AEROSOL TECHNOLOGY FOR OCCUPATIONAL HYGIENE

IASI TECHNICAL UNIVERSITY

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Recommended Reading: AEROSOL TECHNOLOGY; William C. Hinds, John Wiley and Sons, Inc., New York, (ISBN 0-471-19410-7), latest edition.

COURSE DESCRIPTION:

This course deals with the properties, behavior, measurement and control of airborne particles found in the workplace environment. These aerosols come in many different forms, such as dusts, fumes, mists and smoke. Industrial aerosols affect health and the quality of life. This course is designed for the graduate student pursuing studies in occupational hygiene, but it is also of value, to health physicists, environmentalists, occupational physicians, environmental engineers, and safety professionals. Those people in professions that must understand aerosol behavior to understand health effects, measure aerosol concentrations, evaluate hazards, or to control and/or eliminate aerosols from release into the air.

The course assumes a background in occupational hygiene or related profession, and an understanding of chemistry, physics and in mathematics. An important aspect of this course is the quantitative description of aerosol behavior. To this end, many example problems will be presented in class, and on some occasions problems will be assigned for students to work. This is important to learn how the theory presented in class can be applied to field situations.

The course begins with a review of gas kinetics, mechanics, and progresses rapidly to more complicated subjects relating to gas-particle interactions and the resulting particle behavior. Particle statistics is delayed until the student has a preliminary understanding of aerosol properties and behavior, and thus can appreciate the need for statistical characterization. Where possible, applications are discussed after new principles have been presented. The more complicated theoretical applications such as filtration theory and respiratory deposition of industrial aerosols are introduced after the numerous underlying particle behavior principles have been covered. While considerable theoretical information is presented, every effort will be made to make the course as practical as possible.

It is planned that this course will be offered for two hours, three nights per week, for 8 or 9 weeks to accommodate working professionals. However, it must be emphasized that attending each lecture is critical since each lecture builds on the previous lecture. A student can get behind quickly, and never catch up.

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COURSE OBJECTIVES:

A. The student will acquire an understanding of the principles which govern the Behavior of industrial aerosols.

B. The student will gain a thorough understanding of aerosol measurement methods used in occupational hygiene, and in many cases the corresponding deposition patterns in the pulmonary system.

C. The student will leave the course with an understanding of the mechanisms utilized in the control of industrial aerosols for protection of worker health. This will also include the an understanding of the equipment used in the removal of toxic particles from gas streams exiting industrial facilities.

COURSE OUTLINE

INTRODUCTION:

A. Aerosols in the environment.
B. Applications of occupational aerosol science
C. Particle size, shape, density, and aerosol concentrations.
D. Definitions of the various forms of industrial aerosols.

PROPERTIES OF GASES:

A. Kinetic theory of gases including molecular velocity, mean free path, viscosity and mass transfer by diffusion.
B. Turbulence and laminar flow.
C. Measurement of gas velocity, flow and pressure.

UNIFORM PARTICLE MOTION:

A. Newton's Resistance Law, Stoke's Law, particle settling velocity, and particle mobility.
B. Slip Correction, dynamic shape factor, and aerodynamic particle size.
C. Still air and stirred settling of particles.
D. Air sampling instruments that rely on settling velocity.

ACCELERATION AND CURVILINEAR PARTICLE MOTION:

A. Relaxation time, acceleration and stopping distance.
B. Curvilinear motion and Stoke's Number.
C. Inertial impaction and Cascade Impactors.

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D. Cyclone separators.

MICROSCOPIC MEASUREMENT OF PARTICLE SIZE:

A. Equivalent sizes of irregular shaped particles.
B. Optical microscopy for Asbestos Counting.
C. Automatic particle sizing methods.

PARTICLE SIZE STATISTICS:

A. Properties of particle size distributions, moment averages, and the lognormal distribution.
B. Hatch-Choate conversion equations.
C. Cascade Impactor data reduction.

ADHESION OF PARTICLES:

A. Adhesive forces.
B. Detachment of particles.
C. Particle bounce.

BROWNIAN MOTION AND PARTICLE DIFFUSION:

A. Diffusion coefficient, particle mean free path, and Brownian displacement.
B. Particle deposition by diffusion
C. Diffusion batteries.

THERMAL AND OTHER RADIOMETRIC FORCES:

A. Thermophoresis and thermal precipitators.
B. Photophoresis
C. Diffusiophoretic force.

ELECTRICAL PROPERTIES:

A. Electric fields, electrical mobility and charging mechanisms.
B. Corona discharge, charge limits and equilibrium charge distribution on particles.
C. Electrostatic precipitators and electrical measurement of aerosols.

FILTRATION THEORY FOR AEROSOLS

A. Macroscopic properties of filters.
B. Single-fibler efficiency.

C. Deposition mechanisms, filter efficiency, and pressure drop.
D. Membrane filters.
E. HEPA filtration.

RESPIRATORY DEPOSITION:

A. Pulmonary deposition sites and mechanisms.
B. Particle Size-Selective TLV's .
C. Inhalable, Thoracic, and Respirable Mass Sampling.

MEASUREMENT OF AEROSOL CONCENTRATIONS:

A. Isokinetic Sampling.
B. Stack Sampling.
C. Sampling from still air.
D. Gravimetric Analysis.
E. Direct Reading Instruments.

COAGULATION:

A. Simple monodisperse coagulation.
B. Polydisperse coagulation.
C. Kinematic coagulation.

OPTICAL PROPERTIES OF AEROSOLS:

A. Extinction, scattering, and visibility.
B. Optical measurement of aerosol size and number.

DUST EXPLOSIONS IN INDUSTRY:

A. Aerosol size and minimum explosive concentration.
B. Deflagration.

ATMOSPHERIC DISPERSION OF AEROSOLS:

A. Eddy diffusion of fine particles.
B. Dispersion from point sources.
C. Dispersion of instantaneous releases.

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AEROSOL POLLUTION CONTROL DEVICES:

A. Settling Chambers.
B. Centrifugal Separators.
C. Filtration Devices.
D. Electrostatic Precipitators.
E. Particle Scrubbers.