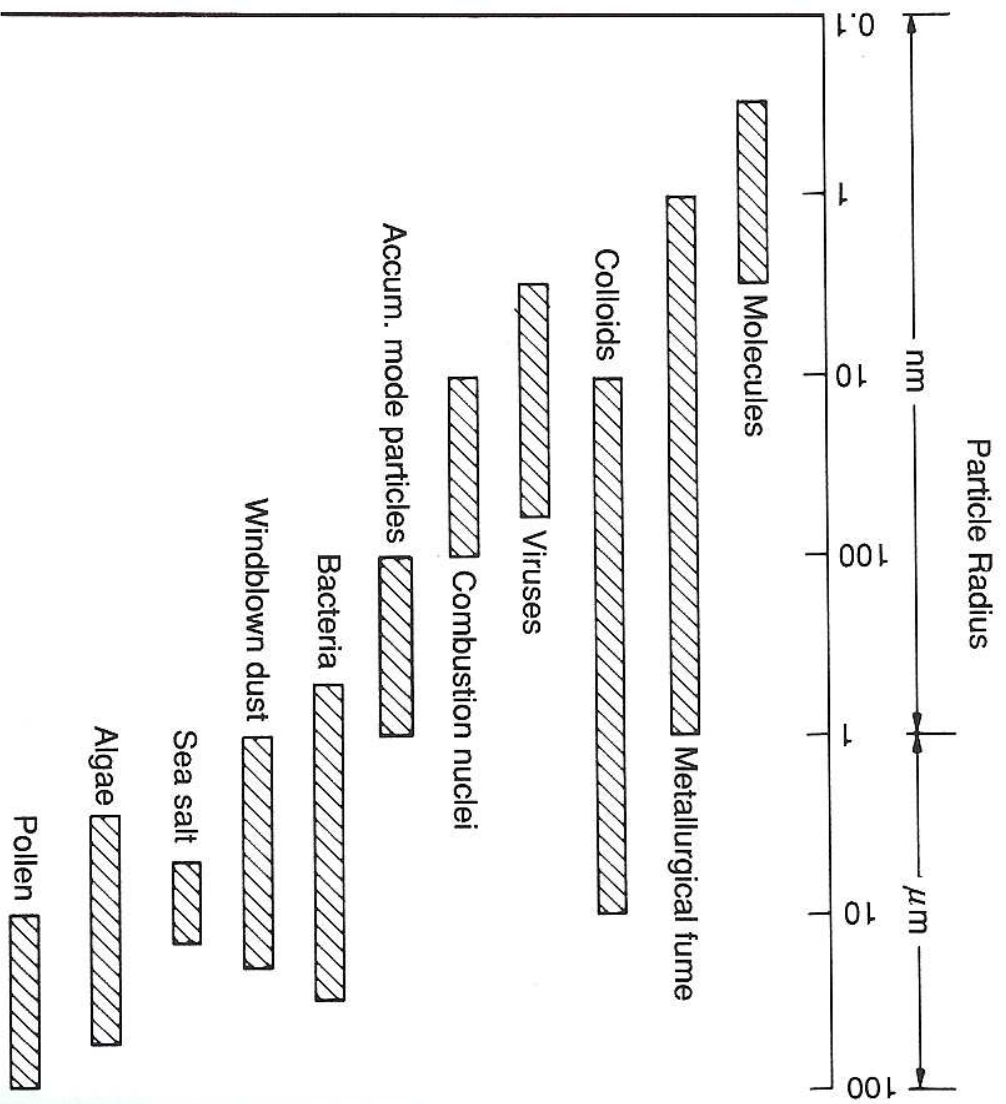


# Review: Atmospheric gas-phase chemistry

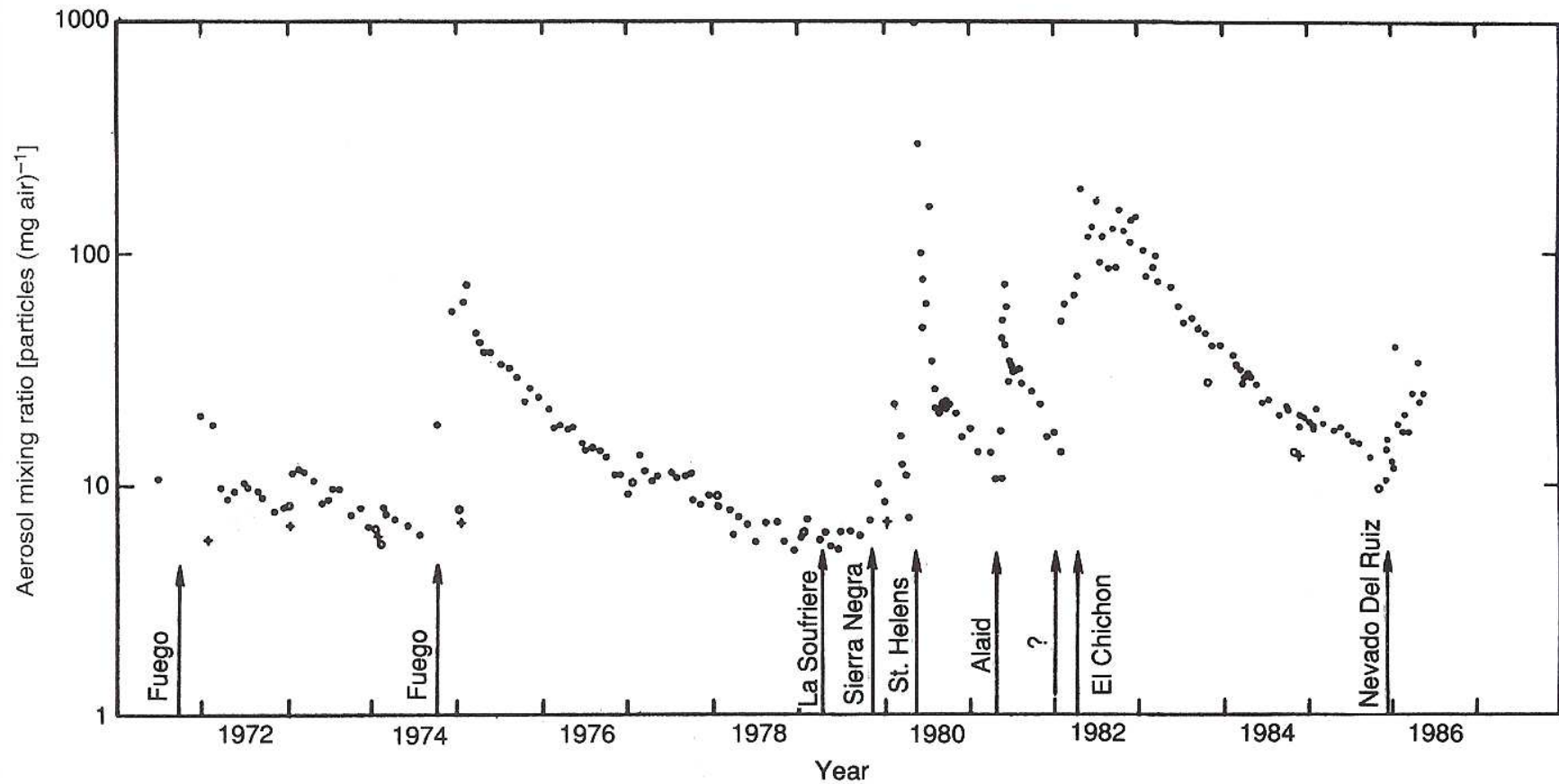
- Radical (Chain) Chemistry à Oxidation
  - Initiation via photolysis (such as  $O_3$ )
  - Most important “cleansing agent”:  $\bullet OH$  Radical
- Most important  $\bullet OH$  radical reaction partners
  - methane ( $CH_4$ ) and carbon monoxide (CO)
  - $\bullet OH$  lifetime:  $\sim 1$  s !!
- Other cleansing mechanisms
  - Reactions with other oxidants, such as ozone
  - Wet and dry deposition
- Ultimate Products:  $CO_2$  and “solubles”

**Figure 5.1** Ranges of equivalent diameters for some types of aerosol and hydrosol particles. For perspective, the diameters of molecules are also shown.

