Rain Machine (Solar Still)

Student Objectives
The student:
- will explain a simple way to desalinate water using solar energy
- understands the evaporation and condensation process, and relates it to the water cycle on Earth.

Key Words:
condensation
desalinization
evaporation
purify
solar still

Materials:
- bowl (one per group)
- plastic cup, 1" shorter than sides of bowl or cut to size (one per group)
- clear plastic food wrap
- tape or rubber bands large enough to go around bowl
- small rocks or weights
- salty water

Time:
1 hour (build & discuss), extra time to periodically check solar still

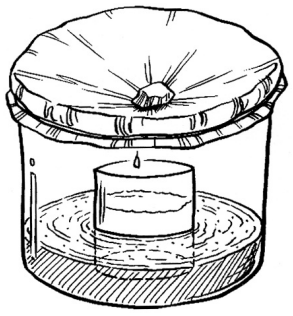
Background Information

Stills are commonly used to purify liquids. Through the process of distillation, non-volatile impurities can be separated from the liquid. Distillation can be a simple process: heat is first added to a liquid to evaporate it and produce a gas or vapor, then heat is removed from the vapor to condense it back to a liquid.

A solar still uses the greenhouse effect to trap energy from the Sun. The solar still is a model of the water cycle on earth: evaporation, condensation, precipitation.

Procedure (prior to class)

1. Make a solar still as an example for the class.



Procedure (during class)

1. Lead the class in a discussion of desalination. Questions that might be asked:
   - Have you ever tasted salt water? Can we drink it?
   - How could we make seawater drinkable? *(Take the salt out of it)*
2. Tell the class that they are going to experiment with a "solar sill", a simple way to use evaporation to make salty water drinkable.
3. Divide the class into working groups of 2 - 3 students per group.
4. Explain the procedure to the class.
   - Salty water will be put in the bowl.
   - The cup will be placed in the middle of the bowl.
   - Plastic wrap will be pulled tightly over the top of the bowl and secured with either a rubber band or tape.
   - A weight is put in the center of the plastic wrap above the cup so that the evaporated water will drip into the cup.
5. Pass out the materials.
6. Help students during the construction process.
7. Place the solar stills in full sun.
8. Write "evaporation" on the board. Lead a discussion on what evaporation is and when they saw it occur.
9. Check the still's progress as often as you desire, in ½ hour increments. Point out the small water droplets on the inside of the plastic wrap. Solar stills can be left out for several days if desired.
10. Taste the water in the cup. Ask the students if it tastes different than their tap water *(yes)*. Why does the water taste different than tap water? Lead a discussion of evaporation and desalination.

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 from 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

- Is rain colorless? Try your solar still with colored water or tea. Does the color evaporate and condense into the center container?
- Can you use a still to remove the water from a solution? Is there water in your milk (or juice)? Put milk or another liquid in your solar still and see what happens.
- Put together a classroom terrarium (with a lid) to make further observations about the water cycle.

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 enjoy 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 (HarperCollins, 2017)
  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.
- ***Harnessing Solar Energy, Grade 4: STEM Road Map for Elementary School*** by Carla Johnson (NSTA Press, 2017)
  This book challenges students to investigate energy and energy sources, with a focus on solar energy, kinetic energy, the greenhouse effect, salinity, and water scarcity. Students will examine solar energy's potential and limitations while being introduced to the concept of scarce resources and potable water.
- ***Inside the Water Cycle: Earth and Space Science*** by William B. Rice (Teacher Created Materials, 2007)
  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

https://www.fossweb.com/delegate/ssi-wdf-ucm-webContent/Contribution%20Folders/FOSS/multimedia_2E/Variables_MM/activities/whiteboard/evaporation/Main.html
FOSS Evaporation page. An interactive activity that allows the student to change the conditions of two experimental set-ups, including beaker shape, climate, and temperature; 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.

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.

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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	X					
Earth in Space and Time	**Big Idea 5**	**SC.3.E.5**	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			
Forms of Energy	**Big Idea 10**	**SC.4.P.10**	X	X						
Grade 5										
The Practice of Science	**Big Idea 1**	**SC.5.N.1**	X							
Earth Systems and Patterns	**Big Idea 7**	**SC.5.E.7**	X	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.1.2 - Compare the observations made by different groups using the same tools and seek reasons to explain the differences across groups.
- SC.3.N.1.6 - Infer based on observation.

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

- SC.3.N.3.1 - Recognize that words in science can have different or more specific meanings than their use in everyday language; for example, energy, cell, heat/cold, and evidence.

- 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 5: Earth in Space and Time

- SC.3.E.5.2 - Identify the Sun as a star that emits energy; some of it in the form of light.

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.1.2 - Compare the observations made by different groups using multiple tools and seek reasons to explain the differences across groups.
- SC.4.N.1.5 - Compare the methods and results of investigations done by other classmates.

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.

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.

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.
- SC.5.E.7.2 - Recognize that the ocean is an integral part of the water cycle and is connected to all of Earth's water reservoirs via evaporation and precipitation processes.

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

Fourth Grade Standards

Science–Energy

- 4-PS3-4 - Apply scientific ideas to design, test, and refine a device that converts energy from one form to another.

Rain Machine (Solar Still)

1. Where did the water droplets on the plastic wrap come from? _____

_____

_____

2. What happens to the rain on a sidewalk after the sun comes back out?

_____

_____

_____

3. What would have happened to the water in the bowl if the bowl wasn't covered with the plastic wrap? _____

_____

_____

4. What energy source was used in this device? _____

5. Where might we apply this idea on a large scale? _____

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