Environmental Engineering Cheatsheet

A comprehensive cheat sheet covering essential concepts and formulas in environmental engineering. This guide provides a quick reference for professionals and students dealing with water quality, air pollution, waste management, and environmental regulations.

Water Quality Engineering

Water Quality Parameters

Parameter	Description and Significance
pH	Measure of acidity or alkalinity; affects aquatic life and chemical reactions.
Dissolved Oxygen (DO)	Amount of oxygen dissolved in water; essential for aquatic organisms.
Biochemical Oxygen Demand (BOD)	Amount of oxygen consumed by microorganisms in decomposing organic matter.
Chemical Oxygen Demand (COD)	Measure of the oxygen equivalent of all organic matter in a water sample that is susceptible to oxidation.
Total Suspended Solids (TSS)	Total amount of solid material suspended in water.
Turbidity	Measure of water clarity; affected by suspended solids and dissolved materials.

Water Treatment Processes

Process	Description
Coagulation/Flocculation	Adding chemicals to clump small particles together into larger, settleable flocs.
Sedimentation	Allowing the heavier flocs to settle out of the water.
Filtration	Removing suspended particles by passing water through a filter medium (e.g., sand, gravel).
Disinfection	Killing or inactivating pathogenic microorganisms (e.g., chlorination, UV radiation).
Aeration	Increasing the oxygen content of water to remove dissolved gases and oxidize certain pollutants.

Key Formulas

Hardy-Cross Method (Pipe Network Analysis):
Iterative method to determine flow distribution in a pipe network based on head loss equations.

Manning's Equation (Open Channel Flow):
$V = (k/n) * R^{2/3} * S^{1/2}$
where:

- V = velocity (m/s or ft/s)
- k = conversion factor (1 for metric, 1.49 for US customary)
- n = Manning's roughness coefficient
- R = hydraulic radius (m or ft)
- S = channel slope (m/m or ft/ft)

Darcy's Law (Groundwater Flow):
$Q = -KA (dh/dl)$
where:

- Q = volumetric flow rate
- K = hydraulic conductivity
- A = cross-sectional area
- dh/dl = hydraulic gradient

Air Quality Engineering

Air Pollutants

Pollutant	Source and Effects
Particulate Matter (PM2.5, PM10)	Combustion processes, industrial activities; respiratory issues, reduced visibility.
Ozone (O3)	Secondary pollutant formed by photochemical reactions; respiratory irritant, damages vegetation.
Nitrogen Oxides (NOx)	Combustion processes; contributes to smog and acid rain.
Sulfur Dioxide (SO2)	Combustion of sulfur-containing fuels; respiratory irritant, contributes to acid rain.
Carbon Monoxide (CO)	Incomplete combustion of fuels; reduces oxygen delivery in the bloodstream.
Lead (Pb)	Industrial processes, historical use in gasoline; neurological effects.

Air Pollution Control Technologies

Technology	Description
Scrubbers	Use liquid to remove particulate matter or gases from industrial exhaust streams.
Electrostatic Precipitators (ESPs)	Use an electric field to remove particulate matter from exhaust streams.
Baghouses	Use fabric filters to remove particulate matter from exhaust streams.
Catalytic Converters	Convert harmful pollutants (e.g., CO, NOx) into less harmful substances (e.g., CO2, N2).
Adsorption	Using materials like activated carbon to trap pollutants on their surface.

Key Formulas

Gaussian Plume Model:
$C(x, y, z) = (Q / (2 * \pi * u * \sigma_y * \sigma_z)) * \exp(-y^2 / (2 * \sigma_y^2)) * [\exp(-(z-H)^2 / (2 * \sigma_z^2)) + \exp(-(z+H)^2 / (2 * \sigma_z^2))]$
where:

- C = concentration at point (x, y, z)
- Q = emission rate
- u = wind speed
- σ_y, σ_z = horizontal and vertical dispersion coefficients
- H = effective stack height

Stack Height Calculation:
Based on regulatory requirements to ensure adequate dispersion of pollutants.

Solid Waste Management

Waste Generation and Composition

Category	Description and Examples
Municipal Solid Waste (MSW)	Waste from households, commercial establishments, and institutions (e.g., paper, plastics, food waste).
Industrial Waste	Waste from manufacturing and industrial processes (e.g., chemicals, metals).
Hazardous Waste	Waste that poses a substantial threat to human health or the environment (e.g., toxic chemicals, radioactive materials).
Construction and Demolition (C&D) Waste	Waste from construction, renovation, and demolition of buildings and structures (e.g., concrete, wood).
Electronic Waste (E-waste)	Discarded electronic devices (e.g., computers, phones, televisions).

Waste Treatment and Disposal Methods

Method	Description
Landfilling	Disposing of waste in engineered landfills with liners and leachate collection systems.
Incineration	Burning waste at high temperatures to reduce volume and generate energy.
Composting	Decomposing organic waste aerobically to produce compost, a soil amendment.
Recycling	Processing waste materials into new products to reduce resource consumption.
Anaerobic Digestion	Decomposing organic waste in the absence of oxygen to produce biogas, a renewable energy source.

Key Calculations

Landfill Capacity Calculation:
Estimating the remaining capacity of a landfill based on waste input and compaction rates.

Waste Diversion Rate:
Percentage of waste diverted from landfills through recycling and composting programs.

Methane Generation Rate (Landfills):
Estimating methane production from landfills for energy recovery projects.

Environmental Regulations and Sustainability

Key Environmental Regulations

Clean Water Act (CWA):
Regulates the discharge of pollutants into U.S. waters and sets water quality standards.

Clean Air Act (CAA):
Regulates air emissions from stationary and mobile sources to protect public health and the environment.

Resource Conservation and Recovery Act (RCRA):
Governs the management of solid and hazardous waste, including generation, transportation, treatment, storage, and disposal.

Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA):
Provides a framework for cleaning up abandoned or uncontrolled hazardous waste sites.

National Environmental Policy Act (NEPA):
Requires federal agencies to assess the environmental impacts of proposed actions and consider alternatives.

Sustainability Metrics

Metric	Description and Significance
Carbon Footprint	Total greenhouse gas emissions caused by an organization, event, product, or person.
Water Footprint	Total volume of freshwater used to produce goods and services.
Ecological Footprint	Measure of human demand on the Earth's ecosystems.
Life Cycle Assessment (LCA)	Assessment of the environmental impacts associated with all stages of a product's life, from cradle to grave.
Material Flow Analysis (MFA)	Systematic assessment of the flows and stocks of materials within a defined system.

Sustainable Practices

Reduce, Reuse, Recycle:
Minimize waste generation and maximize resource utilization.

Energy Efficiency:
Implement measures to reduce energy consumption and greenhouse gas emissions.

Water Conservation:
Implement water-saving technologies and practices to reduce water usage.

Green Infrastructure:
Use natural systems to manage stormwater and enhance urban environments.

Sustainable Procurement:
Purchase products and services that have a reduced environmental impact.