the harmful effects of ozone. (Combinations of the two gases at concentrations occasionally found in the ambient air appear to increase airway resistance to breathing.)

Sulfur dioxide tends to have more toxic effects when acidic pollutants, liquid or solid aerosols, and particulates are also present. (In the 1950s and 1960s, thousands of excess deaths occurred in areas where SO<sub>2</sub> concentrations exceeded 1 ppm for a few days and other pollutants were also high.) Effects are more pronounced among mouth breathers, e.g., people who are exercising or who have head colds. These effects include:

- Health problems, such as episodes of bronchitis requiring hospitalization associated with lower-level acid concentrations.

- Self-reported respiratory conditions, such as chronic cough and difficult breathing, associated with acid aerosol concentrations. (Asthmatic individuals are especially susceptible to these effects. The elderly and those with chronic respiratory conditions may also be affected at lower concentrations than the general population.)
- Increased respiratory tract infections, associated with longer term, lower-level exposures to SO<sub>2</sub> and acid aerosols.
- Subjective symptoms, such as headaches and nausea, in the absence of pathological abnormalities, due to long-term exposure.

### **Effects on Plants**

Sulfur dioxide easily injures many plant species and varieties, both native and cultivated. Some of the most sensitive plants include various commercially valuable pines, legumes, red and black oaks, white ash, alfalfa and blackberry. The effects include:

- Visible injury to the most sensitive plants at exposures as low as 0.12 ppm for 8 hours.
- Visible injury to many other plant types of intermediate sensitivity at exposures of 0.30 ppm for 8 hours.
- Positive benefits from low levels, in a very few species growing on sulfur deficient soils.

### **Other Effects**

Increases in sulfur dioxide concentrations accelerate the corrosion of metals, probably through the formation of acids. (SO<sub>2</sub> is a major precursor to acidic deposition usually known as acid rain.) Sulfur oxides may also damage stone and masonry, paint, various fibers, paper, leather, and electrical components.

Increased SO<sub>2</sub> also contributes to impaired visibility. Particulate sulfate, much of which is derived from sulfur dioxide emissions, is a major component of the complex total suspended particulate mixture. SO<sub>2</sub> also accelerates the decay of building materials and pain