Boot Reer Root Beer

Standard I:
Students will understand that chemical and physical changes occur in matter.

Objective 2:
Evaluate evidence that indicates a physical change has occurred.

Objective 3:
Investigate evidence for changes in matter that occur during a chemical reaction.

Intended Learning Outcomes:
1. Use science process and thinking skills.

Content Connections:
Science 1-3; Dry ice versus yeast

Science Standard

I

Objective

2&3

Connections

Background Information

A physical change involves the changes that can be observed without changing the identity of substances. A chemical change is a process in which reactants are changed into one or more different products. A chemical change occurs whenever compounds are formed or decomposed. During this reaction, there is a rearrangement of atoms that makes or breaks chemical bonds. This change is usually not reversible.

Another way in which the distinction between chemical and physical changes is often expressed is to state that only chemical reactions involve the rearrangement of atoms within the molecule, which leads to the creation of a new molecule (new substance). Physical change does not create anything new; there is no change in the identity of the material (substance).

Changes in state but not chemical composition are not considered chemical changes. For example, while boiling water involves a change in temperature and the release of a gas (water vapor), a chemical change did not take place.

Research Basis

Maryland State Dept. of Education, Baltimore Div. of Instruction (1988). *Better Thinking and Learning: Building Effective Teaching through Educational Research.* 1-98.

Instruction in 30 program areas, this paper is designed as a resource to assist teachers in expanding and refining teaching strategies. Topics included in the article include: activating prior knowledge, cooperative learning, critical thinking, graphic organizers, and metacognitive strategies.

Bathajthy, Ernest. (1988). From Metacognition to Whole Language: The Spectrum of Literacy in Elementary School Science. 26p.

This article considers the integration of reading and writing into elementary science. The article discusses the use of graphic organizers for teaching text structure, and the use of semantic feature analysis for teaching vocabulary concepts.

Materials

- ❑ *Physical/Chemical Change Rhyme*
- ❑ *Question/Prediction Chart*
- ❑ *Compare/Contrast*
- ❑ *Yeast Root Beer Recipe*
- ❑ Dry Ice Root Beer Recipe
- ❑ *Dry Ice Facts*
- ❑ Homemade root beer kit
- ❑ Root beet extract
- ❑ Sugar
- ❑ Water
- ❑ Dry yeast
- ❑ Dry ice
- ❑ Digital Scale
- ❑ Gloves
- ❑ 2 Empty 2-liter bottle for each group (cleaned and sanitized)
- ❑ Measuring cups
- ❑ Measuring spoons
- ❑ *The Root Beer Book: A Celebration of America's Best-Loved Soft Drink*
- ❑ *Root Beer Lady: The Dorothy Molter Story*

Invitation to Learn

Which Soda Pop Contains the Most Fizz?

In this activity the class will be split up into five or six different groups. Each group will be given a different brand 24 oz. bottle of soda pop. The groups will predict which soda has the most fizz and tell why they think that. The groups will be instructed to equally disperse about ½ of their bottle to the members of their group ·using small cups. As the students chink their soda, instruct them to think about descriptive words to describe how the soda pop tastes. The students will write these words on 3x5 cards. The groups will then take the remainder of their soda in the bottle and put a balloon over the opening. Have the students will take turns shaking the bottle lightly. The balloon will begin to fill with carbon dioxide. Then, have the

tie them off. The groups measure their balloons on the scale provided to see how much carbon dioxide was released from their soda. The groups will then compare their findings.

Instructional Procedures

1. Hand out the *Dry Ice Root Beer Recipe.* Read through the recipe with the class. (Because handling dry ice can be dangerous I have chosen to make the root beer with the class assisting me.) Hand out the *Physical/chemical Change Rhymes.* Point out that

in the following recipe a physical change will be used to add fizz to the root beer.

