LESSON 24

Countering Corrosion

COURTESY OF THE NATIONAL ARCHIVES

Why is it important to paint a steel ship?

INTRODUCTION

Imagine you possessed the scientific knowledge to save the country tens of billions of dollars every year! If you could prevent a particular process from occurring, that much money could really be saved. The process is a chemical reaction that corrodes objects made of iron and steel. What is the common name given to this process? Can you identify the reactants and the products in this chemical reaction or the conditions needed for it to take place? How could you prevent it? In this lesson, you will investigate this process and find out the answers to these questions.

OBJECTIVES FOR THIS LESSON

Discuss ideas about the nature and the causes of rusting.

Design and conduct an inquiry to compare the effectiveness of different rust-prevention techniques.

Explain results in terms of the chemical reaction involved in the rusting process.

Getting Started

1. Your teacher will show you some objects. Participate in a class discussion about them.

2. Discuss the answers to the following questions with the other members of your group:

A. What is rust?

B. What conditions are required for rusting to take place?

C. Why is rusting a problem?

3. Think of as many methods of rust prevention as you can. After a few minutes, your teacher will conduct a brainstorming session on your ideas about preventing rust. Record these ideas in your science notebook.

MATERIALS FOR LESSON 24

For your group

- 1 black marker
- 2 petri dishes with lids
- 3 ungalvanized steel nails
- 1 ungalvanized painted steel nail
- 1 galvanized steel nail
- 1 stainless steel nail
- 1 magnesium ribbon
- 1 paper towel
- 2 labels
- Access to a jar of petroleum jelly

Inquiry 24.1
Can Rusting Be Stopped?

PROCEDURE

1. In this inquiry, you will work with the other members of your group to design an experiment to compare the effectiveness of different methods of rust prevention.

2. One member of your group should collect a plastic box containing the materials. Check its contents against the materials list.

3. Write the title of the inquiry in your notebook. Under the title, write a sentence or a short paragraph describing what you are trying to find out.

4. Discuss with the other members of your group how you could use the materials in the plastic box to design an experiment to compare the effect of corrosion on the following objects: a nail wrapped in magnesium, a stainless steel nail, a nail treated with paint, a galvanized (zinc-coated) nail, and a nail coated with petroleum jelly.

5. Come to an agreement on the design of your experiment and then set up the experiment. Using the labels in your plastic box, label your experiment with the names of the members of your group.

6. In your notebook, draw a labeled diagram showing how you set up the experiment. Below the diagram, write a short description of the procedure.

7. Design and draw your own results table. You will need to include items such as the appearance of the nails at the start of the experiment and at the end (which will be after at least 3–4 days). You may wish to score each nail for "rustiness."

8. Make sure that you check your apparatus every class period during the course of the experiment. It is your group's responsibility to make sure that the conditions the objects are exposed to remain constant.

9. After the designated time, record your results in the table and discuss your findings with the other members of your group.

10. A member of your group will be asked to report on some of your findings. Make sure you are ready to make such a report.

REFLECTING ON WHAT YOU'VE DONE

1. Discuss the class results with the other members of your group. Think about the answers to the following questions:

   A. Did all the rust-prevention techniques work?

   B. Were they equally effective?

   C. Why did some techniques work and others did not?

   D. How did the different techniques prevent the rusting reaction from taking place?

2. You will discuss your results with the rest of the class. After the discussion, write one sentence in your notebook, explaining what happened to each nail.

3. Write a paragraph summarizing everything you know about the process of rusting. Include a word equation for the process.

THE WORK NEVER ENDS

The Golden Gate Bridge is one of the world's great bridges. It spans 2.7 kilometers across the Golden Gate Strait at the end of San Francisco Bay. More than 1.5 billion cars have crossed over it. It contains 75 million kilograms of steel. It can withstand powerful tides, hurricane winds, and major earthquakes. But one thing could send it tumbling into the bay below: corrosion. The iron in steel combines with the oxygen in air to form iron oxide, or rust. Water and salt, which the bridge is constantly exposed to, greatly speed up rust formation. To keep the mighty bridge from crumbling apart, maintenance crews must constantly battle rust.

Preventing Rust

Dry steel rusts very, very slowly. But wet steel rusts very quickly. If steel is in contact with saltwater, it rusts even faster. Paint prevents rust by keeping oxygen, water, and salt away from the steel surface.

Applying the Paint

A painter puts down a primer coat. Primer sticks to the metal, but it isn't that tough or waterproof. So after the primer dries, the painter puts on two protective top coats of paint that keep out air and water.

CORBIS/DIGITAL STOCK

The Golden Gate Bridge (San Francisco, California) is an example of steel used in close proximity to saltwater.

Touching Up

Whenever rust spots appear on the bridge, maintenance crews go to work scraping off the rust and worn paint. Metal workers then cut out and replace any corroded metal.

Repainting

Although it is called "Golden," the Golden Gate Bridge has always been painted International Orange. The bridge was first painted in 1937, the year it opened. Between 1965 and 1995, the entire bridge was repainted. Bit by bit, all of the old paint was scraped off and a new, tougher acrylic formula was put on. But even the new paint can break down in spots. Maintenance crews constantly inspect the bridge and touch up any rusted areas. □

QUESTION

How do car or bicycle manufacturers stop or reduce rusting? Draw a simple sketch of either a car or a bike and label all the different methods of rust prevention you can identify.

CORBIS/ROGER RESSMEYER

Paint is applied to combat the rust problem. Paint prevents the iron in the steel from coming into contact with water and oxygen, the other reactants in the rusting equation.