Solar Still 2

Student Objective
The student:
- will be able to explain a simple way to desalinate water using solar energy
- will be able to explain why desalination of water is important for the future.

Key Words:
condensation
desalinization
evaporation
purify
solar still

Materials:
- 2 liter bottle clear (1 per group)
- 2 liter bottle with outside painted black (1 per group)
- ½" clear plastic tubing (1 foot per group)
- duct tape
- salt
- water
- bowls or containers for mixing
- spoons
- funnel (1 for every 3 or 4 groups)

Time:
1 hour

Background Information

Over the last 50 years in seaside population centers where drinking water is scarce, desalination plants have been built that turn salt water into fresh water. Currently in Florida, roughly 180 desalinization plants purify brackish water (a mixture of salt water and fresh water). At present no desalinization plants that purify sea water are operating in the state, but there are plans to build some in the future.

The traditional way to purify salt water is through **distillation**–heating the water until it turns into steam and then collecting the steam in a separate container. The problem with this method is the large amount of energy required to produce small amounts of purified water.

Another way of desalination is through **reverse osmosis**. In reverse osmosis salt water is pushed through a membrane under high pressure. The membrane allows the water but not the salt to pass through it, resulting in purified water on one side and brine on the other.

The drawbacks to desalination include the high cost of the energy needed to operate the plants and the safe disposal of the brine. These factors have made researchers find new ways to desalinate water with greater energy efficiency and to dilute the brine and return it safely to the ocean so that it doesn't harm marine life.

Procedure (prior to class)

1. Paint the outside of half of the bottles black.
2. Make a model of the solar still that the students can refer to during the construction process.

Procedure (during class)

1. Lead the class in a discussion of desalination. Ask the class to describe what happened during the Rain Machine investigation.
2. Tell the class that they are going to experiment with another solar still design.
3 Show them the model of the still they are going to make. Explain that salty water will be put into the black bottle and then the still will be put in the sun. Ask them what they think will happen. Some points to cover:
    - Why is the bottle with the salt water painted black? (*Because it will absorb more solar radiation–remember the Solar Energy and Color Investigation!)*
    - Where do they think the drinkable water will end up?
4 Explain the construction process:
    - mix 1 Tablespoon salt in one quart of water
    - pour the salt water into black painted bottle using a funnel
    - with duct tape, attach one end of the tubing to the black bottle (inserted just slightly into the bottle) and the other end of the tubing to the clear bottle–seal tightly.
5. Pass out the materials.
6. Help students during the construction process.
7. Place the solar stills outside or in a sunny windowsill. The black bottle should be slightly elevated (place on a board or a book). Leave for a day (outside), or several days (inside on a windowsill).

Procedure (follow-up day)

1. Have the students observe their bottles. They should taste a drop or two of the water in the clear bottle to verify that it is not salty.
2. Have the students complete their Science Journal.
3. Discuss the investigation and the results with the class. Were they surprised that the water 'moved' from the black bottle to the clear. Make sure that they understand that evaporation and distillation were involved in the process. Compare the apparatus and process in this investigation with the Rain Machine investigation.
4. Lead a discussion with the class about drinking water and desalination. Points to cover are:
    - We have only so much drinking water available naturally from our rivers and springs
    - Our population is growing and our water consumption is growing
    - We waste a lot of water for non-drinking and non-cooking purposes
    - The majority of the water on the planet is salt water and undrinkable for humans.
5. Ask the students what they think should be done about this problem.

Key Words and Definitions

- **condensation -** a reduction to a denser form as from steam to water
- **desalinization** - process of removing salt and other chemicals and minerals in water
- **evaporation** - process of changing into vapor
- **purify** - to remove undesirable elements or impurities
- **solar still** - a device that uses solar energy to evaporate a liquid

Further Research

1. What kind of desalinization plants are in use in the state of Florida? Are there any in your community?
2. How could solar stills be used in refugee camps? In hurricane relief efforts?
3. How could you use a solar still if you were stranded on an island (like Robinson Crusoe)? What kind of materials might you use to make your still?

