

Photometer Basics

Scott Norman, CIH CSP
Product Specialist
TSI Incorporated
Shoreview MN



UNDERSTANDING, ACCELERATED

Overview

Aerosol physics

How photometer technology works

Strengths and limitations of photometers

Why photometers are used for aerosol monitoring

Photometer field application examples

Q & A



Exposure Monitoring



Aerosol:
Fume, mist, smoke, dust



Aerosol Characteristics

Size

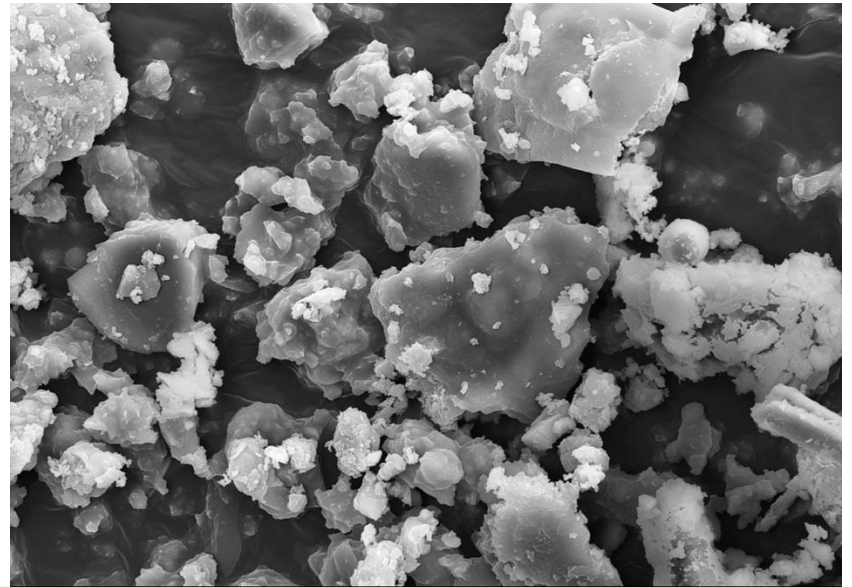
Shape

Density

Aerodynamic diameter

Not all particles are spheres

Mass concentration is calculated
