APTI Course 427

Combustion Source Evaluation

Administrative

- Post-test similar to pretest, open notes
- Daily schedule
 - Three 90 minute sessions
 - Two 15 minute breaks
- Presentation follows Student Manual
- Read ahead for each day

APTI Course 427

Combustion Source Evaluation

Chapter 1:

Overview

Chapter Overview

- Significance of Combustion Sources
- Carbon and Energy
- Fuels
- Air Pollution
- Overview of Combustion Sources

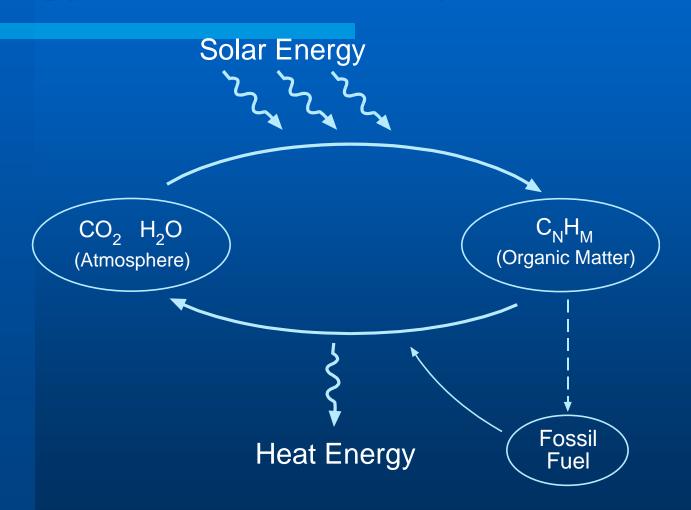
Significance of Combustion Sources

Table 1-1. Examples of Sources and Fuels				
Source Type	Principal Fuels			
Steam-electric power plant	Bituminous coal, subbituminous coal, residual oil, natural gas (fossil fuels)			
Waste-to-energy steam power plant	Wood, municipal solid waste, misc.			
Factory boiler	Gas, No. 2 oil, No. 6 oil, site specific waste			
Combustion turbine power plant	Natural gas or distillate oil			
Cement kiln	Fossil fuels, tires, used oil, hazardous waste			
Residential or commercial furnace	Natural gas or No. 2 oil			
Trucks, cars & railroad engines	Gasoline or diesel fuel			
Incinerators	Natural gas, fumes, organic liquid and			
	solids			

Carbon and Energy

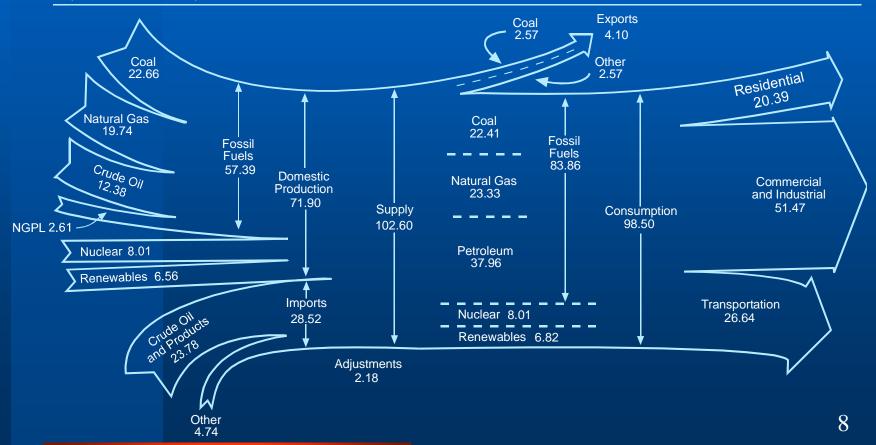
- All common fuels are hydrocarbons.
- Energy is derived from the oxidation of carbon and hydrogen.

Energy and Carbon Cycle



Energy Production/Consumption

Energy Flow, 2000 (Quadrillion Btu)



Fuels (outline)

Fuel Characteristics

Carbon Emissions

Fuel vs Combustor Design

- Fuel characteristics affect combustor design
- Some sources operate on several fuels
- The many aspects of source design depend on fuel type

Fuel Characteristics

Table 1-2. Fuel Characteristics				
Fuel	Chief Characteristic			
Natural Gas	Mostly CH ₄ (methane) - usually burns clean			
LPG	Mostly C ₃ H ₈ (propane) - higher density than			
	CH_4			
Light Oil (No. 2, Diesel)	Few contaminants - a mixture averaging CH ₂			
Heavy Oil (No. 4, No. 6, residual)	Black (close kin to tar), not readily pumped			
	or burned when cold, sulfur and other			
	contaminants			
Coal (bituminous, anthracite,	Contaminated with sulfur, ash, rock & water.			
lignite)	Composition - C to CH			
Wood	Moderate ash, water content is high &			
	variable. Typical composition - CH ₂ O ₁			

Fuel Characteristics (cont.)

