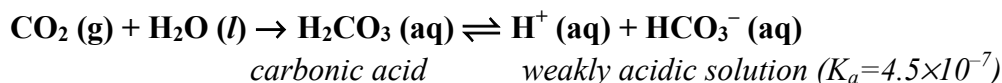


A Short Reading on Acid Rain

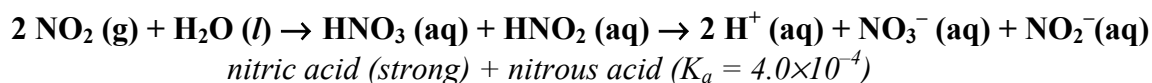
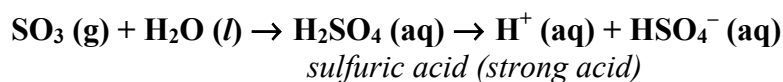
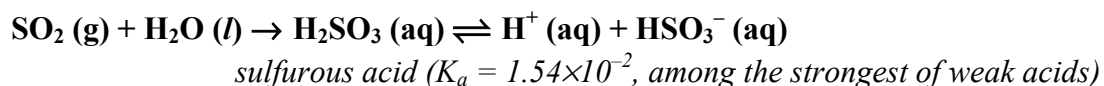
Acid Rain has become a widespread problem in the industrialized world. A variety of problems have been attributed to acid rain. Acid rain causes concrete buildings and marble statues to crumble; fish no longer populate some major lakes; and in some areas crops grow more slowly and forests begin to die. Some questions we want to be able to answer are the following: What air pollutants cause acid rain? How are these pollutants produced? What can be done to decrease air pollutants that cause acid rain? Why does acid rain have such a harmful effect on concrete and living things?

Air pollutants which cause acid rain

Good, clean rainwater is naturally slightly acidic (pH ~ 5.6) because carbon dioxide and other naturally occurring acidic substances are dissolved in the rainwater. The reaction with carbon dioxide is shown here:



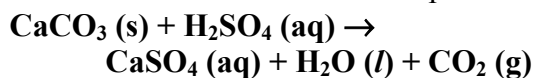
Only rain with a pH below 5.6 is considered “**acid rain.**” Acid rain is most often caused by three common air pollutants, $\text{SO}_2 (\text{g})$, $\text{SO}_3 (\text{g})$ and $\text{NO}_2 (\text{g})$. All three of these gases form strong or relatively strong acids when they dissolve into rainwater.



Harmful effects of Acid Rain



Acid rain is particularly harmful to buildings and statues because the acid reacts with insoluble CaCO_3 in limestone, marble and concrete to form CaSO_4 —a more soluble solid. For example:



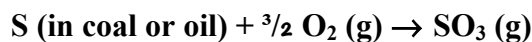
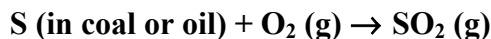
Thus, the $\text{CaCO}_3 (\text{s})$ will be eroded away as it is turned into CaSO_4 and dissolves into the water.

Acid Rain is also particularly harmful to fish and other aquatic life living in lakes. In the northeast, the pH of many lakes has been lowered to a pH of 4-4.5—the acidity of orange juice. Sometimes acid rain can lower the pH of a lake as low as pH of 3—the pH of vinegar. At these acidic levels, fish eggs die and many species of fish cannot live. To counteract the acid rain, sometimes lime (CaO) is added to lakes. CaO (like CaCO_3) can neutralize acids.

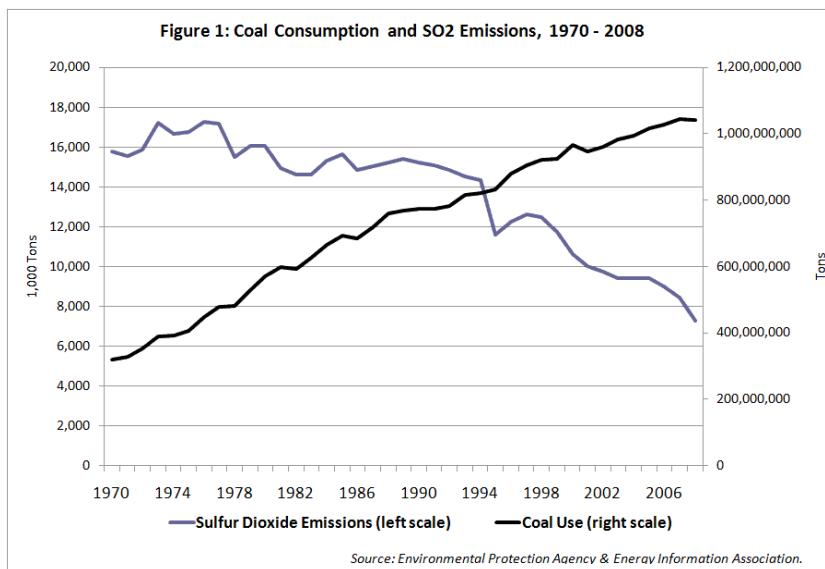


Why SO₂ (g) and SO₃ (g) are released into the air

SO₂ (g) and SO₃ (g) is released into the air mainly due to the burning of coal and oil (in power stations and in homes). This is because coal and oil contain varying quantities of sulfur. Thus, when the coal or oil is burned in oxygen, SO₂ and SO₃ gases are produced as shown:



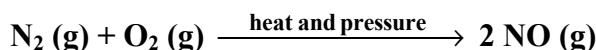
The amount of SO₂ and SO₃ gases released into the air can be greatly reduced by removing most of the sulfur from coal before burning it. Also, some coals and oils naturally contain less sulfur. In recent years, the United States has been successful in decreasing SO₂ pollution. Since 1970 there has been a dramatic decrease in the amount of SO₂ (g) released into the air even though coal burning has increased.



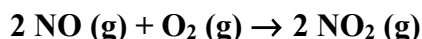
Why NO₂ (g) is released into the air.

Today NO₂ (g) is most commonly released into the air by the large amount of cars and trucks on the roads. NO₂ (g) is released into the air due to two reactions:

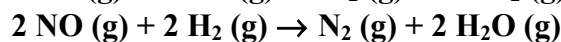
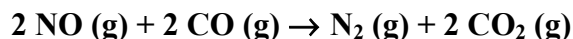
- (1) At the high temperatures and pressures present inside an engine, nitrogen gas and oxygen gas react to form NO (g).



- (2) In the atmosphere, NO from the car's exhaust then is oxidized to form visible orange-brown NO₂ (g):



Catalytic converters have significantly reduced the amount of NO₂ (g) released into the air due to auto exhaust. Almost 7 million metric tons less of NO₂ (g) were emitted in 1991 than in 1980. Basically, the catalytic converters reduce the formation of NO₂ (g) by decreasing the amount of NO (g) in auto exhaust. NO (g) is removed from auto exhaust by these two reactions:



In order to get the rates of these reactions fast enough, catalysts must be used. The most common catalysts for catalytic converters are platinum, palladium and rhodium—all relatively expensive, rare metals.

