Sarnia • Lambton Environmental Association

Industries Working Together

Controlling Acidic Emissions

This monograph, one in a series of single issue documents that deal with our local environment, has been prepared by the Sarnia -Lambton Environmental Association in co-operation with the School Boards of Lambton Kent

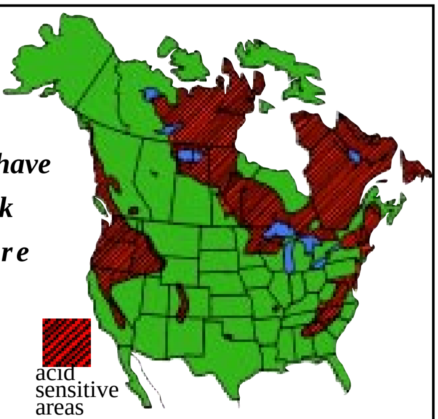
Introduction

Normal rainfall around the world is slightly acidic (pH 5.6 to 5.0); this modest amount of acidity results when carbon dioxide and other acidic materials of natural origin dissolve in moisture that is present in the air. Precipitation over Eastern North America and much of Europe however, is considerably more acidic, due mainly to concentrations of sulphuric and nitric acids which are produced when sulphur and nitrogen oxides (acidic emissions) undergo atmospheric reactions. In addition to the production of these acids, the sun's energy also causes nitrogen dioxide to react with organic compounds in the air, resulting in higher than normal levels of ozone, a powerful oxidant. (Monograph A2)

Vulnerability of regions to acidic precipitation is an important consideration. Regions that have highly alkaline soils (they are rich in calcium and magnesium salts) are protected - their alkaline (basic) salts neutralize acids. Environments with little or no buffering capacity such as those in the granite regions of the Canadian Shield, the Appalachians and portions of the Rockies are more likely to be harmed by acidic emissions.

Facts

Acid rain attacks regions which have granite bedrock and soils that are granite-derived.



C.D. Howe Inst., page 8

Major Sources of Acidic Emissions
coal-fired electric power plants, industrial boilers, metal smelters, automobiles, trucks.

Lambton County Soils and Water
calcium and magnesium carbonates, present in soils and in the water, counteract (neutralize) the effects of acidic emissions.

Key Words

acid - any compound that is capable of releasing hydrogen ions.

buffer - a substance that minimizes changes in hydrogen ion concentration which would otherwise occur as a result of chemical reactions.

oxidant - an acceptor of electrons; most chemical reactions involve electron transfer; the term oxidant is derived from the word oxygen; oxygen is a powerful oxidant.

photochemical reaction - a chemical reaction that is initiated by or influenced by light (particularly ultraviolet).

