Western Engineering

Outreach

Hot Ice

Grade 6-8

Meet Today's ENG HERO!

Ying Zheng -Professor at Western University

Before joining Western Engineering, Dr. Zheng was the Chair Professor of Chemical Engineering/Reaction Engineering at the University of Edinburgh. She is a well-known researcher in the field of Catalysis and Reaction Engineering in North America. She has received awards such as CSChE Syncrude Canada Innovation award, Imperial Oil Research Award, and Humboldt Fellowships. To learn more about Dr. Zheng visit: https://www.eng.uwo.ca/chemical/faculty/zheng_y/index.html

Learning Goal:

Students will consider acidic and basic chemicals.
Curriculum Connections: Grade 7- Pure Substances and Mixtures

Materials Needed:

- 4 cups of white vinegar {acetic acid}
- 4 tablespoons of baking soda {sodium bicarbonate}
- 1 Pot
- A glass measuring cup or mason jar {heat safe glass}
- 1 Plate
- Balloon
- Water bottle or Pop bottle

Engineering and Science Connections:

Today we will be becoming chemical engineers! Chemical engineers help create and research all different kinds of things that have chemicals in them.

Today we will be going over chemical reactions. A chemical reaction is the combination of two reactants to form an entirely new product. Bonds are broken and new bonds are created. A chemical reaction is not always caused by mixing two substances together.

Today we will be doing an acid base reaction, so what is that exactly? You may have heard of the term acid before, and you have likely heard something referred to as acidic like lemonade or orange juice. And while you may have a general idea of what these terms mean, it's helpful to understand what these terms mean on a scientific level.

Think of the delicious tangy taste you get when you sip either of these beverages. That tang is the direct result of these beverages' acidic nature. The reason that these beverages and many other substances are naturally acidic is because they contain lots of hydrogen ions. An ion is a special type of atom or molecule that has an electric charge. A hydrogen ion, then, is one that has a tiny electrical charge.

Every substance in the universe is made up of hundreds and thousands of tiny atoms, molecules and ions. When there is a large amount hydrogen ions in a substance, then it can be called acidic. In food, that means it will have a sour or tangy taste. Lots of things other than food can be acidic as well!

Base is a term we rarely use in everyday life, at least in this context, and that means it might be a slightly less familiar concept. One everyday example of a base substance is baking soda, commonly used to bake cakes, cookies, and other sweet treats. If you try to taste this, you'll see that it's very bitter. If you rub it between your fingers, you'll find it has a strange, soapy feeling. This is all because baking soda has a basic nature.

Basic substances contain lots of hydroxide ions. These are a different type of molecule with a small electrical charge. In foods, this means they will taste more bitter. Plenty of things other than food can be basic, however.

Video Recommendation: *How to make Hot Ice at home - Amazing Science Experiment*

https://www.youtube.com/watch?v=pzHiVGeevZE

Activity:

How does a fast chemical reaction of baking soda and vinegar work?
Today we will be trying this! You will need the following:

- Baking Soda
- Vinegar
- Balloon
- Water bottle or Pop bottle

Steps for the activity

1. Use a funnel to add 1/3 cup baking soda to the inside of a balloon.
2. Fill a plastic bottle with approximately 1 cup vinegar.
3. Attach the balloon to the mouth of the plastic bottle, then lift the balloon upright so the baking soda falls and causes the reaction.

What Happened During the Activity?

The vinegar and the baking soda mix to make an acid-base reaction. The reaction creates carbon dioxide gas that bubbles up from the mixture. The gas expands up and out of the bottle and inflates the balloon.

Time to Begin

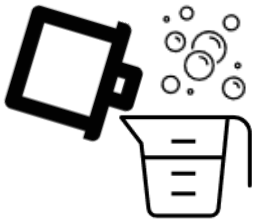
Today's main activity we will be doing a slow chemical reaction with vinegar and baking soda to make crystals!
Warning! We will be using a hot stove, please do this activity with adult supervision !

1. Carefully measure out 4 cups of vinegar and pour it into a medium pot.

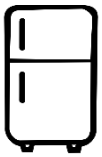

2. Slowly add 4 tablespoons of baking soda, one tablespoon at a time, to the pot.


3. Boil the solution over medium-low heat until you have about 3/4-1 cup of the solution. You should be able to see white powdery crystals forming on the sides of the pot near the top of the solution. If you boil your solution at a higher temperature it may turn yellow-brownish but don't worry, the experiment will still work!

4. Pour the concentrated sodium acetate solution into a glass Pyrex measuring cup, or heat safe glass, and place it in the fridge to cool.



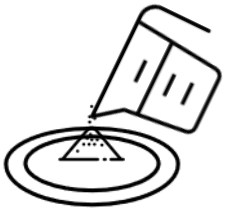
5. Wait about 30-45 minutes, so the solution is cool enough to turn into ice.



6. Place a small pile of the baking soda on the plate.

7. Take the solution out of the fridge. Be careful not to move the solution around too much because a bump could start the crystallizing process in the solution.

8. Pour the solution onto the sodium acetate slowly and observe the crystal formation!



Debrief

The sodium acetate solution in the refrigerator is what we call a supercooled liquid. That means the sodium acetate is in liquid form below its usual melting point. Once you touch, bump, or add a small crystal the liquid crystallization will begin, and the liquid will change to a solid.

When the molecules in the solute (sodium acetate) are in a solution they normally are surrounded by solvent (water) molecules. If enough solute molecules stick together, they can overcome the forces in the solvent that

would normally break the solute molecules apart. Once this happens, this clump of solute molecules serves a place, or nucleation site, for other solute molecules to cling to and the crystallization process takes off.

The sodium acetate powder we placed on the plate acted as a nucleation site or seed for the dissolved sodium acetate in the solutions.

The crystallizing sodium acetate releases energy in the form of heat. That's why sodium acetate is often used in hand warmers as it releases heat when crystallizing!

What Did You Learn?

- What is Chemical Engineering?
- Chemical Reactions
- Acid and Bases

Future Learning

- Research vinegar and baking soda volcanoes
- What is a neutralization reaction?

Share your creations!

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Thanks for discovering with us!