Table 1-2. Fuel Characteristics				
Fuel	Chief Characteristic			
Waste Oil	Distillate oil with some contaminants			
Refinery gas, producer gas, coke oven gas	Gas mixtures with inerts plus some contaminants			
Landfill gas, sewage treatment gases	Mostly CH ₄ & CO ₂ with smelly contaminants			
Solid wastes	Contaminated with almost anything			

Fuel Choices

- A source will use the least expensive fuel
- that's practical & permitted
 - •Limited by existing equipment?
 - Environmental restrictions?
- Clean fuels are expensive
- Trade off between expensive fuel & expensive equipment & permits

Carbon Emissions

Table 1-3. Carbon Emissions (10 ⁶ tons)				
Sector	Total Carbon	Electric*		
Transportation	496	1		
Industrial	481	180		
Residential	290	193		
Commercial	243	183		

^{*}Electric is part of the total.

Air Pollution (outline)

- Origin
- Emission rates

- Types of pollutants
- Emission controls

Origin

Direct

Indirect

Dilution, transport, ambient impacts

Determining Emission Rates

- Estimating rate is proportional to
 - Amount of fuel burned
 - Fuel contaminant content

- AP-42
 - ?? Applicability & reliability ??

Emission Rates Units

Common measurement units:

- lb/hour or tons/year
- ppm or lb/ft³ (corrected)
- Ib/mmBTU
- lb/ton of product

Types of Pollutants

- Products of incomplete combustion or PIC (CO, carbon, organic species)
- 2. Emissions formed from fuel contaminants (SOx, particulates, etc.)
- 3. Nitrogen oxides (NOx)

Emission Control

Table 1-4. Typical Emission Rates (lb/mmBTU)				
Source	Pollutant	Uncontrolled	Controlled	
Natural gas furnace	NOx	0.1 to 0.5	.02 to .02	
No. 6 oil fired boiler	NOx Particulates SO ₂	0.45 0.10± 2.50	0.25 0.05± <1.00	
Pulverized coal boiler	NOx Particulates SO₂	0.80 10.00 4.50	0.40 <0.05 <1.50	
Wood fired boiler	Particulates	2.50	0.1 to 0.6	
Diesel Engine	NOx Particulate – PM10 CO	3.2 0.05 – 1.0 0.85	1.9	
Combustion Turbine	NOx	0.50	0.035	

Overview of Combustion Sources (outline)

- Overview
- Engines
- Boiler Systems
- Other Combustion Sources

Overview of Combustion Sources (2)

- Stationary sources account for 1/3 of CO₂
- Sizes
 - Small sources are manufacturer certified

Internal Combustion Engines

- Two types
 - Reciprocating & combustion turbines
- Uses

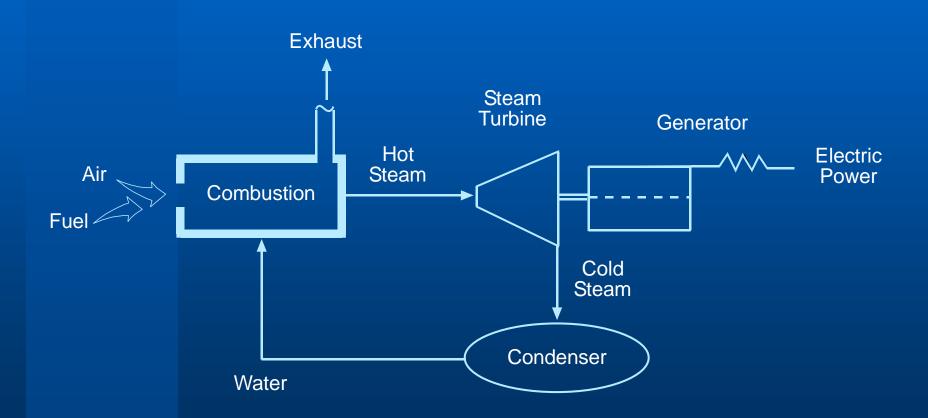
- Emissions
 - Clean fuels mean NOx is the main issue
- Basic Configuration
 - Factory built mean they are highly predictable

Boilers

- Most common stationary combustion source
- Come in all sizes

Can be configured to burn ANY fuel

Boiler with Steam Turbine Generator



Other Combustion Sources

Cement Kilns

Solid Waste Incinerators

Hazardous Waste Incinerators

Thermal Oxidizers

Other Combustion Sources

Cement Kilns

Solid Waste Incinerators

Hazardous Waste Incinerators

Thermal Oxidizers

Chapter Summary

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- Fuels
- Air Pollution
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