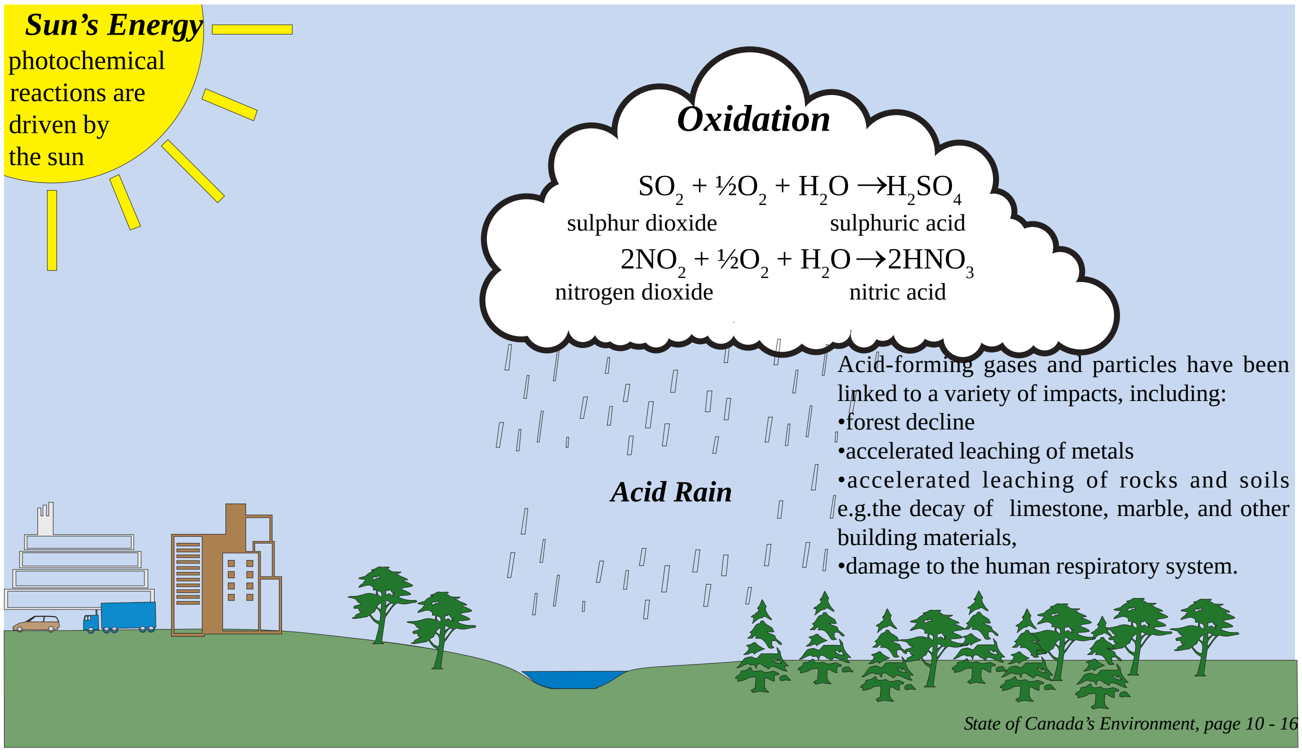
pH - describes a system's hydrogen ion concentration, $[H^+]$; $pH = -\log[H^+]$

pH 0 ... 7 ... 14

← stronger acids — neutral — stronger bases →

Acid Rain

Oxidation of Acid-Forming Gases Produces Acid Rain



State of Canada's Environment, page 10 - 16

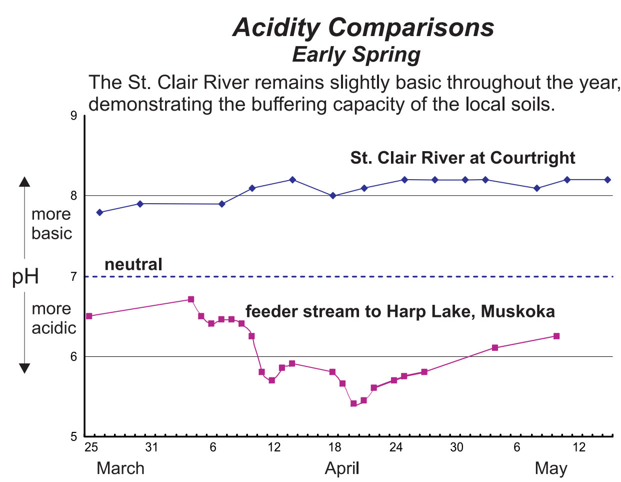
Acid Rain - A Major Problem

Acid Rain

- **produces fluctuations in the pH of water systems**; acidic, melted snow (spring runoff) lowers pH causing aquatic life to experience chemical "shock" effects, eg. hatching success of Rainbow Trout eggs is lowered when the pH falls below 5.5

- **reduces crop productivity and forest growth rates**; vegetation alters the chemistry of precipitation; eg. deciduous trees raise soil pH while coniferous trees lower it
- **accelerates the rate at which heavy metals are leached** from soils, rocks and sediments of waterways
- **accelerates weathering** of limestone surfaces on buildings and monuments;

> Acid rain is not a new phenomenon: observations from industrialized areas in Great Britain and Sweden date back more than 100 years.



Factors that account for these big pH changes in the feeder stream include:
- the much smaller flow of water in the stream
- the feeder stream's location on the Canadian shield where buffering capacity is low compared to that of the carbonate-rich soils in Lambton County.