2. As you follow the recipe, point out to the class some facts about dry ice. Hand out *Dry Ice Facts* and talk about some of the things dry ice is used for, how it is manufactured, and what it is made of.
3. When finished, put dry ice in the root beer and have the students observe the effect. Discuss sublimation. Sublimation is the change from solid to gas while at no point becoming a liquid. When you place dry ice into some warm or hot water, clouds of white fog are created. This white fog is not the $C0_2$ gas, but rather it is condensed water vapor mixed in with the invisible $C0_2$. Also discuss that the carbon dioxide is mixing and attaching to the liquid root beer mixture.
4. Ask the class: What type of a change is occurring to the root beer mixture? A physical change is occurring. This is because no new substances are being made, and we can easily reverse the change. The carbon dioxide existed as a solid before we placed it in the root beer and it exists in a gaseous form to create fizz in our root beer.
5. As the dry ice sublimates in the root beer (10-15 min), take this time to use some of your leftover dry ice chunks to do a couple of experiments.

Popping Film Cans

A fun (and often wild) activity vividly demonstrates the sublimation process. Place a piece of dry ice into a plastic 35mm film container - the kind that has the snap on cap. Then wait. The cap will pop off, and sometimes fly several meters. The clear Fuji brand containers shoot farther than the gray and black Kodak type. Warn anyone performing this experiment not to aim for anyone's eyes.

Singing Spoon

Press a warm spoon firmly against a chunk of dry ice. The spoon will scream loudly as the heat of the spoon causes the dry ice to instantly turn to gas where the two make contact. The pressure of this gas pushes the spoon away from the dry ice, and without contact, the dry ice stops sublimating. The spoon falls back into contact again, and the cycle repeats. This all

happens so quickly that the spoon vibrates, causing the singing sound you hear.

Fog Effects

When you place dry ice into some warm or hot water, clouds of white fog are created. This white fog is not the $C0_2$ gas, but rather it is condensed water vapor, mixed in with the invisible $C0_2$. The extreme cold causes the water vapor to condense into clouds. The fog is heavy, being carried by the $C0_2$ and will settle to the bottom of a container, and can be poured.

6. In this last step, the students will taste the root beer and write down some of the characteristics of the root beer on the *Venn Diagram*. (Focus on descriptive words and the fizz of the root beer. I like to ask the class to rate the fizz on a 1-10 scale.)
7. Hand out the *Yeast Root Beer Recipe* to the groups. (Each of these recipes are different from one another.) Read through the recipe with the class, and distribute the tools needed to make this type of root beer. It should be explained to the students that the recipes are different to allow comparing and contrasting. Discuss with the class that zymology is the study of fermentation. Fermentation is the chemical conversion of carbohydrates (sugars) into alcohols or acids. Basically, the yeast eats the sugar and a chemical change occurs, creating carbon dioxide. The students will then fill out their *Question/ Prediction* handout. The students will try to rate which root beer recipe will have the most fizz.
8. I have found it more exciting to let the students follow the recipe and make it themselves. Sometimes the students make errors or alterations to the recipe and the outcome is valuable in discussing the scientific process. Make sure to rotate through the class offering help as the class follows their recipe.
9. After the groups have made their root beer, make sure they label their bottles. Then put the bottles somewhere in the sun where they will not be disturbed for at least 4 hours. Then chill the bottles overnight.
10. In this last step, have the students taste test their root beer. Make sure the students get a chance to taste each of the root beer recipes. Using the Venn Diagram, have the class describe

how the recipes are the same and how they are different. Focus on descriptive words and similes and metaphors.

Assessment Suggestions

- Rubric: Were the objectives reached? Was Root Beer Created?
- Non-Fiction Vocab-u-Write
- K.W.L.

curriculum Extensions/Adaptations/ Integration

- Explore zymology on the internet/PowerPoint. What types of jobs use zymology and what types of products are made using zymology? Provide ideas for extension for advanced learners.
- Explain and predict the effects that would occur if various changes were made to the root beer recipes
- Supply students with vocabulary and definitions.
- Extend time limit for students with special needs.
- Use pictures in a Power Point presentation to show the steps of the recipe.
- Include ideas for integration for other curricular areas Have the students describe what other things taste like using similes and metaphors.