from known density



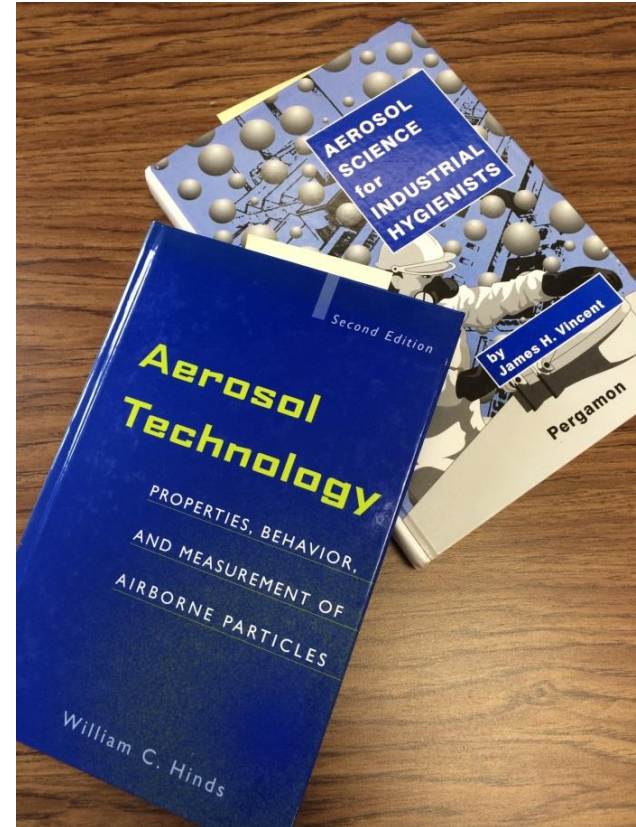
Aerosol science

Physics of aerosols

Properties

Behavior

Measurements



Aerosol Size Matters



Image courtesy of the U.S. EPA

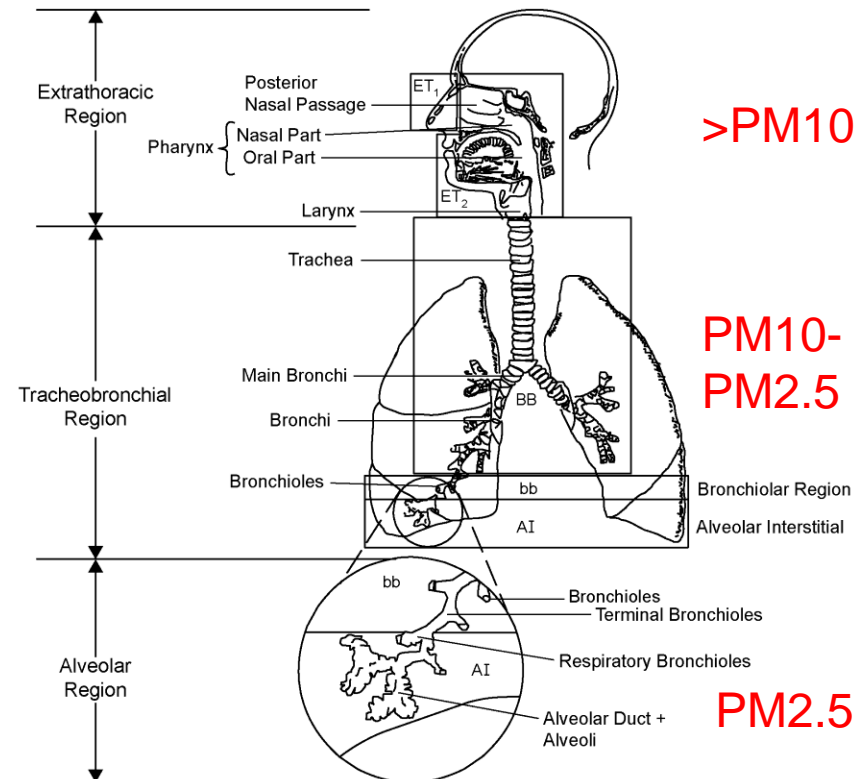


Respiratory Tract

Extrathoracic region

Tracheobronchial (TB)
region

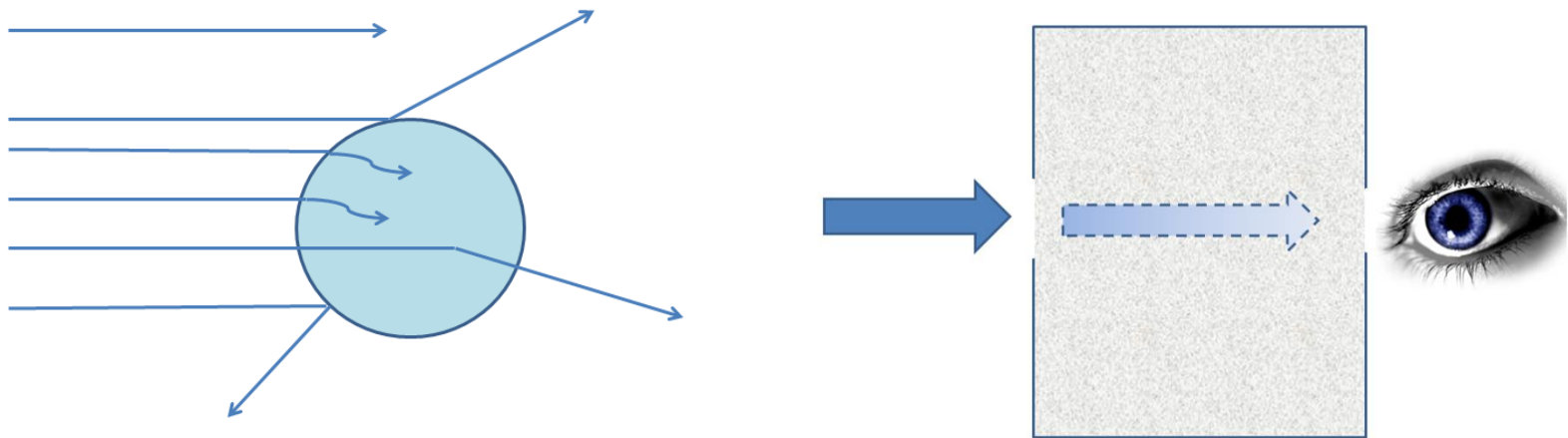
Alveolar (A) region



Based on International Commission of Radiological Protection (1994) and U.S. Environmental Protection Agency (1996a).
Air Quality Criteria for Particulate matter, 2004, p 6-5.