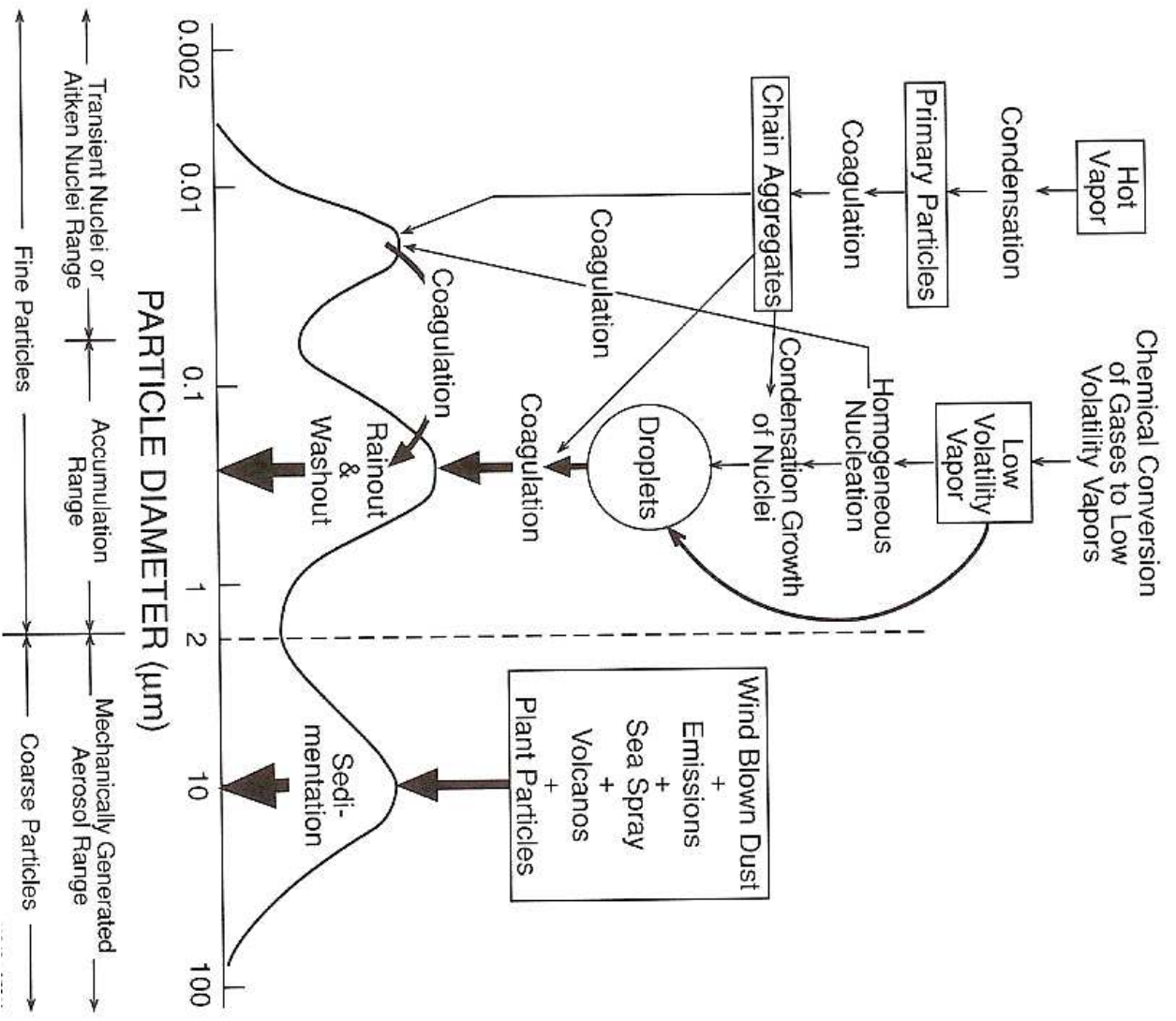


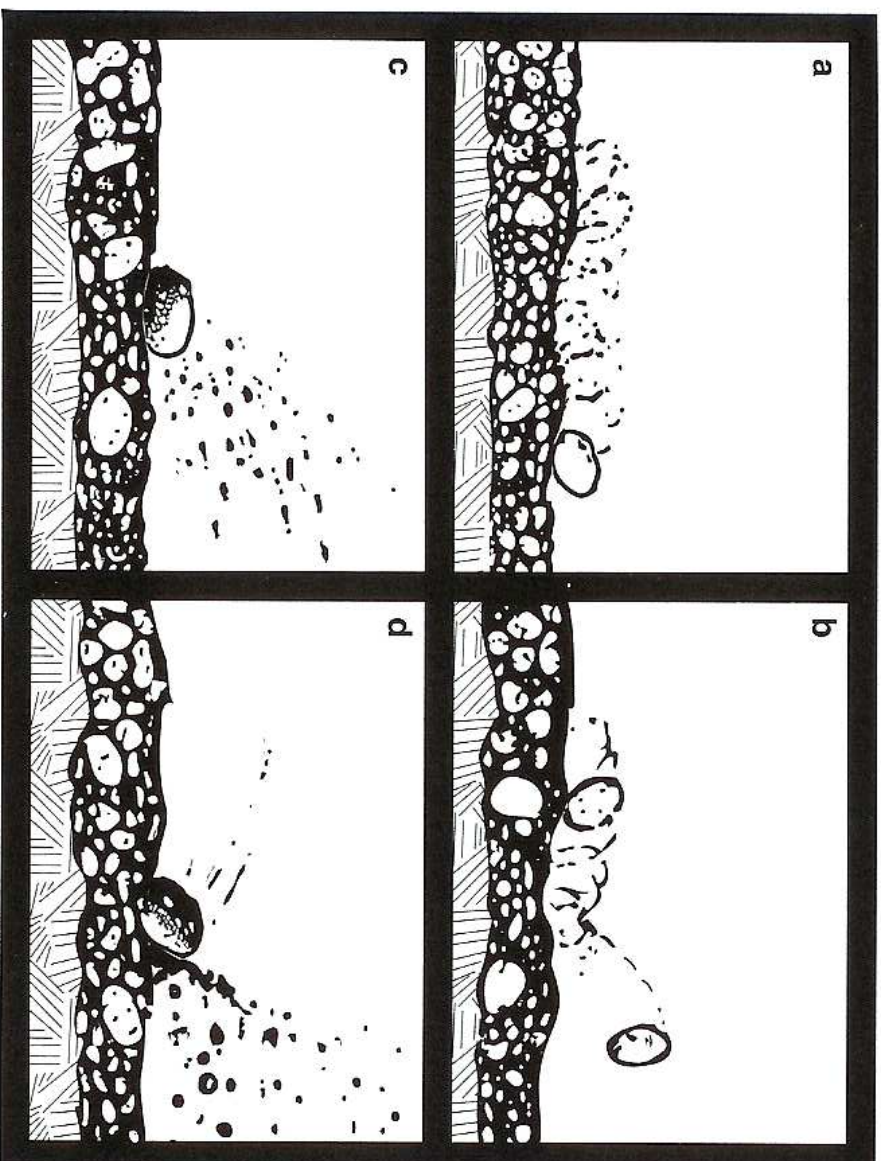
**Table 4.1**  
**Global Sources of Atmospheric Aerosols (in megatonnes per year)**  
 (Adapted by L. Barrie)