Family connections

- Have the students take a copy of *Root Beer Lady: The Dorothy Molter Story* home to read with their parents.
- Have students make a list with their parents of household products that have yeast/carbon dioxide in them. Then have them write what characteristics the yeast/carbon dioxide has upon the products.

Additional Resources

Books

The Root Beer Book: A Celebration of America's Best-Loved Soft Drink, by Lara E. Quarantiello; ISBN 0936653787

A Flying Needs Lots of Root Beer, by Charles M. Schulz; ISBN 0694010464

Root Beer Lady: The Dorothy Molter Story, by Bob Cary; ISBN 0938586688

Web sites

http://www.root-beer .org/

http://www.geocities .com/NapaValley/1140/

Physical/Chemical Change Rhyme

A Physical Change changes how things look,

Like tearing the pages of a book,

Or freezing a liquid, like water to ice,

Or painting a house to make it look nice.

A Chemical Change has come to pass

If you can see a new solid, liquid, or gas.

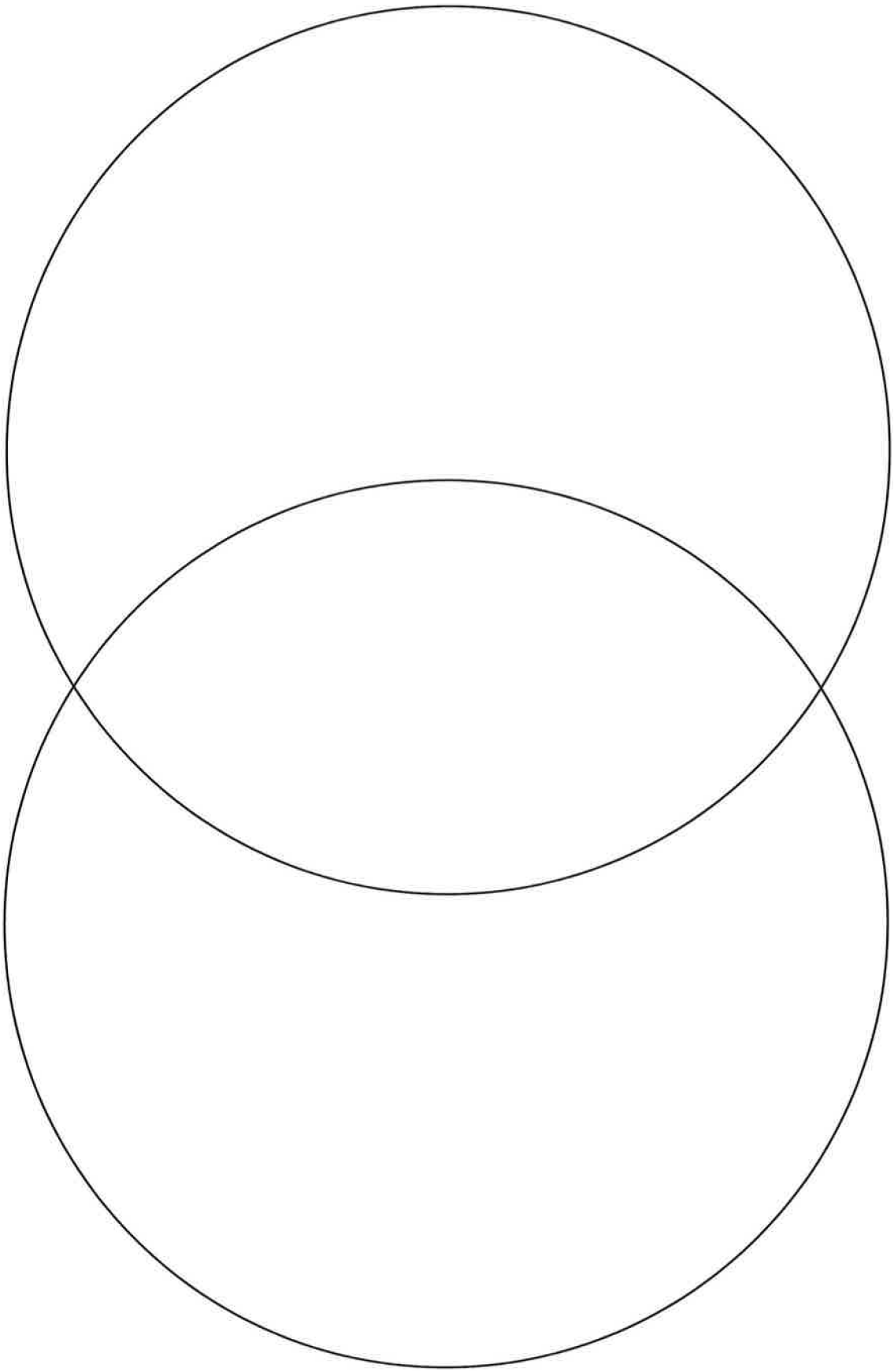
The color may change or the energy too.

