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 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 inground solar still allows this capillary water to be recovered and purified in the process. 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 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 is not right over the center of the collecting container.
7. After they have successfully built the solar still, have them complete their Science Journal.

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" This book is at once light enough for youth to comprehend and yet comprehensive enough for adults. By breaking the subject down into three primary categories--matter systems, energy systems and life systems, he 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, Art includes a conprehensive discussion of our current environmental issues and the major changes we must institute in order to prevent and mitigate further harm.

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

Energy Whiz

Be an EnergyWhiz star! Submit pictures of your class' in ground solar still with a description of its size and building materials to **http://energywhiz.com/**. See your class on the internet!

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			.1	.2	.3	.4	.5	.6	.7
Nature of Matter	**Standard 1**	**SC.A.1.3-**				**X**			
	Standard 2	**SC.A.2.3-**			**X**				
Energy	**Standard 1**	**SC.B.1.3-**	**X**	**X**	**X**		**X**		
	Standard 2	**SC.B.2.3-**							
How Living Things Interact With Their Environment	**Standard 1**	**SC.G.1.3-**				**X**	**X**		
	Standard 2	**SC.G.2.3-**							

Benchmark SC.A.1.3.4 - The student knows that atoms in solids are close together and do not move around easily; in liquids, atoms tend to move farther apart; in gas, atoms are quite far apart and move around freely.

Grade Level Expectations

The student:

Sixth

- understands that matter may exist as solids, liquids, and gases

Seventh

- knows the direction of energy flow when a change in the phase of matter occurs

Eighth

- understands that changes in energy cause phase changes.

Benchmark SC.A.2.3.3 - The student knows that radiation, light, and heat are forms of energy used to cook food, treat diseases, and provide energy.

Grade Level Expectations

The student:

Sixth

- knows forms of radiant energy and their application to everyday life

Seventh

- knows uses of radiation, light, and thermal energy to improve the quality of life for human beings

Eighth

- extends and refines knowledge of uses of forms of energy to improve the quality of life.

Benchmark SC.B.1.3.1 - The student identifies forms of energy and explains that they can be measured and compared.
Grade Level Expectations
The student:
Sixth
- understands that energy can be converted from one form to another

Eighth
- understands that energy can be transferred by radiation, conduction, and convection
- knows examples of natural and man-made systems in which energy is transferred from one form to another.

Benchmark SC.B.1.3.2 - The student knows that energy cannot be created or destroyed, but only changed from one form to another.
Grade Level Expectations
The student:
Sixth
- understands that energy can be changed in form
- uses examples to demonstrate common energy transformations.

Benchmark SC.B.1.3.3 - The student knows the various forms in which energy comes to Earth from the Sun.
Grade Level Expectations
The student:
Sixth
- knows types of radiant energy that come to Earth from the Sun.

Benchmark SC.B.1.3.5 - The student knows the processes by which thermal energy tends to flow from a system of higher temperature to a system of lower temperature.
Grade Level Expectations
The student:
Eighth
- knows the processes by which thermal energy tends to flow from a system of higher temperature to a system of lower temperature
- knows that the average kinetic energy of the atoms or molecules that make up an object changes when the temperature of the object changes.

Benchmark SC.G.1.3.4 - The student knows that the interactions of organisms with each other and with the non-living parts of their environments result in the flow of energy and the cycling of matter throughout the system.
Grade Level Expectations
The student:
Seventh
- understands how the carbon dioxide-oxygen cycle, water cycle and nitrogen cycle are important for the survival of organisms.

Benchmark SC.G.1.3.5 - The student knows that life is maintained by a continuous input of energy from the sun and by the recycling of the atoms that make up the molecules of living organisms.

Grade Level Expectations

The student:

Seventh

- understands way matter is recycled (for example the water cycle)
- knows that life on earth is dependent upon a continuous supply of energy from the Sun.

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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

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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.