- LESSON 3 -
THEME: CARBON IN THE ENVIRONMENT
TOPIC 7: CARBON IN THE ENVIRONMENT

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MAKING CHARCOAL BRIQUETTES FROM WASTE ORGANIC MATERIALS:

Materials Needed:
- Waste organic materials (e.g., sawdust, rice husks, coconut shells)
- Charcoal dust or powder
- A binding agent (e.g., starch, clay)
- Water
- A mixing device (e.g., hammer mill, blender)
- A briquette machine or press
- A drying rack or oven

Procedure:
1. Charcoal Production: Produce charcoal from wood through carbonization.
2. Crushing and Milling: Crush and mill the charcoal into a fine powder.
3. Mixing: Mix the charcoal powder with a binding agent and water to create a uniform blend.
4. Briquetting: Use a briquette machine or press to shape the blend into briquettes.
5. Drying: Dry the briquettes to remove excess moisture.
6. Curing: Allow the briquettes to cure for several hours or days to harden.

Purification Process:
- Sieving: Sieve the briquettes to remove any impurities or irregularly shaped briquettes.

Applications:
- Fuel: Use the charcoal briquettes as a fuel for cooking, heating, or industrial processes.
- Barbecues and Grills: Use the charcoal briquettes as a fuel for barbecues and grills.

Note: The specific steps and purification processes may vary depending on the desired charcoal briquette quality and application. Additionally, proper safety measures should be taken during the process to avoid accidents and ensure a safe working environment.

MAKING CHARCOAL FROM WOOD:

Materials Needed:
- Trees (preferably hardwoods like oak, maple, or beech)
- Axe or chainsaw for felling and cutting
- Kiln or pit for carbonization
- Heat source (e.g., firewood, diesel)
- Ventilation system
- Water for cooling
- Sieves or screens for purification

Procedure:
1. Harvesting: Select and fell trees, then cut them into manageable logs.
2. Splitting: Split logs into smaller pieces to increase surface area.
3. Drying: Dry wood pieces to reduce moisture content.
4. Loading: Load wood pieces into kiln or pit.
5. Carbonization: Heat wood in kiln or pit to high temperatures (200-300°C) in absence of oxygen.
6. Cooling: Allow charcoal to cool before removing from kiln or pit.

Purification Process:
- Sieving: Sieve charcoal through screens or sieves to remove impurities and achieve uniform size.

Applications:
- Fuel: Use charcoal as fuel for cooking, heating, or industrial processes.
- Water Filtration: Use charcoal as filter medium to remove impurities from water.
- Agriculture: Use charcoal as soil amendment to improve soil fertility and structure.

Note: The specific steps and purification processes may vary depending on desired charcoal quality and application.
Additionally, proper safety measures should be taken during the process to avoid accidents and ensure a safe working environment.

THE CHEMISTRY BEHIND BURNING ORGANIC MATERIAL BURNS IN A LIMITED SUPPLY OF OXYGEN

When organic material burns in a limited supply of oxygen, it undergoes a process called **pyrolysis** or **carbonization**.

Decomposition: The organic material (e.g., wood) breaks down into simpler molecules, releasing volatile gases and liquids.

Dehydration: Water molecules (H_2O) are released, leaving behind a carbon-rich material.

Decarboxylation: Carbon dioxide (CO_2) is released, leaving behind a carbon-rich material.

Pyrolysis: The carbon-rich material breaks down into:

a. Volatile compounds (e.g., methane, CH_4; hydrogen, H_2; and other hydrocarbons)

b. Char (carbon, C): the solid residue, which is the charcoal

c. Tar: a liquid mixture of hydrocarbons

Carbonization: The char (carbon) is the final product, which is the charcoal.

Chemical equations:

$C_6H_{12}O_6$ (wood) → C (char) + H_2O (water) + CO_2 (carbon dioxide) + CH_4 (methane) + other hydrocarbons

Note: The specific chemical equations and reactions may vary depending on the type of organic material and the conditions of the pyrolysis process.

In summary, burning organic material in a limited supply of oxygen leads to pyrolysis, which breaks down the material into simpler molecules, releasing volatile gases and liquids, and leaving behind a carbon-rich solid residue, which is the charcoal.

CARBON DIOXIDE GAS

Molecular Formula: CO_2

Elemental Composition: Carbon & Oxygen

Chemical Structure: O=C=O

Molecular Weight: 44.01 g/mol

Category: Covalent compound (Formed by sharing of electrons)

Properties:
Color: Colorless
Odor: Odorless
Taste: Slightly acidic
State: Gas at room temperature and pressure
Density: 1.98 kg/m3
Test with a lit splint: Extinguishes a lit splint with a "hissing" sound, indicating the presence of CO_2.

