Neptune's Furnace

Overview: We're going to do a chemistry experiment to simulate the heat generated by the internal core of Neptune by using a substance used for melting snow mixed with baking soda.

What to Learn: Calcium chloride splits into calcium ions and chloride ions when it is mixed with water, and energy is released in the form of heat. The energy released comes from the bond energy of the calcium chloride atoms, and is actually electromagnetic energy. When the calcium ions and chloride ions are floating around in the warm solution, they are free to interact with the rest of the ingredients added, like the sodium bicarbonate, to form carbon dioxide gas and sodium chloride (table salt).

Materials

- Calcium chloride
- Sodium bicarbonate (baking soda)
- Phenol red or red food dye
- Re-sealable plastic baggie
- Gallon milk jug container
- Straight pin
- Warm water
- Cold water

Experiment

1. Cut the top off the milk jug just above the handle so you can easily put your experiment in the jug.
2. Fill your milk jug with cold water most of the way. Leave enough room for you to add the bag without overflowing the water, and make sure you put in very cold water. Set this aside.
3. Add an inch of warm water to the plastic bag.
4. Add a couple of drops of red dye to the bag.
5. If you are using a hot pack, open the hot pack (use scissors) carefully. You don't want to puncture the water pouch inside. Throw the water pouch away and pour the rest of the contents into a container (this is calcium chloride). You want a couple of tablespoons of calcium chloride in the plastic baggie.
6. Seal the bag closed and roll the pellets between your fingers.
7. Use a straight pin and make six holes near the top of the bag, away from the water.
8. Open the bag and add a couple of tablespoons of sodium bicarbonate (baking soda). Quickly zip up your bag!
9. Make sure the bag is sealed *before* inserting it into your cold water jug. Watch carefully for several minutes and record your observations with the next step.
10. Draw your experiment during step 9. Label all parts of what's going on with your experiment:

Reading

We're simulating the heat generation on Neptune using a chemistry experiment with a hot pack.

Most instant hot packs available in drugstores work on this same principle we're about to investigate. When the hot pack is needed, the bag is squeezed to cause the water and salt to mix. Depending on the salt used in the pack, energy is either absorbed (cold pack) or given off (hot pack). Ammonium nitrate is the most commonly used salt in cold packs. And calcium chloride is the most commonly used salt in hot packs.

Calcium chloride splits into calcium ions and chloride ions when it is mixed with water, and energy is released in the form of heat. This is the same heat energy you will feel when holding the baggie and rubbing the pellets.

Dissolving calcium chloride is highly exothermic, meaning that it gives off a lot of heat when mixed with water (the water can reach up to 140°F, so watch your hands!). The energy released comes from the bond energy of the calcium chloride atoms, and is actually electromagnetic energy.

When the calcium ions and chloride ions are floating around in the warm solution, they are free to interact with the rest of the ingredients added, like the sodium bicarbonate, to form carbon dioxide gas and sodium chloride (table salt). You can tell there's carbon dioxide gas inside when the bag puffs up.

As the gas in the bag increases, it puffs out and increases the pressure. This stretches the bag and some of the gas is released out the holes in the top of the bag, bubbling up to the surface of the milk jug. After a while, the warm water will also rise out of the holes due to the temperature difference between the bag and jug and you'll see red drift up to the top surface of the milk jug. The heat generated by Neptune is deep in the core, and it bubbles up and radiates out to space, just like the warm bag bubbling its contents to the cold water jug. The entire planet is a whirling, swirling, fast-moving ball of gas and ice that move because of temperature and pressure differences.

Neptune is one of the ice giants of our solar system, and the furthest planet from the sun. Because it's a gas giant, you couldn't land your spaceship on the surface because it doesn't have one. You'd continuously fall until the pressure crushed your ship. And then when you got down far enough, you'd be roasted, because Neptune radiates 2.6 times more energy than it gets from the Sun. That's impressive, especially since it's so far from the Sun (30.1 AU, or more than 30 times the Earth-Sun distance). The average daily wind speed on Neptune is 1,200 mph. That's four times *faster* than the biggest hurricanes on Earth!

Neptune has more mass than Uranus even though it's smaller than Uranus. The rings around the planet weren't confirmed until a space probe passed it and sent us back pictures of the blue planet. It's hard for backyard astronomers to find this planet, since it's not a naked-eye object. You need a complicated-looking set of star charts or a GPS tracking system coupled with astronomical data to point your scope in the right direction. Even then, all you see is a white-blue looking star.

Although it's a gas giant, it's classified as an ice giant, since there are large amounts of methane and ammonia ices in the upper atmosphere, giving the planet its blue color. The largest of 13 moons is Triton (not to be confused with Saturn's massive moon, *Titan*), which orbits Neptune in the opposite direction from the planet's rotation and also up at an incline from the planet's equator.

Exercises

1. What happens when the chemicals come in contact with each other?
2. What did you notice when you sealed the bag closed and rolled the pellets between your fingers?
3. What happened when the solution is placed in the cold water jug?
4. What does this experiment have to do with Neptune? Why did we use the baking soda at all?

Answers to Exercises: Neptune's Furnace

1. What happens when the chemicals come in contact with each other? (When the calcium ions and chloride ions interact with the sodium bicarbonate, they form carbon dioxide gas and sodium chloride (table salt).)

2. What did you notice when you sealed the bag closed and rolled the pellets between your fingers? (Dissolving calcium chloride is highly exothermic, meaning that it gives off a lot of heat when mixed with water.)

3. What happened when the solution was placed in the cold water jug? (This removes energy from the reactions and causes the table salt to precipitate out more quickly.)

4. What does this experiment have to do with Neptune? Why did we use the baking soda at all? (As the gas in the bag increases, it puffs out and increases the pressure. This stretches the bag and some of the gas is released out the holes in the top of the bag, bubbling up to the surface of the milk jug. After awhile, the warm water will also rise out of the holes due to the temperature difference between the bag and jug and, you'll see red drift up to the top surface of the milk jug. The heat generated by Neptune is deep in the core, and it bubbles up and radiates out to space, just like the warm bag bubbling its contents to the cold water jug. The entire planet is a whirling, swirling, fast-moving ball of gas and ice that move because of temperature and pressure differences.)