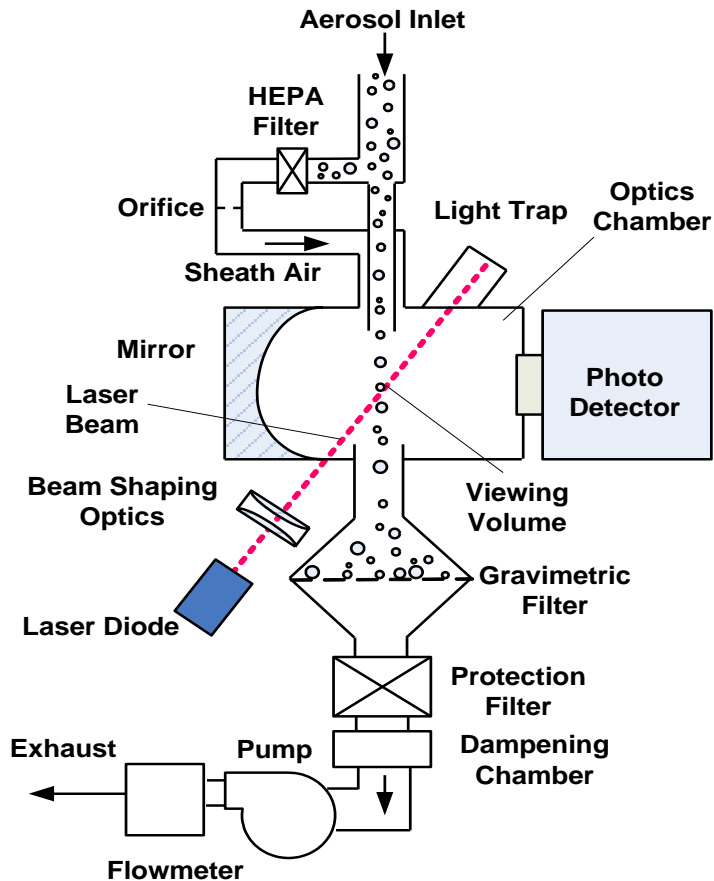
Aerosol properties



- **Aerosols absorb, reflect, refract and diffract light**
- **Light passing through an aerosol concentration is affected by the properties of the aerosol.**



Light Scattering Photometer Technology



8533 DustTrak DRX



Particle counting vs. light scattering

Particle counting is like counting the number of rain drops or snow flakes that hits the window

OPCs count the number of raindrops (or snow flakes) hitting the windshield.

- Works for certain size drops at low concentration levels

CPCs count the number of ultrafine particles



Photometric light scattering

Photometers measure the amount of light scattered by the fog.

Think of how bright the fog is in the headlights.

“thicker fog” is brighter.

A photometer would calculate more mass based on a brighter response from thicker fog based on the calibration aerosol.



Calibration aerosol

Photometers are calibrated to a known test aerosol.

- known density
- known refractive index
- known size distribution

A bucket of golf balls will not weigh the same as a bucket of ping pong balls.

The photometer sees Ping Pong balls, but calculates mass concentration based on the calibration aerosol (golf balls)



Calibration factor

Calibration factors are developed to 'inform' the instrument that the sampled aerosol is different than the test aerosol. Thus the mass measurement needs correction.