Occurrence:
- Found in Earth's atmosphere (0.04%)
- Released through human activities (fossil fuel combustion, deforestation)
- Present in volcanic gases and ocean water

Word Equation Of Carbon Dioxide Production:

Limestone (Calcium Carbonate) + Dilute Hydrochloric Acid → Calcium Chloride + Water + Carbon Dioxide

In chemical symbols:

$CaCO_3$ (limestone) + HCl (dilute hydrochloric acid) → $CaCl_2$ (calcium chloride) +H_2O (water) + CO_2 (carbon dioxide)

USES OF CARBON DIOXIDE
Food and Beverages: CO_2 is used to create the fizz in soft drinks, beer, and sparkling water, making them refreshing and carbonated.
Industrial Applications: CO_2 is used in oil recovery, chemical synthesis, and power generation, helping to extract resources and produce energy.
Cooling and Agriculture: CO_2 is used as a refrigerant in commercial and industrial cooling systems, and in greenhouses to enhance plant growth and photosynthesis.
Safety and Cleaning: CO_2 is used in fire extinguishers to put out electrical fires, and as a solvent for cleaning surfaces and equipment.
Environmental and Energy Applications: CO_2 is used in carbon capture and storage, enhanced oil recovery, and other
technologies to reduce greenhouse gas emissions and promote sustainable energy solutions.

ATMOSPHERIC AND OCEAN WARMING

The increase in carbon dioxide in the air leads to atmospheric and oceanic warming through several mechanisms:

Trapping heat: CO_2 absorbs infrared radiation, trapping heat in the atmosphere and preventing it from being released into space.
Greenhouse effect: CO_2 is a greenhouse gas, enhancing the natural greenhouse effect and leading to an increase in global temperatures.
Ocean absorption: The oceans absorb some of the excess CO_2, which increases their acidity and temperature.
Feedback loops: Warmer oceans release more CO_2, amplifying the warming effect.
Therefore this tells us that the nature of carbon dioxide is that of a potent greenhouse gas, capable of altering the Earth's energy balance and leading to significant climate changes.

IMPACTS OF CARBON DIOXIDE ON CLIMATE

Global Warming: CO_2 traps heat, increasing global temperatures and altering climate patterns. (Example: 2020 was the hottest year on record, with temperatures 1.2°C above pre-industrial levels.)
Extreme Weather Events: CO_2-influenced climate change leads to more frequent and intense heatwaves, droughts, and storms. (Example: Hurricane Harvey in 2017 was intensified by CO_2-driven climate change.)
These impacts demonstrate the significant effects of carbon dioxide on the Earth's climate, leading to rising temperatures and extreme weather events.

GREENHOUSE GASES:

Greenhouse gases (GHGs) are gases that trap heat in the Earth's atmosphere, leading to global warming.
Examples:
- Carbon dioxide (CO_2)
- Methane (CH_4)
- Nitrous oxide (N_2O)
- Ozone (O_3)
- Fluorinated gases (F-gases)

SOURCES OF GREENHOUSE GASES

- Human activities: burning fossil fuels, deforestation, agriculture, industrial processes
- Natural sources: volcanic eruptions, wildfires, ocean releases

WAYS GREENHOUSE GASES ARE AFFECTING THE CLIMATE

Major ways Greenhouse Gases are affecting the climate include:

Rising Global Temperatures: The average global temperature has risen by about 1°C since the late 1800s, leading to:
- Increased heatwaves, droughts, and water scarcity
- Melting of polar ice caps, glaciers, and sea-level rise
- Changes in seasonal patterns and weather extremes.

Extreme Weather Events: Greenhouse gases intensify weather events, leading to:
- More frequent and intense storms, hurricanes, and typhoons
- Severe droughts, wildfires, and heatwaves
- Unpredictable and dangerous weather patterns

Sea-Level Rise: Melting ice caps and glaciers cause sea levels to rise, resulting in:
- Coastal erosion, flooding, and saltwater intrusion
- Loss of coastal ecosystems, habitats, and biodiversity

Displacement of coastal communities and cities

Changes in Precipitation Patterns: Greenhouse gases alter global precipitation patterns, leading to:
- Droughts, water scarcity, and impacts on agriculture
- Floods, landslides, and infrastructure damage
- Changes in ecosystems, biodiversity, and food chains.

Loss of Biodiversity: Climate change affects ecosystems, leading to:
- Extinctions, habitat loss, and species migrations
- Disruptions to food chains, fisheries, and agriculture
- Decreased ecosystem resilience and adaptability

CONTROLLING THE NEGATIVE EFFECTS OF GREENHOUSE GASES

- Transition to renewable energy sources
- Increase energy efficiency and conservation
- Electrify transportation and industry
- Carbon capture and storage technologies
- International cooperation and climate policies (e.g., Paris Agreement)

All countries can control GHG emissions by:
- Implementing policies and regulations
- Investing in clean energy and technology

- Promoting sustainable land use and forestry practices
- Encouraging individual actions and behavior change
- Collaborating globally to address this shared challenge