TEXAS COMMISSION ON ENVIRONMENTAL QUALITY

Lesson Plans for Teachers

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Air Pollution Control

Purpose

To show how air pollution is controlled.

Grade level

- 6th grade
- 7th grade
- 8th grade

Science TEKS

- 6.1 a, b
- 6.2 a-e
- 6.4 a
- 6.7 b
- 6.8 a
- 6.12 b
- 7.1 a, b
- 7.2 a-e
- 7.4 a
- 7.14 a, c
- 8.1 a, b
- 8.2 a-e
- 8.4 a
- 8.5 b
- 8.14 c

Objectives

At the end of the lesson the student will be able to distinguish between an electrostatic precipitator and a wet scrubber and the principles behind the operation of these control techniques.

Focus

When any product is made by industry, waste may be produced that can pollute the air. Wet scrubbers and electrostatic precipitators are two devices used to clean up the air waste stream before it enters the atmosphere.

Background

Air contaminants are emitted into the atmosphere as particulates, aerosols, vapors, or gases. The most common methods of eliminating or reducing pollutants to an acceptable level are destroying the pollutant by thermal or catalytic combustion, changing the pollutant to a less toxic form, or collecting the pollution by use of equipment to prevent its escape into the atmosphere. Pollutant recovery may be accomplished by the use of one or more of the following:

Baghouses - Dry particulates are trapped on filters made of cloth, paper or similar materials. Particles are shaken or blown from the filters down into a collection hopper. Baghouses are used to control air pollutants from steel mills, foundries, and other industrial furnaces and can collect more than 98 percent of the particulates.

Cyclones - Dust-laden gas is whirled very rapidly inside a collector shaped like a cylinder. The swirling motion creates centrifugal forces causing the particles to be thrown against the walls of the cylinder and to drop into a hopper. Cyclones are used for controlling pollutants from cotton gins, rock crushers, and many other industrial processes and can remove up to 95 percent of solid pollutants.

Electrostatic precipitators - By use of static electricity, they attract particles in much the same way that static electricity in clothing picks up small bits of dust and lint. Electrostatic precipitators, 98 to 99 percent effective, are used instead of baghouses when the particles are suspended in very hot gases, such as in emissions from power plants, steel and paper mills, smelters, and cement plants.

Wet scrubbers - Particulates, vapors, and gases are controlled by passing the gas stream through a liquid solution. Scrubbers are used on coal burning power plants, asphalt/concrete plants, and a variety of other facilities that emit sulfur dioxides, hydrogen sulfides, and other gases with a high water solubility. Wet scrubbers are often used for corrosive, acidic, or basic gas streams. (Note that recovery control devices include adsorption and condenser techniques as well.)

Activities

Here are two activities to help demonstrate how a wet scrubber and an electrostatic precipitator work.

How to Make a Wet Scrubber

Purpose

To become familiar with a wet scrubber by building and using one.

Time required 1 or 2 periods

Materials

- paper towels
- 12-cm piece of glass tubing
- three 2.5-cm pieces of glass tubing
- three 55-ml flasks
- two glass impingers (glass tubing drawn at one end to give it a smaller diameter so as to let out smaller bubbles)
- heat source (burner or hot plate)
- three 2-hole rubber stoppers (of a size to fit the mouths of the flasks)
- two 30-cm pieces of rubber tubing
- ringstand apparatus
- vacuum source

Background information

The wet scrubber is one of the most common pollution control devices used by industry. It operates on a very simple principle: a polluted gas stream is brought into contact with a liquid so that the pollutants can be absorbed.

Procedure

Write your answers on a separate sheet.