A chemical change makes something new.

Question/Prediction Chart

Question	Prediction

Venn Diagram



Yeast Root Beer Recipe

Ingredients

- 1 teaspoon dry yeast
- ½ cup warm water
- 2 cups granulated sugar
- 1 quart hot water
- 4 teaspoons root beer extract
- 3 quarts warm water

Directions

1. Dissolve yeast in ½ cup warm water.
2. Dissolve sugar in 1 quart of hot water.
3. In a gallon jar, mix yeast and sugar mixtures.
4. Add the root beer extract and 3 quarts warm water. Mix well.
5. Cover jar and set in sun for 4-hours.
6. Chill and let brew for a day.

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How to Make Root Beer

Making root beer is easy once you gather all the necessary supplies. It's a great family project and a way to teach the younger ones that not everything tasty comes from an aluminum can. And it's delicious, too!

Things You'll Need for Yeast Root Beer

Clean 2-liter plastic soft drink bottle with cap

funnel

1 cup measuring cup

1/4 tsp. measuring spoon

1 Tbsp. measuring spoon

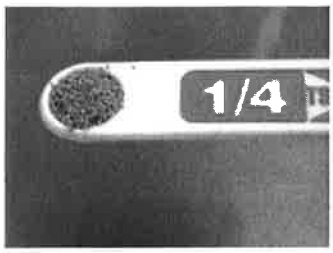
cane (table) sugar [sucrose] (1 cup)

Zatarain's Root Beer Extract (1 tablespoon)

powdered baker's yeast (1/4 teaspoon) (Yeast for brewing would certainly work at least as well as baking yeast.)

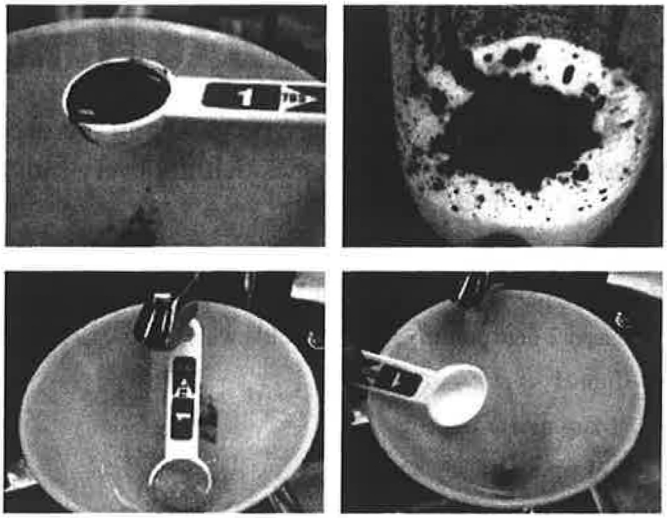
cold fresh water

1. Using a clean bottle and a dry funnel, add the ingredients in sequence as stated in the steps that follow. First add a level cup of table sugar (or cane sugar). Adjust the amount to achieve the desired sweetness.
2. Measure out 1/4 teaspoon powdered baker's yeast and pour it in the funnel. The yeast should be fresh and active, and any brand that is available will work.
3. Shake well to make sure that the yeast grains are distributed evenly into the sugar.
4. Swirl the sugar/yeast mixture in the bottom of the bottle in order to make it concave and enable it to catch the extract in the middle.
5. Replace the funnel and add 1 Tbsp. of root beer extract on top of the dry sugar. Notice how the extract sticks to the sugar. This will help dissolve the extract as seen in the next few steps.
6. Fill the bottle halfway with fresh cool tap water that has only a little chlorine. (Pour through the funnel and use this opportunity to rinse extract stuck to the funnel and

