

Classroom Activity

Synfuels Production from Lignite

How Carbon Monoxide and Hydrogen are Converted to Water and Methane

OBJECTIVE: Illustrate how the methanation unit at the Great Plains Synfuels Plant converts hydrogen and carbon monoxide molecules (products from gasifying lignite) to water and methane (natural gas).

DEMONSTRATION MATERIALS: Basketball
 Grapefruit
 Orange
 Six Grapes or Cherries
 Seven Toothpicks

ACTIVITY: The fruit is used as atoms to show the chemical reaction in the methanation unit, which uses a nickel catalyst bed to convert hydrogen and carbon monoxide to water and methane.

Orange = Carbon

Grapefruit = Oxygen

Grapes = Hydrogen

Link the orange and grapefruit together with a toothpick, while explaining that the gasifiers initially convert lignite into carbon monoxide (carbon attached to oxygen) and hydrogen (six grapes). The hydrogen and carbon monoxide are passed over a nickel catalyst symbolized by a basketball. The catalyst causes the molecules to rearrange forming methane or natural gas (four grapes attached to an orange - CH_4) and water (two grapes attached to a grapefruit - H_2O).

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How Components in the Gas Liquor Stream are Separated in the Separation Unit

The gas liquor stream is produced by gasifying lignite.

OBJECTIVE: Demonstrate how to separate the oils from the water liquids through cooling and salt additives. The oils and water in the gas liquor stream are difficult to separate since they are similar in density. Therefore, cooling and salts are used to separate tar oils, used as boiler fuel, and the water stream, which contains ammonia, phenol and water.

MATERIALS:

- Beaker
- Hot Plate
- Water
- Vegetable Oil
- Food Coloring
- Ice Cubes
- Salt

ACTIVITY: The vegetable oil represents tar oil in the gas liquor stream, while colored water represents the water components in the stream. The mixture is heated and stirred to simulate the gas liquor as it exits gasification at 400 degrees F. and 400 pounds of pressure. Three conditions help in the separation process:

- (1) slower flow rate;
- (2) cooling; and
- (3) salt.

Turn off the magnetic stirrer and heat, and add ice and salt. The oil and water separates, simulating gas liquor separation.