Related Reading

- ***A Drop Around the World*** by Barbara McKinney (Dawn Publishers, 1998)
  The story of Drop (the main character) takes us on an adventure to a cow's stomach, on mountain peaks, in steam, snow, floods, coral reefs, etc. Students injoy finding Drop on each of the colorful pages.
- ***Down Comes the Rain (Let's-Read-and-Find-Out Science 2***) by Franklyn Branley and James Hale
  This book is a concise and informative look at the water cycle. Branley provides a fundamental understanding of how water is recycled, how clouds are formed, and why rain and hail occur. A few easy science activities are included.
- ***Hydro's Adventure Through the Water Cycle*** by Randi Goodrich (Geoquest Publications, 2004)
  Join with Hydro, the wise, whimsical and well-known water molecule, as he crisscrosses the skies, slides down our mountains and then evaporates into a cloudy mist.
- ***Inside the Water Cycle: Earth and Space Science*** by William B. Rice
  A book about the water cycle, how it works and the different states of water in the world.
- ***The Water Cycle (Nature's Changes)*** by Bobbie Kalman (Crabtree Publishing, 2006)
  Describes the three states of water and how it moves from one form to the other in the atmosphere and on the surface.

Internet Sites

http://archive.fossweb.com/modules3-6/Water/activities/evaporation.html
FOSS Evaporation page. An interactive activity that allows the student to change the conditions of two sides including beaker shape, climate and temperature and then choose which vessel of water will evaporate faster.

http://www.atmos.washington.edu/k12/pilot/water_cycle/index.html
Water: A Never-Ending Story. Student friendly information on the water cycle that starts out by asking if we are drinking the same water that the dinosaurs drank.

http://www.harcourtschool.com/activity/science_up_close/408/deploy/interface.swf

Harcourt School Publishers Evaporation and Condensation site. Interactive activity with animations that explain evaporation in detail. Descriptions and detail can be narrated which is useful for slow readers and young students.

http://www.swfwmd.state.fl.us/education/kids/

Southwest Florida Water Management District's kids website.

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

PBS Kids, Plum Landing. Kids telling kids about how evaporation works and doing experiments with evaporation that students can easily copy.

https://www.youtube.com/watch?v=z5G4NCwWUxY

Crash Course Kids 12.1. The Great Aqua Adventure. Video explaining the water cycle, evaporation, condensation and precipitation, and shows how you can create a mini water cycle in your kitchen.

Solar Still 2

Florida NGSS Standards & Related Subject Common Core

			.1	.2	.3	.4	.5	.6	.7	.8
Grade 3										
The Practice of Science	**Big Idea 1**	**SC.3.N.1**	**X**					**X**	**X**	
The Role of Theories	**Big Idea 3**	**SC.3.N.3**		**X**	**X**					
Earth Structures	**Big Idea 6**	**SC.3.E.6**	**X**							
Changes in Matter	**Big Idea 9**	**SC.3.P.9**	**X**							
Forms of Energy	**Big Idea 10**	**SC.3.P.10**	**X**	**X**						
Grade 4										
The Practice of Science	**Big Idea 1**	**SC.4.N.1**	**X**		**X**	**X**			**X**	
The Role of Theories, Laws, Hypotheses, and Models	**Big Idea 3**	**SC.4.N.3**	**X**							
Forms of Energy	**Big Idea 10**	**SC.4.P.10**	**X**	**X**						
Energy Transfer & Transformations	**Big Idea 11**	**SC.4.P.11**		**X**						
Grade 5										
The Practice of Science	**Big Idea 1**	**SC.5.N.1**	**X**	**X**						
Earth Systems and Patterns	**Big Idea 7**	**SC.5.E.7**	**X**							
Changes in Matter	**Big Idea 9**	**SC.5.P.9**	**X**							
Forms of Energy	**Big Idea 10**	**SC.5.P.10**	**X**	**X**						

Third Grade Benchmarks
Science–Big Idea 1: The Practice of Science

- SC.3.N.1.1 - Raise questions about the natural world, investigate them individually and in teams through free exploration and systematic investigations, and generate appropriate explanations based on those explorations.
- SC.3.N.1.6 - Infer based on observation.
- SC.3.N.1.7 - Explain that empirical evidence is information, such as observations or measurements, that is used to help validate explanations of natural phenomena.

Science–Big Idea 3: The Role of Theories, Laws, Hypotheses, and Models

- SC.3.N.3.2 - Recognize that scientists use models to help understand and explain how things work.
- SC.3.N.3.3 - Recognize that all models are approximations of natural phenomena; as such, they do not perfectly account for all observations.

Science–Big Idea 6: Earth Structures

- SC.3.E.6.1 - Demonstrate that radiant energy from the Sun can heat objects and when the Sun is not present, heat may be lost.

