



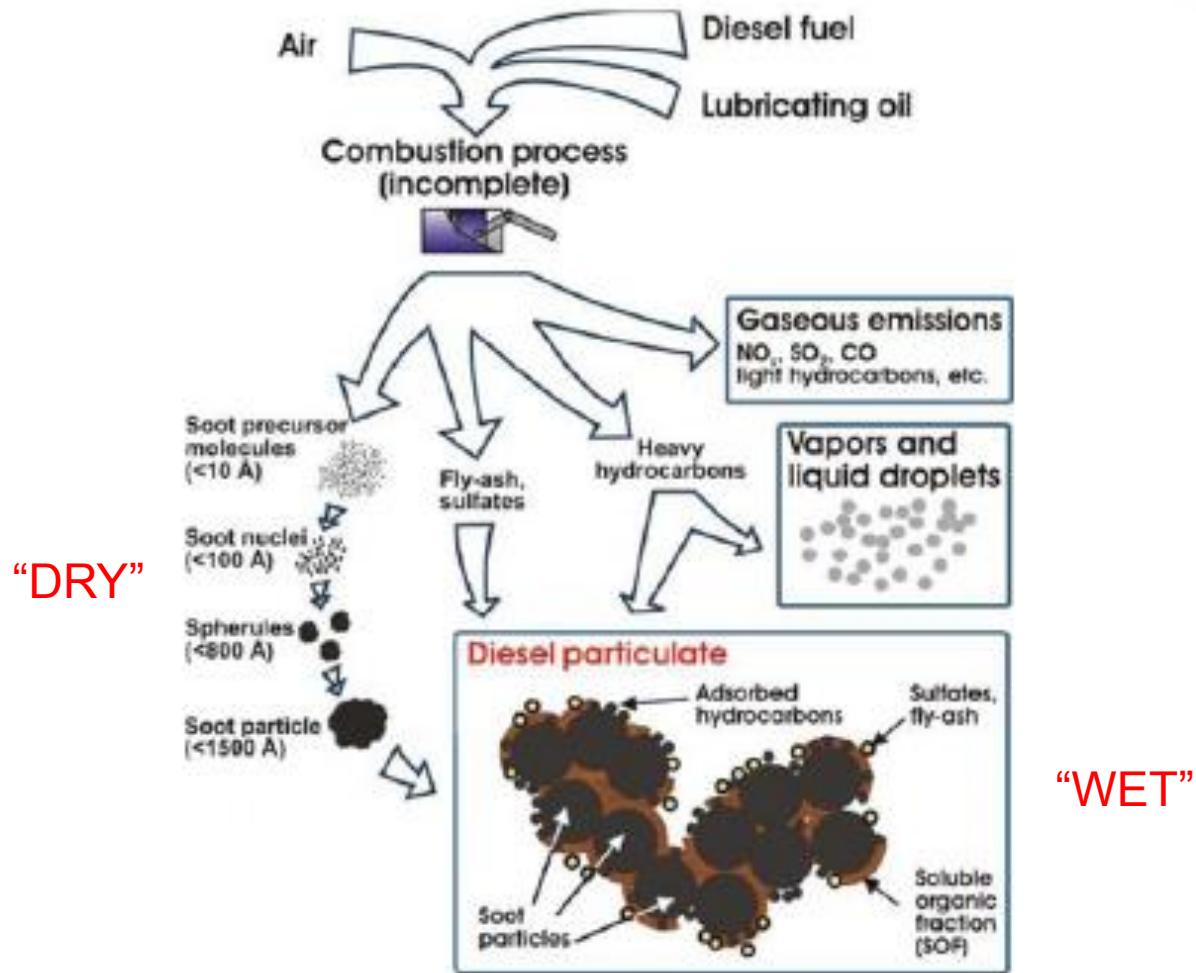
Diesel Components

Provided by Dr. Bruce Hope

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ATSAC Meeting #7

Diesel Engine Exhaust



Diesel Exhaust Components

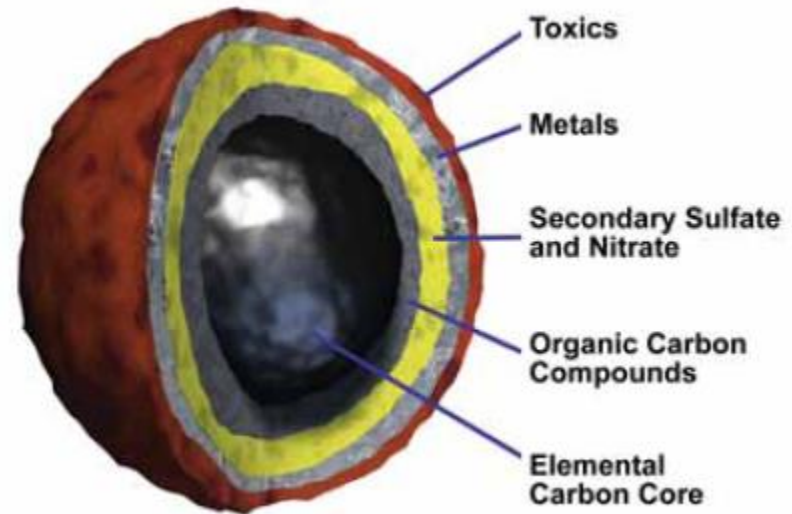
- Gases (vapors)
 - NO_x, SO_x, etc. / Light hydrocarbons (benzene, etc.)
- Amorphous liquid particles (aerosols)
- Ash
- “Dry” particles (“soot” / EC)
- “Wet” particles (also “soot” / EC)
 - Adsorbed & condensed heavy hydrocarbons
 - Soluble Organic Fraction
 - Sulfates / Hydrated sulfuric acid