MOE, 1980, page 18

SO_2 and NO_2 Monitoring

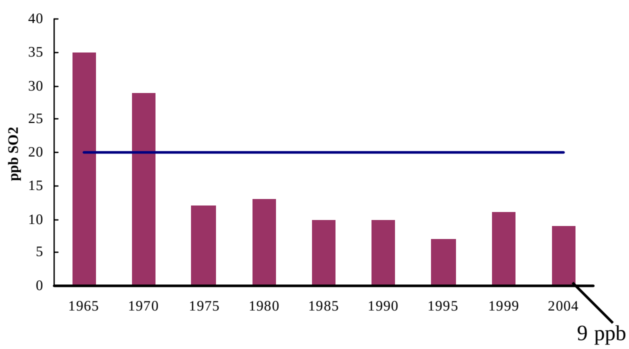
The Monitoring Network Extends From Port Huron to Courtright

Substance Monitored	**SO_2** **sulphur dioxide**	**NO_2** **nitrogen dioxide**
Sources	combustion of fuels smelting of base metals processing "sour" natural gas	combustion of fuels cleaning of metals welding vehicle exhausts
Monitoring Stations	5 stations (two are operated by MOE)	3 stations (one is operated by MOE)
Ontario's Acceptable Air Quality Criteria	250 ppb, one hour ave. 100 ppb, 24 hour ave.	200 ppb, one hour ave. 100 ppb, 24 hour ave.

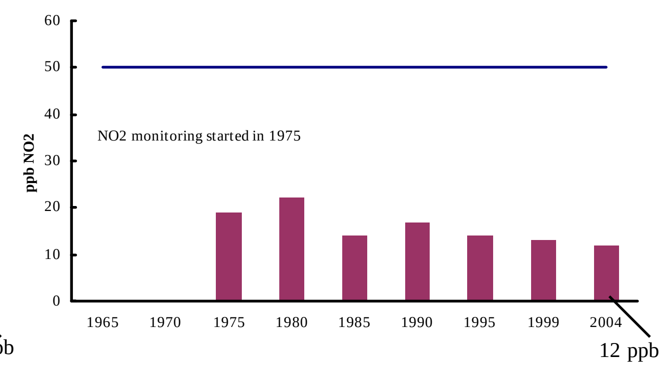
MOE, 2003, page 15, 20

Some Monitoring Results

SO_2 Annual Averages – Front St. Sarnia



NO_2 Annual Averages – Front St. Sarnia



- The MOE annual air quality criterion of 20 ppb was satisfied at all monitoring sites during 2004, with mean values ranging from 5 ppb (Lasalle Rd site) to 9 ppb (Front St. site)and 9 ppb at the Riverbend site in Corunna.
- The daily criterion of 100 ppb was not exceeded even once in 2004.
- The one-hour criterion of 250 ppb was satisfied in 2004 with the following exceptions:
  - 1 hour, October 12th
  - 2 hours, July 1st & 2nd

- The daily criterion of 100 ppb was satisfied at the monitoring sites throughout 2004.
- The hourly criterion of 200 ppb was satisfied at the monitoring stations throughout 2004.
- Nitrogen oxides are monitored at two Lambton Association stations - Front St. and Corunna.

SO_2 and NO_2 Control Technology is Applied in the Combustion of Fuels

Three stages of emission controls are introduced during:

	1 - Precombustion	**2 - Combustion**	**3 - Postcombustion**
SO_2	***Remove Sulphur from Fuels*** Sulphur in coal and also in crude oil can be reduced to elemental sulphur by reaction with hydrogen.	***Mixed Bed Combustion*** eg. Mix coal and limestone (pulverized) in the combustion chamber - production of SO_2 is reduced.	***Flue gas desulphurization*** A mixture of water and powdered limestone is sprayed into flue gas; SO_2 is removed. The main by-product, calcium sulphate, is used to make wallboard.
NO_2	***Remove Nitrogen From Fuels*** Reaction with hydrogen converts the nitrogen (N_2) to ammonia (NH_3).	***Decrease Temperature of Combustion*** (1) use catalysts to reduce temperature requirements for combustion. (2) stage combustion initial stage - limit oxygen supply; nitrogen in the fuel is then released without being oxidized. (3) final stage - increase the air-to-fuel ratio to permit complete combustion of the fuel.	***Catalytic Emission Controls*** Oxidized forms of nitrogen (NO, NO_2) are converted to molecular nitrogen (N_2). C.D. Howe Inst. pages 62 - 65

Conclusion

Although natural sources of sulphur oxides and nitrogen oxides do exist, more than 90% of the sulphur and 95% of the nitrogen emissions occurring in eastern North America are of human origin.

Government of Canada, 1991, 24-6

Resources

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