Science–Big Idea 9: Changes in Matter

- SC.3.P.9.1 - Describe the changes water undergoes when it changes state through heating and cooling by using familiar scientific teams such as melting, freezing, boiling, evaporation, and condensation.

Science–Big Idea 10: Forms of Energy

- SC.3.P.10.1 - Identify some basic forms of energy such as light, heat, sound, electrical, and mechanical.
- SC.3.P.10.2 - Recognize that energy has the ability to cause motion or create change.

Fourth Grade Benchmarks

Science–Big Idea 1: The Practice of Science

- SC.4.N.1.1 - Raise questions about the natural world, use appropriate reference materials that support understanding to obtain information (identifying the source), conduct both individual and team investigations through free exploration and systematic investigations, and generate appropriate explanations based on those explorations.
- SC.4.N.1.3 - Explain that science does not always follow a rigidly defined method ("the scientific method") but that science does involve the use of observations and empirical evidence.
- SC.4.N.1.4 - Attempt reasonable answers to scientific questions and cite evidence in support.
- SC.4.N.1.7 - Recognize and explain that scientist base their explanations on evidence.

Science–Big Idea 3: The Role of Theories, Laws, Hypotheses, and Models

- SC.4.N.3.1 - Explain that models can be three dimensional, two dimensional, and explanation in your mind, or a computer model.

Science–Big Idea 10: Forms of Energy

- SC.4.P.10.1 - Observe and describe some basic forms of energy, including light, heat, sound, electrical, and the energy of motion.
- SC.4.P.10.2 - Investigate and describe that energy has the ability to cause motion or create change.

Science–Big Idea 11: Energy Transfer and Transformations

- SC.4.P.11.2 - Identify common materials that conduct heat well or poorly.

Fifth Grade Benchmarks

Science–Big Idea 1: The Practice of Science

- SC.5.N.1.1 - Define a problem, use appropriate reference materials to support scientific understanding, plan and carry out scientific investigations of various types such as: systematic observations, experiments requiring the identification of variables, collecting and organizing data, interpreting data in charts, tables, and graphics, analyze information, make predictions, and defend conclusions.

- SC.5.N.1.2 - Explain the difference between an experiment and other types of scientific investigation.

Science–Big Idea 7: Earth Systems and Patterns

- SC.5.E.7.1 - Create a model to explain the parts of the water cycle. Water can be a gas, a liquid, or a solid and can go back and forth from one state to another.

Science–Big Idea 9: Changes in Matter

- SC.5.P.9.1. - Investigate and describe that many physical and chemical changes are affected by temperature.

Science–Big Idea 10: Forms of Energy

- SC.5.P.10.1 - Investigate and describe some basic forms of energy, including light, heat, sound, electrical, chemical, and mechanical.
- SC.5.P.10.2 - Investigate and explain that energy has the ability to cause motion or create change.

National Next Generation Science Standards

Third Grade Standards

Science–Engineering Design

- 3-ETS1-1 - Define a simple design problem reflecting a need or a want that includes specified criteria for success and constraints on materials, time, or cost.
- 3-ETS1-3 - Plan and carry out fair tests in which variables are controlled and failure points are considered to identify aspects of a model or prototype that can be improved.

Fourth Grade Standards

Science–Energy

- 4-PS3-2 - Make observations to provide evidence that energy can be transferred from place to place by sound, light, heat, and electric currents.
- 4-PS3-4 - Apply scientific ideas to design, test, and refine a device that converts energy from one form or another.

Science–Engineering Design

- 4-ETS1-1 - Define a simple design problem reflecting a need or a want that includes specified criteria for success and constraints on materials, time, or cost.
- 4-ETS1-3 - Plan and carry out fair tests in which variables are controlled and failure points are considered to identify aspects of a model or prototype that can be improved.

Fifth Grade Standards

Science–Engineering Design

- 5-ETS1-1 - Define a simple design problem reflecting a need or a want that includes specified criteria for success and constraints on materials, time, or cost.
- 5-ETS1-3 - Plan and carry out fair tests in which variables are controlled and failure points are considered to identify aspects of a model or prototype that can be improved.

Solar Still 2

1. Draw a diagram of your desalination plant below and label its parts.

2. Where did the water in the clear bottle come from? _____

_____

3. How did the water get from one bottle to another? _____

_____

_____

4. Do you think that this kind of desalination plant could be used to make drinking water for a whole city? _____ Why or why not?

_____

_____

_____