Particle Composition

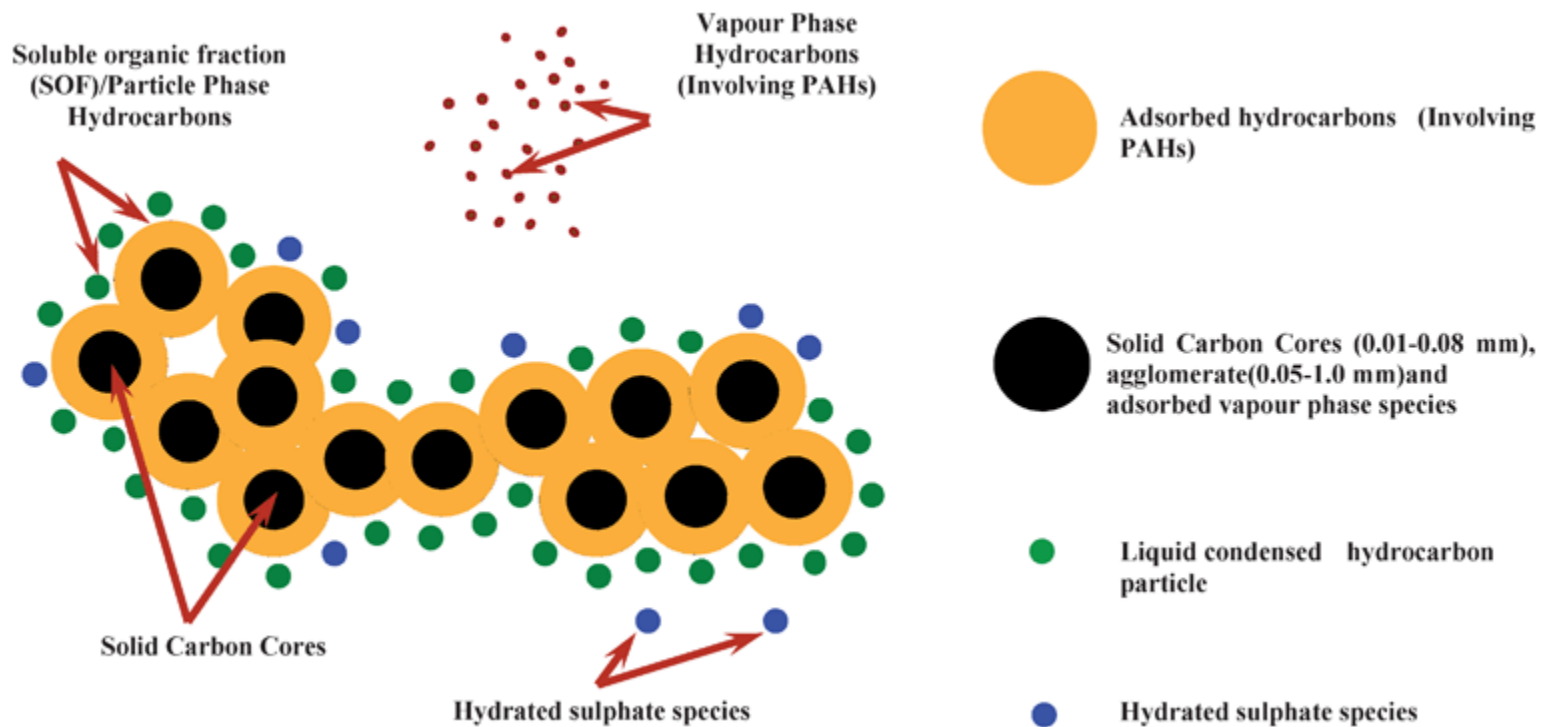
- Nonvolatile or Insoluble
 - Carbonaceous fraction (elemental carbon)
 - Ash fraction (mostly metals, as sulfates & oxides)
- Volatile or Soluble
 - Sulfate fraction (hydrated sulfuric acid)
 - Nitrate fraction
 - Organic fraction (soluble/volatile organic fraction)
 - SOF = Alkenes, Ketones, Acids, Aromatics, Alkanes, Alcohols, Esters

Particle Structure

- Mostly elemental carbon (soot)
- About 20% to 40% adsorbed or condensed organic compounds
- Also sulfate, nitrate, metals, other trace elements
- PAHs less than 1% of PM by mass
- 92% of mass is in particles smaller than 1 micron



Particle Agglomeration



Emission Comparisons

- Diesel Engines

- ~ 60% EC
- ~ 20% Lube oil SOF
- ~ 10% Sulfate, Water
- ~ 5% Fuel SOF
- ~ 5% Ash

- Gasoline Engines

- ~ 80% Unresolved complex mixture
- ~ 10% Ash
- ~ 5% Sulfates, EC, etc.
- ~ 5% Oxygenated

EC as “Active Ingredient”

- OEHHA (1993) - 0.003 per $\mu\text{g}/\text{m}^3$
 - Basis presumably very fine particles with a carbon core coated by condensed organic compounds
- Vermeulen et al (2014) - 0.00004 per $\mu\text{g}/\text{m}^3$
 - Extrapolating to a 1×10^{-6} risk for urban EC exposures
- Schauer (2003)
 - EC is not a unique tracer for diesel exhaust
 - Other sources of EC must be addressed
 - A consistent EC measurement technique is needed
 - NIOSH 5040?

Soot (EC/BC) Sources