Aerosol Sources	Total Emissions $D < 25 \mu\text{m}$	Emissions $D < 1 \mu\text{m}$
<u>Manmade</u>		
<i>Primary:</i>		
Industrial dust	40-130	20-65
Soot	10-30	10-30
Biomass burning	50-190	50-190
Windblown dust	820	140
<i>Gas-Particle Conversion of:</i>		
SO <sub>2</sub> : Smelters/power plants	120-180	120-180
NO <sub>x</sub> : Autos/power plants	20-50	5-10
Anthropogenic VOCs	5-25	5-25
<u>Total Manmade Sources</u>	1065-1325	565-640
<u>Natural</u>		
<i>Primary:</i>		
Windblown dust	1000-3000	265
Forest fires	3-150	2-75
Sea salt	1000-10000	20-100
Volcanoes	4-10000	0.4-100
Organics	26-50	—
<i>Gas-Particle Conversion of:</i>		
DMS, H <sub>2</sub> S	60-110	60-110
Volcanic SO <sub>2</sub>	10-30	10-30
Biogenic NO <sub>x</sub>	10-40	10-40
Biogenic VOCs	40-200	40-200
NH <sub>3</sub> to NH <sub>4</sub> <sup>+</sup> salts	80-270	80-270
<u>Total Natural Sources</u>	1363-3550	397-1390



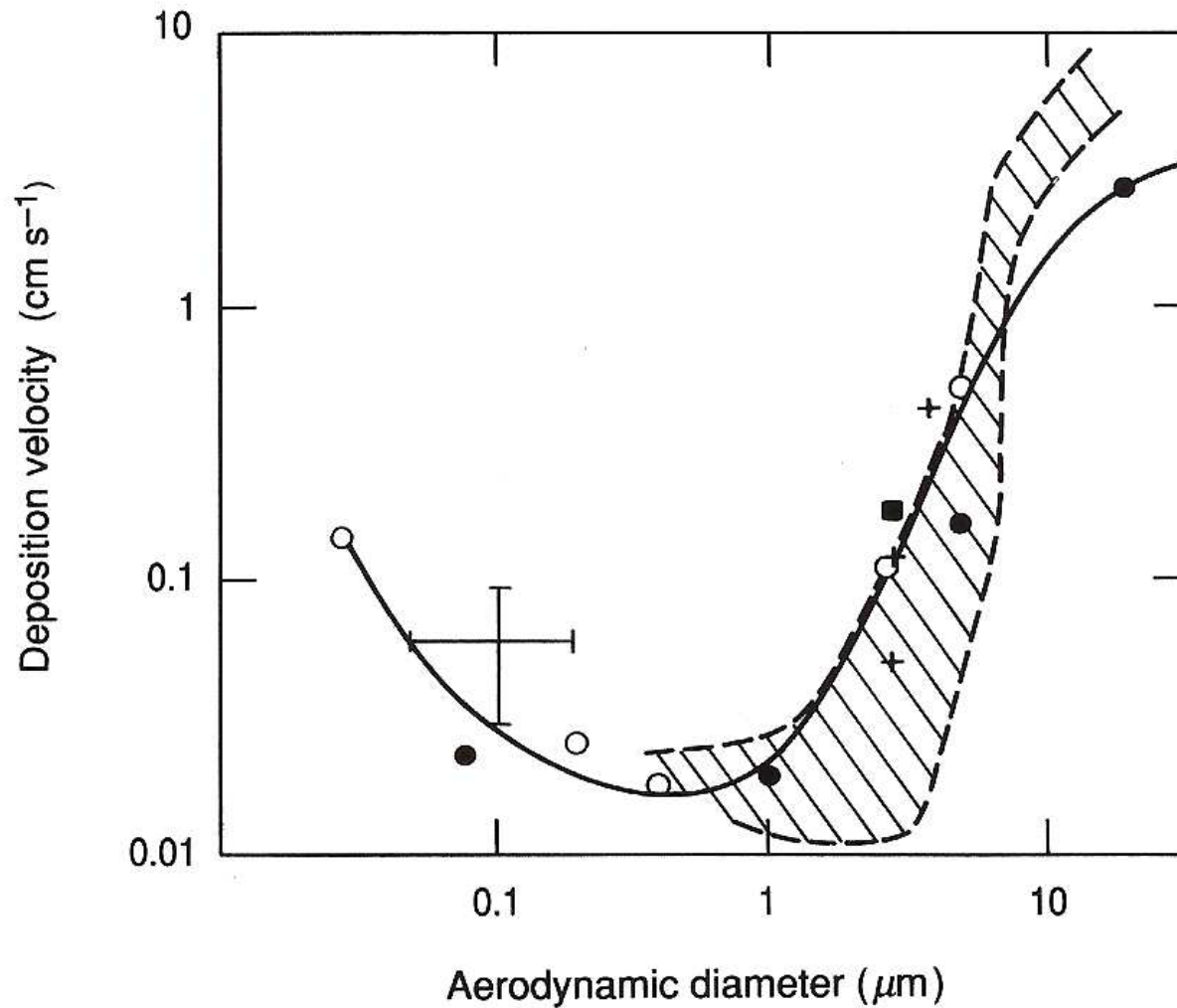
Maximum stratospheric aerosol mixing ratios for particles  $>0.3 \mu\text{m}$  (from balloon data collected until 1986, Laramie, Wyoming, USA). Included are the dates of major volcanic eruptions (Hofmann et al., *Geophysical Research Letters*, 13, 614-617, 1987)