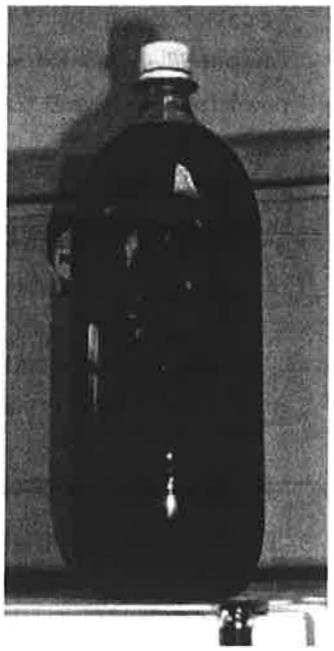


tablespoon.) Swirl to dissolve the ingredients.

7. Fill the bottle to the neck, this time with fresh water, leaving only about an inch (2.54cm) of headspace. Securely screw the cap to seal the bottle. Invert repeatedly to thoroughly dissolve the contents.



8. Place the sealed bottle at room temperature for about three or four days until the bottle feels hard to a forceful squeeze. Then move it to a cool place (below 65 F (18 C)). Refrigerate overnight to thoroughly chill before serving. Crack the lid of the bottle just a little to release the pressure slowly.



Tips:

- There will be sediment of yeast at the bottom of the bottle, so that the last bit of root beer will be turbid. Decant carefully if you wish to avoid this sediment.
- Mankind has used fermentation for thousands of years for raising bread, fermenting wine and brewing beer. The products of the fermentation of sugar by baker's yeast Saccharomyces cerevisiae (a fungus) are ethyl alcohol and carbon dioxide. Carbon dioxide causes bread to rise and gives effervescent drinks their bubbles. This action of yeast on sugar is used to 'carbonate' beverages, as in the addition of bubbles to champagne.
- Artificial sweetener cannot be used to replace the sugar. Sugar is required for yeast to generate carbon dioxide, which carbonates the beverage. No sugar, no carbonation. You might experiment with less sugar, and add a substitute to make up for the lower sweetness, but it is not known just how little you can add and still get adequate carbonization.
- Use bottled water instead of tap.

Warnings:

- Do not leave the finished root beer in a warm place once the bottle feels hard. After a couple weeks or so at room temperature, especially in the summer when the temperature is high, enough pressure may build up to explode the bottle! There is no danger of this if the finished root beer is refrigerated. Move to a refrigerator overnight before opening.
- There might be alcohol in this homemade soft drink. The alcoholic content that results from the fermentation of this root beer has been found, through testing, to be between 0.35 and 0.5 %. Comparing this to the 6% in many beers, it would require a person to drink about a gallon and a half (5.7 L) of this root beer to be equivalent to one 12 ounce (355 mL) beer. It can be said that this amount of alcohol is negligible, but for persons with metabolic problems who cannot metabolize alcohol properly, or religious prohibition against any alcohol, consumption should be limited or avoided. However, there are many high school biology labs that have made this beverage without any problems.

Dry Ice Root Beer

Prepare your class with a demonstration or class activity to show sublimation and/or solubility of a gas in a liquid. This activity is done as a demonstration!

Materials:

5-gallon container (those orange Rubbermaid ones with a spigot are perfect)
5 pounds sugar
5 gallons water
1 bottle root beer extract
5 pounds or so of dry ice

Procedure

Put water in container. If you can use cold water, that's great. Add sugar and extract. Mix well. This makes enough for about 200 3 oz. cups of root beer. At this point it would be a good idea to pour out enough root beer for one or two classes into a smaller container and carbonate the root beer for one or two classes at a time. You need about 1 pound of dry ice per gallon of root beer mix. When you are ready, add the dry ice to the root beer mixture. The students will enjoy watching it bubble, etc. and you can use the wait time to discuss sublimation and solubility of gas in a liquid. Serve the root beer in 3 oz. cups and have the students answer the following questions while they drink.