Density

Size

Refractive index

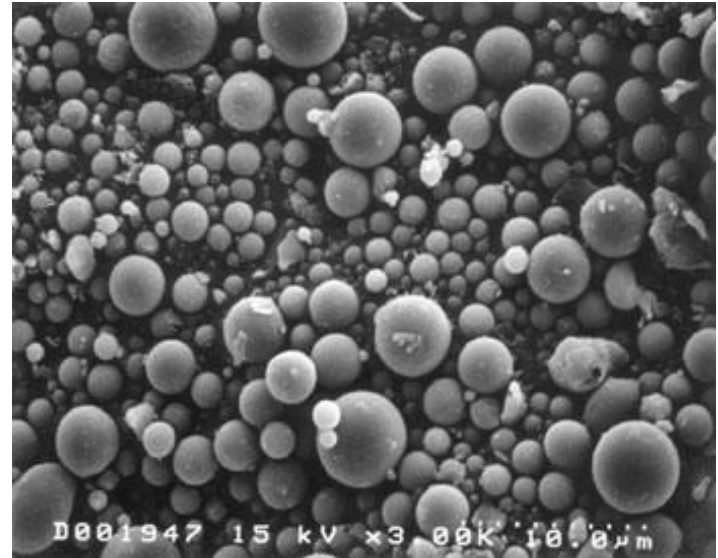


Aerosol distribution

A photometer sees aerosols of all shapes and sizes

The photometer measures the light scattering of these particles as a group.

Mass is calculated based on the properties of the calibration aerosol.



Fly ash – FHWA.dot.gov



Strengths and limitations of photometers

Limitations

Calibrated to test aerosol
Humidity effects
Contaminated optics



8533 DustTrak DRX Desk top



Strengths and limitations of photometers

Strengths

Real-time

Data logging

Alarms



8534 DustTrak DRX Handheld



Traditional IH Sampling

Gravimetric Measurement

Results:

Total mass 0.527 mg/m³

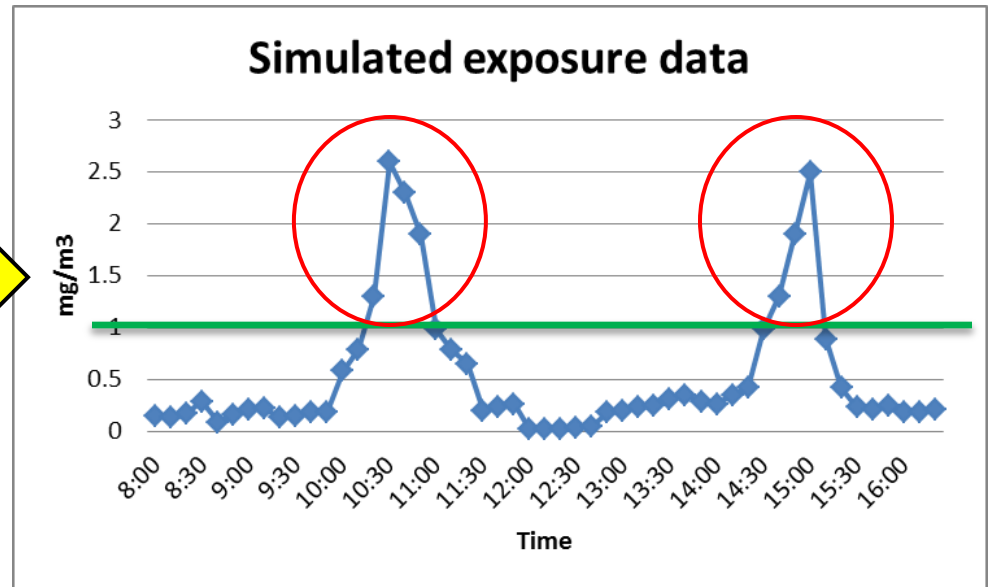


Real-Time Instruments

Photometric Measurement



Total Mass: 0.527 mg/m³



Why photometers are used for aerosol monitoring

Real time

Direct read

Data logging

Alarm notification



AM510 Personal Aerosol Monitor



Aerosol / Dust Sources

Construction, Mining, Agriculture

- Total dust PM100 – PM10
- Silica PM4 “respirable”



Welding Fume

- Hexavalent chrome



Foundry

- Silica
- Metal fume



Woodworking / machine shop



Application examples

Personal monitoring

Mining

Organization has characterized site aerosol exposures and developed custom calibration factors for silica.

Miners wear AM510 personal aerosol monitors on a regular basis to track silica exposure levels.



SHELL OIL SANDS

ALBERTA, CANADA



SMOKE RESPONSE: HIGH PRAISE FOR EVERYONE

It began as a haze on the horizon, drifting down from what would become one of the largest fires Alberta has ever seen.

Conditions at MRM mine were such that by Saturday evening May 21, response team members, led by AIT on-call leader Mario Levesque, decided to meet with more than a hundred MRM mine shift workers face to face.

