

## APES Chapter 15 – Air Pollution and Stratospheric Ozone

### **Intro: Cleaning up Chattanooga**

- a) geographic features
- b) ranking
- c) solution
- d) new challenges from ozone

### **I. Air Pollution – Global Concern**

Major Pollutants – Criteria Air Pollutants (CAA, EPA) ...See Table 5.1

- A. Sulfur Oxides (SO<sub>x</sub>)  
Sulfur Dioxide (SO<sub>2</sub>)
  
- B. Nitrogen Oxides (NO<sub>x</sub>)  
Nitric Oxide (NO)  
  
Nitrogen dioxide (NO<sub>2</sub>)
  
- C. Carbon Oxides  
Carbon monoxide (CO)
  
- D. Particulate Matter (PM or SPM) ...(see Fig. 15.2)  
PM<sub>10</sub>  
  
PM<sub>2.5</sub>
  
- E. Ozone (O<sub>3</sub>)  
  
Photochemical Oxidants  
  
Smog – 2 types:
  - a) Photochemical smog – “Brown” or “LA” Smog
  - b) Sulfurous smog – “Gray” or “London” Smog
  
- F. Lead (Pb)

Other Air Pollutants:

- G. Volatile Organic Chemicals (VOC's)
  
- H. Mercury (Hg) – another heavy metal
  
- I. Carbon Dioxide (CO<sub>2</sub>)

## **II. Primary and Secondary Pollutants (see Fig 15.5)**

- A. Primary Pollutants – pollution that comes directly from smokestacks, exhaust Pipes, combustion sources, particulates  
Ex:
- B. Secondary Pollutants – result from chemical reactions in atmosphere as sunlight, water and oxygen react with primary pollutants.  
Control must focus on reductions of primary pollutants.

## **III. Air Pollution Sources**

- A. Natural Emissions (see Fig. 15.4)
- B. Anthropogenic Emissions

Trends in Criteria Pollutants (see Fig. 15.5 and 15.6)

## **IV. Photochemical Smog in the USA**

- A. Chemical process of smog formation (see Fig. 15.7)

Tropospheric Ozone

Photochemical Smog (if VOC's are present)

- B. Thermal Inversion (see 15.8)  
Occurs when atmospheric weather conditions interact with pollutants:

## **V. Acid Deposition (see Fig. 15.9)**

Natural acidity (pH) of rainfall is 5.6 to 7.0

Acid deposition is below 5.6

- A. Formation ...Primary Pollutants to Secondary Pollutants to Acid Deposition

A regional problem that crosses borders:

- B. Effects of Acid Deposition (Fig. 15.10)

Aquatic ecosystems: Salamanders (Amphibians) as indicators

Terrestrial ecosystems: effects on Soil – metal mobilization (Al, Hg)

Effects on Human Structures:

## **VI. Pollution Control – Prevention, Technology, Innovation**

### A. Control of SO<sub>x</sub> and NO<sub>x</sub> emissions

1. SO<sub>2</sub> from Coal
2. NO<sub>x</sub> from petroleum products

### B. Control of Particulate Matter - (Fly Ash) at Power Plants and Factories

1. Baghouse Filter (Fig. 15.11)
2. Electrostatic Precipitator (Fig. 15.12)
3. Scrubber (Fig. 15.13)

### C. Smog reductions: two areas of focus

1. VOC's
2. NO<sub>x</sub>

### D. Innovative Pollution Control

1. Replacing/eliminating use of wood-burning stoves
2. Reduce automobile driving, use of catalytic converters (less NO<sub>x</sub>)
3. Market solutions – the SO<sub>2</sub> allowance exchange (a permit system)  
Buy and sell permits on an open market  
This is a model for future CO<sub>2</sub> allowances...

## **VII. Stratospheric Ozone**

### A. The benefits of the ozone layer:

### B. What could happen if depletion continues:

### C. Formation and Breakdown of Ozone...the O<sub>2</sub> O<sub>3</sub> cycle:

### E. D. Anthropogenic Sources – Ozone Depleting Chemicals (ODC's)

Ex: CFC's (the "wonder chemical")

Methyl bromide

Halons and others:

## F. Efforts to Reduce Ozone Depletion

1. 1987 – The Montreal Protocol...24 nations agree ...eventually 180 nations

Reductions:

Substitutions:

Management:

## VIII. Indoor Air Pollution

### A. Developing Countries

### B. Developed Countries

1. Asbestos

2. CO

3. Radon

4. VOC's

5. Sick Building Syndrome

Reasons (According to EPA):

Inadequate, faulty ventilation

Chemical Contamination from Indoor Sources

Chemical Contamination from Outdoor Sources

Biological Contamination (mold spores, pollen)

## **Working Toward Sustainability – New Cook-stove Design**