**Figure 5.4** Motions of wind-driven soil particles. (a) Creeping motion of a particle moving as a consequence of a wind speed slightly greater than threshold; (b) A coarse particle lifted into the air by turbulent air fluctuations; (c) A particle collision with the surface, followed by breaking off of smaller particles that were encrusted on the colliding particle's surface; (d) A particle collision followed by "splashing" of the soil. (Adapted with permission from D. Gillette, Major contributions of natural primary continental aerosols: Source mechanisms, *Annals of the New York Academy of Sciences*, 338, 348–358. Copyright 1980 by New York Academy of Sciences.)

## Particle Deposition: “Slinn-Model”



**Figure 5.7** The deposition velocity of particles to grass. Field data for a number of experiments by different research groups are shown, some by data points and fitted lines, some by hatched areas. (Courtesy of J. A. Garland, Atomic Energy Research Establishment, UK.)

## LENGTH MEASURE ( $\mu\text{m}$ )

<p><b>Comparisons</b></p>	<p> <math>\text{O}_2</math> <math>\text{CO}_2</math> <math>\text{SO}_2</math> <math>\text{N}_2</math> <math>\text{H}_2\text{O}</math> </p> <p>Gas molecules</p> <p>Mean free pathlength (STP)</p> <p>Solar radiation</p> <p>Terrestrial radiation</p> <p>Visibility to naked eye: in darkfield in brightfield</p>
<p><b>Nomenclature</b></p>	<p>Colloid chemistry:</p> <p>Molecular disperse</p> <p>Colloidal disperse</p> <p>Coarse disperse</p> <p>Cloud physics: { Cloud, condensation nuclei, Clay, Silt, Fine sand, Coarse sand, Rain, Mist, Drizzle }</p> <p>Soil science: Aitken particles, Large particles, Giant particles</p> <p>Air chemistry: Condensation nuclei, Accumulation mode</p> <p>Aerosol physics: Rayleigh mode, Mie particles, Ultralarge ions</p> <p>Small ions</p> <p>Large ions</p> <p>Ultralarge ions</p> <p>Atmospheric optics</p>
<p><b>Production and removal</b></p>	<p>Gas-to-particle conversion</p> <p>Wet removal</p> <p>Dry removal</p> <p>Coagulation</p> <p>Mechanical disintegration</p>
<p><b>Integral properties</b></p>	<p>Total number</p> <p>Electrical conductivity</p> <p>Turbidity, Visibility</p> <p>Total surface</p> <p>Total mass</p> <p>Dry deposited mass</p>
<p><b>Collection for counting, mass determination, chemical analysis, physical properties, in general: bulk properties</b></p>	<p>Collection possible for anisokinetic conditions</p> <p>Collection possible for isokinetic conditions</p> <p>Nuclei counter</p> <p>Impactor, Impinger</p> <p>Thermal precipitation</p> <p>Electrical precipitation</p> <p>Centrifuge</p> <p>Diffusion</p> <p>Filters</p>