Despite the dense smoke, the top-of-mind questions were crystal clear: How safe is it to work in these conditions? Is there a way to monitor air quality where we're actually working? What are you doing to protect our health and safety?

"Safety of workers was and continues to be our top priority," says Adrian Gnyra, HSSE Manager. "A comprehensive response plan was put in place to ensure everyone's safety so operations could continue."

"We worked as quickly as we could to set specific exposure limits for particulates based on the advice from our own doctors and nurses, Alberta Occupational Health and Safety and other operators," said Colin Ashton, Plant Production Manager.

Six air-monitoring instruments were quickly put to work, consistently taking samples

outdoors, indoors and in truck cabs in specific locations around site. This will continue as long as smoke persists.

"We used these readings to make hourly decisions on the safety of the air quality. When readings were high, workers were brought inside to safe areas and operations were temporarily halted," says Ashton.

The ongoing response has relied on the hard work and collaboration of many teams, including Environment, Emergency Response, and Health and Safety, to name just a few. But most of all, hats off to the perseverance of everyone on site.

"I have high praise for everyone involved because of your consistent professionalism and skill in dealing with conditions that are unprecedented at Albian," said General Manager, Christian Houle. Read more...



Darryl Mackoway, labourer - MMU, uses an air quality monitor to take readings at Jackpine.



Forest Fires:

DustTrak used to
measure smoke levels
for worker safety

Australian Outback

Dust storm & wild fire alerts



The University of Sydney

Fugitive Dust

FUGITIVE DUST means any solid particulate matter that becomes airborne, other than that emitted from an exhaust stack, directly or indirectly as a result of the activities of any person.



Perimeter Fence Line Monitoring Meadowlands Stadium - New Jersey



Comstock Mining – Virginia City, Nevada



8537 Environmental Enclosure,
DustTrak II,
Heated Inlet,
Netronix GSM Modem



BP OIL SPILL GULF OF MEXICO



- TRACK SMOKE PLUMES
- Protect Firefighters & Clean Up Crew Health
- Quantify particle mass exposures to help EPA reporting



DustTrak and P-Trak In Space!



DustTrak and P-Trak used on NASA Space Shuttles and the International Space Station (ISS) for over 10 years to measure crews working and living space air quality and for use as smoke/fire detectors



China PM2.5 Levels

Ambient urban pollution



Mission China

Beijing

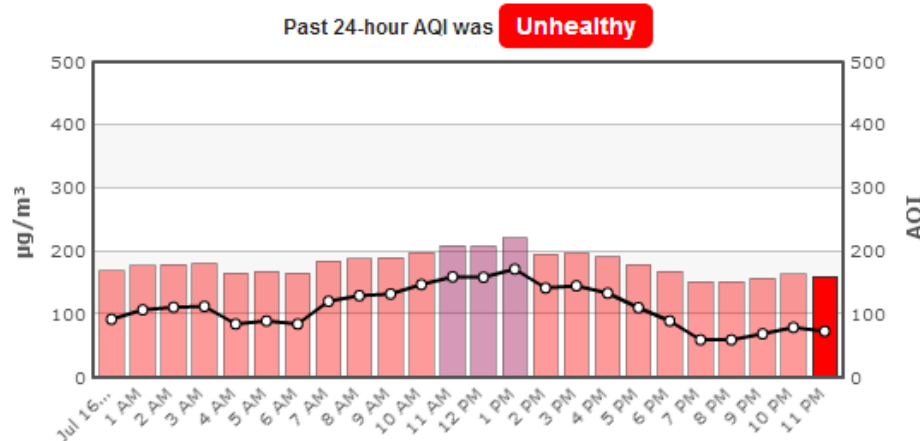
Posts

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Feeds



Beijing - PM2.5



Most Recent AQI

Jul 16, 2014 11 PM

161 AQI

Unhealthy

if at this level for 24 Hours

Concentration: 74.0 µg/m³



Summary

Light Scattering Photometers

Precise

Portable

Real Time

Direct Reading



DustTrak II and DustTrak DRX



AM510 Personal Aerosol Monitor



Environmental Enclosures



8537 Environmental Enclosure



Q & A

Scott Norman, CIH, CSP
Product Specialist

TSI Incorporated
Shoreview, MN
(651) 490-2702
scott.norman@tsi.com