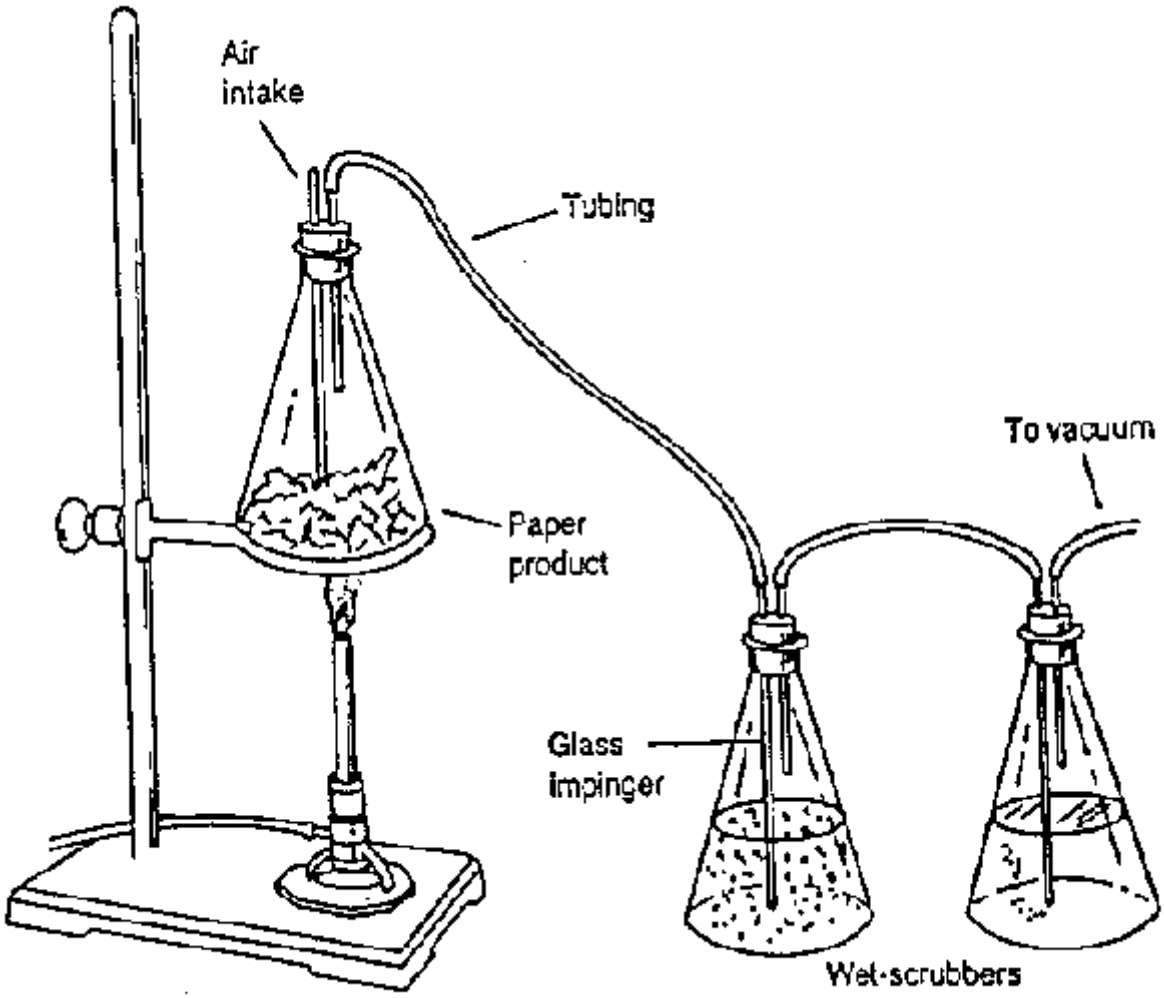
Set up the apparatus as shown in the figure below. Put a paper towel in a 55-ml flask and place this above the burner. Using a 2-hole stopper that makes an air-tight seal with the flask, insert a 12-cm section of glass tubing through one of the holes. The tubing should reach to approximately 1.2-cm from the bottom of the flask. Insert a 2.5-cm piece of glass tubing into the other hole of the stopper. Connect a 30-cm piece of rubber tubing to the 2.5-cm piece of glass tubing, making sure an air-tight seal exists. Fill a second 500-ml flask approximately 3/4 full of water. Using a second double-hole stopper, put a 2.5-cm piece of glass tubing into one of the holes, and insert the glass impinger into the other. Construct a third flask like the second.

Connect the rubber tubing and heat the first flask (combustion chamber) until smoke appears.
Put a vacuum on the third flask to draw a stream of smoke through the second flask (the wet scrubber).
If smoke collects in the second flask above the water, a second scrubber can be added.