Suggested questions:

1. How do you know that the dry ice sublimes and doesn't go through the liquid phase first?
2. What is the gas that dry ice emits?
3. What would be another way to carbonate a drink?
4. You are drinking an acid in your cup. How did it become an acid?
5. Has this changed your attitude about acids? Explain your answer.

Alternate Plan: STUDENTS MAKE THEIR OWN INDIVIDUAL CUP OF Root beer SO THEY GET PRACTICE IN CONVERSIONS AND MEASURING AS WELL AS LEARNING ABOUT SUBLIMATION

Materials

7-gallon container (those orange 10 Gallon Rubbermaid ones with a spigot are perfect)

5 pounds sugar (if you don't have a container this large, just reduce the quantities proportionally)
5 gallons water
1 bottle root beer extract
5 pounds or so of dry ice
graduated cylinders
paper towel

3 oz. cups (one per person)
balances
spoons or straws to stir with

Procedure

1. Mix water and root beer extract together in a five-gallon container.
2. Give each student a 3 oz. cup
3. Have students figure out how much root beer/water mixture they need to put in their cup. You can give them the following conversions:
   454 grams = 1 pound
   1 gallon = about 20,000 ml (or one liter =1,000 ml, one quart is about 1 liter, one gallon = 4 quarts, 1liter = 32 ounces if you're brave)
4. From the above conversions, students should be able to figure out that they need 93 ml of the water/root beer mixture, 10.7 grams of sugar, and 10.7 or so grams of dry ice.
5. Have students measure water/root beer mixture into their cup, measure the sugar, add to water mixture and stir, and then add dry ice to their cup.
6. After discussing sublimation and solubility of gas in a liquid, have students answer the following questions on their own paper.

Conclusion questions

1. How do you know that the dry ice sublimes and doesn't go through the liquid phase first?
2. What is the gas that dry ice emits?
3. What would be another way to carbonate a drink?
4. You are currently drinking an acid in your cup. How did it get that way?
5. Has this changed your attitude about acids? Explain your answer.

Safety concerns:

Teachers and students, be sure to keep all Chemical Safety Rules that are specified by your teacher and in all general laboratory experiences.

Dry Ice Facts

History

In 1835 the French chemist Charles Thilorier published the first account of dry ice. Upon opening the lid of a large cylinder containing liquid carbon dioxide he noted much of the carbon dioxide rapidly evaporated leaving solid dry ice in the container. Throughout the next 60 years, dry ice was observed and tested by scientists.

Manufacturing

1. Carbon dioxide is pressurized and refrigerated until it changes into its liquid form.
2. The pressure is reduced. When this occurs some liquid carbon dioxide vaporizes, and this causes a rapid lowering of temperature of the remaining liquid carbon dioxide. The extreme cold makes the liquid solidify into a snow-like consistency.
3. The snow-like solid carbon dioxide is compressed into either small pellets or larger blocks of dry ice.

Dry ice is typically produced in two standard forms, blocks and cylindrical pellets. A standard block is most common and is approximately 30 kg. These are commonly used in shipping, because they sublime slowly due to a relatively small surface area. Pellets are around 1 cm in diameter and can be bagged easily. This form is suited to small-scale use, for example, at grocery stores and laboratories. Dry ice is also inexpensive; it costs about US $2 per kilogram.

Applications

Dry ice is commonly used to package items that need to remain cold or frozen, such as ice cream, without the use of mechanical cooling. In medicine it is used to freeze warts to make removal easier. In the construction industry it is used to loosen floor tiles by shrinking and cracking them, as well as to freeze water in valve-less pipes to allow repair. In laboratories, slurry of dry ice in an organic solvent is a useful freezing mixture for cold chemical reactions.

Dry ice can also be used for making ice cream.

