

## Nitrogen Dioxide

### General

Nitrogen dioxide ( $\text{NO}_2$ ) is a reddish-brown, highly reactive gas present in all urban air.  $\text{NO}_2$  is a strong oxidizing agent that reacts in the air to form corrosive nitric acid, as well as toxic organic nitrates. It also plays a major role in the atmospheric reactions that produce ground-level ozone ( $\text{O}_3$ ). The nitrogen oxides ( $\text{NO}_x$ ) normally found in the atmosphere include nitrous oxide ( $\text{N}_2\text{O}$ ), nitric oxide ( $\text{NO}$ ), and nitrogen dioxide ( $\text{NO}_2$ ).  $\text{N}_2\text{O}$  is a stable gas with analgesic characteristics. The typical ambient concentration of  $\text{N}_2\text{O}$  is well below the threshold concentration for a biological effect.  $\text{NO}$  is a colorless gas with a typical ambient concentration less than 0.5 parts per million (ppm). At these concentrations its biological toxicity is not significant; however,  $\text{NO}$  is a precursor to the formation of  $\text{NO}_2$  and an active compound in  $\text{O}_3$  formation.

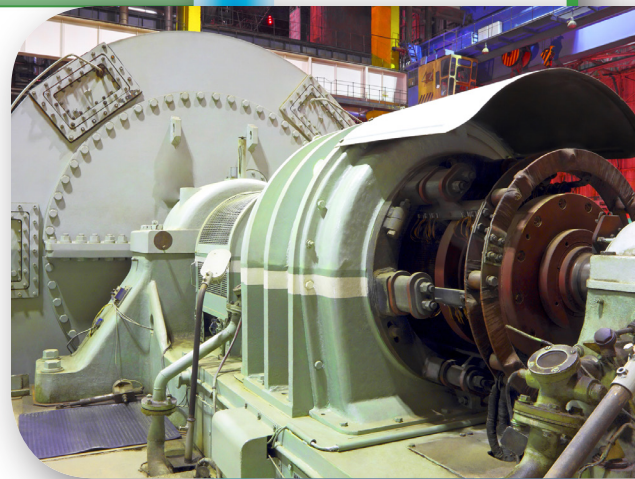
Natural sources of  $\text{NO}_2$  include biological processes in soil and atmospheric oxidation of ammonia. Man-made sources are more important in the occurrence of  $\text{NO}_2$  and  $\text{O}_3$  air pollution because those sources are concentrated in populated areas and account for a greater share of the  $\text{NO}_2$  emissions in such areas. The major man-made source of  $\text{NO}_2$  emissions is high-temperature fuel combustion in motor vehicles and in industrial and utility boilers. These emissions are primarily in the form of  $\text{NO}$  which is oxidized in the atmosphere to  $\text{NO}_2$ . The conversion rate depends on the ambient concentrations of  $\text{NO}$  and  $\text{O}_3$ . If  $\text{O}_3$  is present, the conversion is very rapid. Ground-level emissions account for most of the  $\text{NO}_x$  that are involved in urban  $\text{O}_3$  formation.

### Effects

$\text{NO}_2$  is a pulmonary irritant affecting primarily the upper respiratory system. Individuals with asthma, respiratory disorders and lung diseases are more sensitive to the effects of  $\text{NO}_2$ . Healthy individuals exposed to concentrations of  $\text{NO}_2$  from 0.7 to 5.0 parts per million (ppm) for 10 to 15 minutes have developed abnormalities in pulmonary airway resistance.

At typical ambient concentrations,  $\text{NO}_2$  has not been proven to be related to lung disease; however, at higher concentrations it can irritate the lungs, cause bronchitis and pneumonia, and lower resistance to respiratory infections. Continued or frequent exposure to high levels of  $\text{NO}_2$  can cause pulmonary edema. Inflammation of the lungs can occur 5 to 72 hours after exposure to elevated  $\text{NO}_2$  levels.

$\text{NO}_x$  in the air is a potentially significant contributor to a number of environmental effects such as acid rain and eutrophication (a process whereby a body of water suffers an increase in nutrients that reduce the amount of oxygen in the water, resulting in an environment destructive to fish and other animal life). Other effects of  $\text{NO}_x$  include degradation of vegetation, materials and visibility.  $\text{NO}_2$  and  $\text{NO}$  react with water vapor to form aerosol droplets that limit visibility.  $\text{NO}_2$  affects metals by forming salts that increase corrosion. It also fades fabric, degrades rubber and harms vegetation. Plant damage includes bleaching or death of plant tissue, loss of leaves and decreased growth rate.



### Standards

There are two primary National Ambient Air Quality Standards (NAAQS) for  $\text{NO}_2$ .

1. The 1-hour  $\text{NO}_2$  standard of 100 parts per billion (ppb), as determined by the three-year average of the 98th percentile of the annual distribution of daily maximum 1-hour average concentrations
2. The annual arithmetic mean of 0.053 ppm of  $\text{NO}_2$ .