Ask the student if particles are the only pollutants produced by industry. Discuss how a wet scrubber collects not only particulate matter but also captures waste gases. Demonstrate how the water scrubber works. Discuss that the white plume you see coming from a smokestack may really be steam coming from a water scrubber.

After observing the wet scrubber, answer the following questions:
Why does the water in the wet-scrubber change color?
Why does the wet-scrubber have an impinger (in other words, why is it important for small bubbles to

be formed)?
What does the scrubber filter out of the air? Not filter out?



Suggest ways to dispose of the pollutants that are now trapped in the water.

How To Make An Electrostatic Precipitator

Materials

- plastic tube (fluorescent light tube)
- wire coat hanger
- plastic grocery bag
- electric blow dryer
- punch holes, black pepper or rice krispies

The electrostatic precipitator works on the principle of a static electric charge attracting particles where they are removed.

A 2-foot plastic tube in which fluorescent lights are stored can be used to simulate an electrostatic precipitator. The plastic tube can be charged by running a coat hanger with a plastic grocery bag attached to it. (See diagram below)

(The plastic bag as it moves through the tube strips the negatively charged electrons from the inside of the tube making the overall net charge positive. Anything that has a negative charge will be attracted to the tube because opposites attract.)

Hold the tube over some punch holes, black pepper, or rice krispies. Hold an electric hair dryer so the air stream blows across the top of the tube. The air mass creates a low pressure area at the top and the greater air pressure at the bottom pushes the punch holes up the tube. (This is called Bernoulli's Principal)

Results

- If the tube is charged, the punch holes will stick to the sides.
- This activity can be used to study static electricity.
- If the tube is not charged, the holes will shoot out in a spray.
- This activity can be used to study Bernoulli's principle.

Extension:

Balloon Activity

Materials

- pepper or ashes
- balloons

Procedure

Give each student an inflated balloon and some black pepper. Rub the balloon on your hair or with a piece of cloth. Hold the balloon over the pepper on your desk. What happens to the pepper?

Ask the students what produces air pollution. Discuss that industry is just one producer of air pollution. Ask what kinds of pollutants are produced by industry. Discuss that particles (called particulate matter) can be captured before they enter the atmosphere by an electrostatic precipitator. Demonstrate with the plastic tube and black pepper how particles are attracted to the sides of the tube to an attraction much like the pepper was attracted to the balloon.

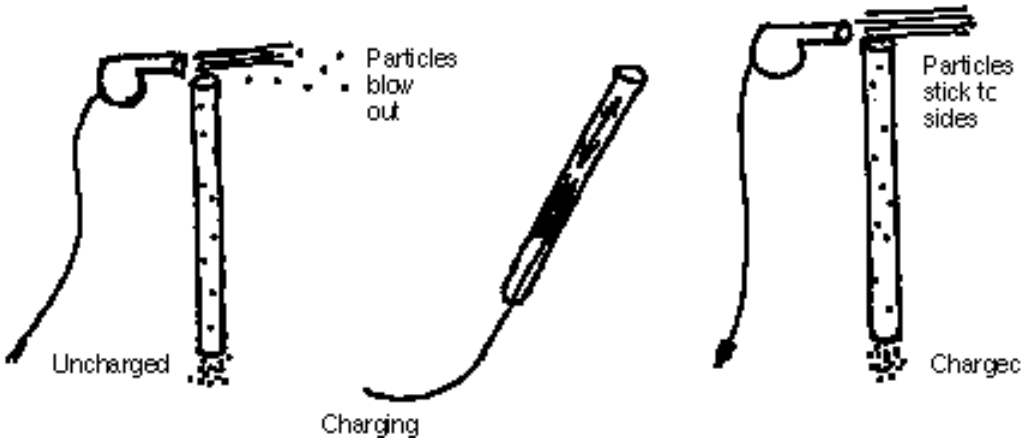
Closure

Restate objectives, begin questioning.

Which type of air cleaner would be the best for removing particles?

Which type of air cleaner would be the best for removing waste gases?

Does a wet scrubber clean up all of the pollutants?



What problems are produced by having too many pollutants in the air we breathe?

If industry is just part of the problem, what can we do to control the amount of air pollution that we cause?

Reference

Activities from Holt, Winston's Environmental Science.

Acknowledgment

Lyn Mock, Stephen F. Austin University Nacogdoches TES Course, 1994