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 capillary water in the soil and be able to explain how to construct a solar still to extract potable water from the soil.

Key Words:
capillary water
condensation
desalinization
evaporation
purify
solar still

Materials
- sheet of thick, transparent flexible plastic at least 1 m square
- several fist sized rocks
- coffee can
- shovel
- graduated cylinder

Time:
1 class period plus 20 minutes

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.

Soil always contains some moisture, but it is often in the form of capillary water. Capillarity is the force that exists between soil particles and water molecules. This force prevents all the water in the soil from draining down through the soil. The water that remains as a thin coating around the soil particles is known as capillary water.

An in-ground solar still allows this capillary water to be recovered and purified. By creating a closed space with a transparent cover material, a greenhouse effect is produced which causes the temperature inside the space to rise. The trapped heat is absorbed by the soil and causes its moisture to vaporize. This vapor rises and condenses on the inside of the plastic where it then runs down and drips into the container of the still.

Procedure (prior to class)
1. Scout out your school for an area that will be able to house your solar still. The area must be in full sun, and capable of having a hole (about 80 cm in diameter) dug there.
2. If you have a large class you may want to divide them up into two or three working groups, and let each group build their own still. Of course you will need to have

materials available for each group and a place for them to dig their still.

Procedure (during class)

1. Lead the class in a discussion of desalination and their results from the Rain Machine investigation. Ask the class what capillary water is, and give them the definition and explanation if they are unsure of it.
2. Explain to the class that they will be using what they learned in the Rain Machine investigation to design and construct a solar still that will remove the moisture from the soil and produce purified drinking water.
3. Tell the students that as of now they are stranded on a deserted island with no fresh water. They have to make a solar still to obtain drinking water to survive.
4 Show the students their materials that they 'found' on the island, take them out to the approved area to build their stills, and wish them luck.
5 During the construction process, encourage them to brainstorm among themselves to figure out the solution. Try not to directly help them if at all possible.
6 Leave the solar stills overnight and check them during the next class period. Have the students measure the amount of water collected in the container. If no water has condensed, have the students figure out why, change their design, and check it during the next class period. Note: Common problems are: not understanding the design problem (trying to build their stills on top of the ground), not enough of a slope into the collecting container (it needs to be at least 35^{o}), too much air (and moisture) escaping around the edges of the plastic, or the weight not being centered over the collecting container.
7. After they have successfully built the solar still, have them complete their Science Journal.

Key Words & Definitions

- **capillary water** - the thin film of water that coats the soil particles even in the driest soil
- **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 a liquid into vapor
- **purify** - to remove undesirable elements or impurities
- **solar still** - a device that uses solar energy to evaporate a liquid

Related Research

1. How does the size and shape of an in-ground still affect the rate of water collection? Vary the depth and/or the width of the still and tabulate the results.
2. Would having living plants in your solar still system increase the amount of water collected? Compare the rate of water collection from equal areas of bare soil and soil covered with plants.
3. In many areas of the world, pure water is becoming very scarce. Research national and international plans and projects for obtaining pure water.

Related Reading

- ***Dr. Art's Guide to Planet Earth: For Earthings Ages 12 to 120*** by Art Sussman PhD and Emiko Koike, (Chelsea Green Publishing, 2000), pages 28 - 33 "The Water Cycle" The author provides a simple framework for thinking about Earth's systems within systems within systems, and stresses our deep interconnection with them. To keep things in perspective, he includes a comprehensive discussion of our current environmental issues and the major changes we must institute in order to prevent and mitigate further harm.
- ***The Water Cycle: Evaporation, Condensation & Erosion*** by Rebecca Harman (Heinemann InfoSearch, 2005)
  Follow a drop of water as it moves around the world. From the largest glaciers, to the steam coming out of a kettle, find out how water can change, and how it can alter landscapes.
- ***Solar Energy Projects for the Evil Genius*** by Gavin Harper (McGraw-Hill, 2007)
  This book includes more than 50 solar energy projects with plans, diagrams and schematics. Included are three types of solar stills, along with cookers and solar electricity projects.

Internet Sites

http://www.swfwmd.state.fl.us/education/splash/
Southwest Florida Water Management District lesson plans relating to water and the water cyclc.

http://www.swfwmd.state.fl.us/education/kids/
Water Resources Education by the Southwest Florida Water Management District includes games, activities, and fact pages.

http://ga.water.usgs.gov/edu/
U.S. Geological Survey's Water Science for Schools site includes information on many aspects of water, pictures, data, maps and interactive activities**.**

Solar Still 2

Florida NGSS Standards & Related Subject Common Core

			.1	.2	.3	.4	.5	.6	.7	.8	.9	.10	.11	.12
Grade 6														
Practice of Science	**# 1**	**SC.6.N.1**				**X**								
Earth Systems & Patterns	**# 7**	**SC.6.E.7**	**X**							**X**				
Grade 7														
Energy Transfer & Transformations	**# 11**	**SC.7.P.11**	**X**	**X**										

Sixth Grade Benchmarks
Science–Big Idea 1: The Practice of Science
- SC.6.N.1.4 - Discuss, compare, and negotiate methods used, results obtained, and explanations among groups of students conducting the same investigation.

Science–Big Idea 7: Earth Systems and Patterns
- SC.6.E.7.1 - Differentiate among radiation, conduction, and convection, the three mechanisms by which heat is transferred through Earth's system.
- SC.6.E.7.8 - Describe ways human beings protect themselves from hazardous weather and sun exposure.

Seventh Grade Benchmarks
Science–Big Idea 11: Energy Transfer and Transformations
- SC.7.P.11.1 - Recognize that adding heat to or removing heat from a system may result in a temperature change and possibly a change of state.
- SC.7.P.11.2 - Investigate and describe the transformation of energy from one form to another.

National Next Generation Science Standards - Sixth to Eighth Grade Standards
Science–Energy
- MS-PS3-3 - Apply scientific principles to design, construct, and test a device that either minimizes or maximizes thermal energy transfer.

Science–Earth's Systems
- MS-ESS2-4 - Develop a model to describe the cycling of water through Earth's systems driven by energy from the sun and the force of gravity.

Science–Engineering Design

- MS-ETS1-1 - Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions.

Solar Still 2

1. In the space below, sketch your solar still and label the parts.

2. Where did the water come from?

3. From your observations of the solar still, what evidence can you present to confirm that the processes of evaporation and condensation are responsible for the water in the container?

4. Where did the energy to cause evaporation come from? How was energy removed from the water vapor to cause condensation?

5. At what rate was water removed from the soil and collected in the container? Use the equation below to determine your answer.

$$\textbf{Rate of water collection (ml/hours)} = \frac{\textbf{Total volume of water collected}}{\textbf{Total time of collection (number of sun hours)}}$$

6. List some practical uses for a solar still.