Survival Still

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
conduction
convection
desalinization
evaporation
radiation
solar still
thermal energy

Materials:
- sheet of thick, transparent flexible plastic at least 1 m square (1 per group)
- coffee can (1 per group)
- shovel (1 per group)
- rocks
- 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.

A 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 where you can build the solar still. The area must be in full sun, and you will need to be able to dig a hole (about 80 cm in diameter) 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.
3. Make sure there are a few fist sized rocks at each location for the groups to 'find'.

Procedure (during class):
1. **Engage:** Lead the class in a discussion of desalination and their results from the Solar Still 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 Solar Still investigation to design and construct a solar still that will remove the moisture from the soil and produce purified drinking water.
3. **Explore:** 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 (a sheet of plastic, a coffee can and a shovel)--take them out to the approved area to build their stills, and wish them luck.
5. Ask students to develop a team plan and design for their Survival Still. They will need to review the Laboratory Manual to guide them through the information they will need to complete them.
6. 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.
7. 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.
8. After they have successfully built the solar still, have them complete their Laboratory Manual.

Evaluation and Student Assessment

Suggested Overall Assessment

Class discussion: 10%
- student participation
- listening and respecting the ideas of others
- asking significant questions to clarify points of view
- using key words and definitions

Group participation: 50% (group or individually evaluated)
- contributing and articulating ideas and solutions in working team environment
- identifying the interconnections of water extraction and capillary action within the soil and using key terms appropriately
- sharing the responsibility for collaborative work and using time efficiently
- analyzing and synthesizing information to solve problems and answer questions

- demonstration a positive work ethic

Lab Manual student sheet: 40% (group or individually completed)

- student answers will vary but expect high standards for each question
- equation should show that Rate = volume/time
- key words and terms should be used throughout the document

Related Research:

- 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.
- 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.
- In many areas of the world, pure water is becoming very scarce. Research national and international plans and projects for obtaining pure water.
- How much water is required for survival? How would you design a still that will provide enough water for yourself and a family of four?

Related Reading

- ***A Golden Thread: 2500 Years of Solar Architecture and Technology*** by Ken Butti & John Perlin (Cheshire Books, 1980)
  A Golden Thread provides a historical perspective of the influence of solar energy on society throughout the ages. The book provides information relating to the scientific, societal and economic influences contributing to the development of solar technology, as well as explanations of how the various forms of solar technology function.
- ***The Return of the Solar Cat*** by Jim Augustyn (Patty Paw Press, 2003)
  "A cat sunning itself in the doorway of a barn knows all about solar energy. Why can't man learn?" (E.B.White). The Return of the Solar Cat book decisively answers this question. Jim Augustyne takes the Suessian approach to showing the reader our myopia when it comes to the nature of renewable energy, politics, and economics through the fun-house mirror of technologically advanced felines and their 'natural' instincts and behavior which are optimized for solar utilization. Augustyne has developed an alternate universe of whimsy and pointy satire where kitties rule and our human foibles and blindness to the advantages of solar energy are entertainingly exposed

Internet Sites

http://www.desertusa.com/mag98/dec/stories/water.html

Desert USA's page detailing how to make a survival still in the desert.

http://www.ehow.com/how_12584_make-solar-still.html

How Things Get Done - How to make a solar still in the wilderness.

Survival Still

		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Earth and Space																					
Standard 5	**SC.912.E.5.**				X																
Physical Science																					
Standard 10	**SC.912.P.10.**	X			X																
Mathematics Standards		**MA.912.A.10.1**																			
Language Arts Standards		**LA.910.1.6.1**																			

Science Standards
Standard 5: Earth in Space and Time
- SC.912.E.5.4 - Explain the physical properties of the Sun and its dynamic nature and connect them to conditions and events on Earth.

Standard 10: Energy
- SC.912.P.10.1 - Differentiate among the various forms of energy and recognize that they can be transformed from one form to others.
- SC.912.P.10.4 - Describe heat as the energy transferred by convection, conduction, and radiation, and explain the connection of heat to change in temperature or state of matter.

Mathematics Standards
Algebra - Standard 10: Mathematical Reasoning and Problem Solving
- MA.912.A.10.1 - Use a variety of problem-solving strategies, such as drawing a diagram, making a chart, guess- and check, solving a simpler problem, writing an equation, working backwards, and create a table.

Language Arts Standards
Reading Process - Standard 6: Vocabulary Development
- LA.912.1.6.1 - The student will use new vocabulary that is introduced and taught directly

Survival Still

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

conduction - the movement of heat through materials by transferring kinetic energy directly from particle to particle

convection - the circulatory movement or transfer of heat through fluids such as air or liquids due to temperature differences (hotter fluids rise and cooler fluids sink)

desalinization - process of removing salt and other chemicals and minerals from water

evaporation - process of changing a liquid into vapor

radiation - the way we receive heat from the sun each day. The energy is emitted in the form of waves and photons (electromagnetic waves) and can be transferred through the vacuum of space.

solar still - a device that uses solar energy to evaporate a liquid

thermal energy - a measure of the internal motion of an object's particles known as heat. The symbol used is 'Q'

Survival Still

1. How much water was collected in your still in the first 24 hours?

   In subsequent 24 hour periods?

2. At what rate was the water removed from the soil and collected in the container?

   What equation is needed to solve this problem?

3. Diagram your final still design and label with measurements. What is the area of the still's surface?

4. What design problems did you encounter and what did you do to correct them?

5. Would you be able to collect capillary water in the desert? Explain why or why not using key word (vocabulary) from this unit.