Dry ice is also used as a source of carbon dioxide. It can be used to carbonate water and other liquids such as root beer. It can be used as bait to trap mosquitoes and other insects

When dry ice is placed in water sublimation is accelerated, and low-sinking dense clouds of fog are created. This is used in fog machines at theaters and nightclubs for dramatic effects.

History of Root Beer

There's nothing quite like a frosty mug of creamy, real, old fashioned root beer. But where did this sweet beverage come from? Though the roots of root beer are so deep, they're more American than apple pie, there are varying theories about just who invented root beer and where it came to be.

FROM THE EARLY AMERICANS TO SHAKESPEARE

There are early historical documents in which Shakespeare is noted to have drank "small beers." This European brew, actually made from an early colonial American recipe, contained 2-12-percent alcohol, and was considered a light, social drink made from herbs, berries and bark. During American Colonial times, root beer was introduced along with other beverages like Birch Beer, Sarsaparilla Beer, and Ginger Beer. Only root beer would emerge as a longtime favorite. There are even historical documents that show 18th century farm owners brewing an alcoholic version of root beer in backyard stills for family get-togethers, social events, and parties.

MEDICINAL ORIGINS

Most historians believe that the invention of an actual root beer recipe happened by pure accident, thanks in part to an inventive pharmacist, eager to create a miracle drug. Though people had been drinking an herbal home brewed variety for years, root beer was still just an experiment for the creative and inventive. In 1870, an unknown pharmacist toying with a handful of roots, berries and herbs, came up with a recipe for root beer which consisted of juniper, wintergreen, spikenard, pipsissewa, sarsaparilla, vanilla beans, hops, dog grass, birch bark and licorice. The original drink was quite medicinal in nature, tasting both bitter and sweet. Even though the pharmacist offered the drink to the public as a cure-all, it was never marketed or well received.

HIRES COMPANY

Meanwhile, Charles Hires, also a pharmacist, was on his honeymoon around the same time when he discovered an herbal tea he simply could not part with. After taking the recipe of herbs, berries and roots home to Philadelphia with him, he began selling a packaged dry mixture to the public made from many of the same ingredients as the original herbal tea. Well received, Hires soon developed a liquid concentrate blended together from more than 25 herbs, berries and roots. The public loved the new drink and as a result, Hires introduced commercial root beer to the public in 1876 at the Philadelphia Centennial Exhibition. In no time, it became a popular drink of its day. By 1893, the Hires family sold bottled versions of their well-known brew, sealing their place in root beer history.

No matter which version of root beer history is true, one thing is for certain: Root beer is an original brew, predating colas and other popular sodas.

GOVERNMENT BAN

The key ingredient to root beer is sassafras root, which is what produces the tangy, thick brewed flavor that root beer is noted for. In 1960, the U.S. Food and Drug Administration banned the use of sassafras oil, labeling it a carcinogen. Root beer makers began

experimenting with new and improved recipes, minus the sassafras oil, hoping to find a suitable tasting alternative. Not long after the ban, the root beer industry was saved when inventors discovered that sassafras could be used after all, if treated first, to remove the oil.

WHAT IS IN ROOT BEER?

There is no true authentic root beer recipe, since there are so many different combinations and brews. Over time, root beer has contained ingredients like allspice, birch bark, coriander seed, ginger and ginger root, hops, burdock root, dandelion root, guaiacum chips, spicewood, wild cherry bark and bitters, wintergreen and wintergreen oil, yellow dock, prickly ash bark and even, molasses.

Today, root beer is made from a mixture of flavorings, sweeteners and carbonation. Depending on the brew, bottler and manufacturer, root beer still contains a large number of herbs (burdock root, sarsaparilla root, yellow dock root, ginger root, juniper berries, wild cherry bark, birch bark, etc.), oils (anise, lemon, artificial wintergreen, etc.), sweeteners (sugar, molasses, corn sugar, fructose, aspartame, brown sugar, lactose, malt extract, etc.) and carbonation (yeast, artificial, forced carbonation.)

The Root Beer *Book: A Celebration of America's Best-Loved Soft Drink,* by Laura E. Quarantiello; ISBN: 0936653787