What's Cooking – 2

Student Objective
The student:
- understands how the Sun's radiation, as heat, can be captured and used
- given a solar cooker, can explain what makes it work and how to improve on the design.

Materials (construction)
- 14" x 14" poster board, sheet cardboard or sheet vinyl (4 pieces per group)
- sheet mylar–available as camping 'space' blankets (½ per group)
- 8" square 1/8" plywood or other stiff material (1 per group)
- water soluble glue
- sponge brushes or disposable type paint brushes
- high temperature black spray paint (grill paint)
- paints to decorate outside (optional)
- binder clips or clothespins (4 per group)
- Science Journal

Materials (cooking)
- oven thermometer or infrared 'gun type' thermometer
- pot holders
- oven roasting bags
- casseroles or pots with lids that can fit in the oven bags
- recipe ingredients

Key Words:
conduction
convection
glazing
insulation
radiation
reflector
solar collector
solar thermal

Time:
(2) ½ hour construction times
1 class for cooking/eating

Background Information

Cooking Tips - Panel Cookers

- Always use lids on pans and place the whole pan in a tightly closed high temperature oven bag. Thin, shallow, aluminum or steel pans will heat faster.
- Most recipes that can be cooked on top of the stove without frequent stirring will work with a panel cooker. Crock-pot recipes will also work well.
- Foods generally use less liquids or cook in their own juices. This produces better tasting and more nutritious food.
- Foods never burn and rarely overcook in a panel cooker.
- Use a meat thermometer instead of a timer to determine if the food is done.
- A lazy susan underneath your panel cooker can help you rotate it easily to follow the sun. Remember to adjust your panel cooker every 20 minutes or so.

Foods particularly suited for the classroom include: rice mixes, chili, chowder, stew, baked beans, couscous and quinoa.

Some specific food tips:

- cook (steam) yellow and green vegetables in dark colored casseroles to prevent discoloration
- vegetables and meats can be cooked with no water or added liquid
- meats cook better if cut into small pieces.

Temperature

- On a clear and sunny day a panel cooker will heat the contents to boiling for a sustained time. On these days you can cook anything.
- On a partially cloudy day the panel cooker will heat the contents above pasteurization temperature (149º), and probably to boiling. On these days you can easily cook most things, but extra care should be taken with meats (check the temperature).
- Adjust your cooking time to account for the lower temperature. A rule of thumb is to figure twice the regular cooking time.

Procedure (prior to class)

It would be helpful to construct a cooker of this type that can serve as a model for the class to look at during the construction process.

Procedure (during construction times)

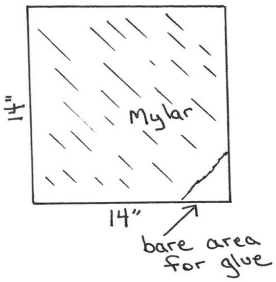
1. Explain construction procedure for the cooker and show the finished example.
   First day:
   - spray paint one side of bottom board (outside, in designated painting area)
   - working on one panel at a time, spread glue on one side of the panel, leaving one corner without glue - you will be gluing in this area later
   - lay mylar over the top and work bubbles out to the edges. Start with a piece of mylar that is larger than your panel–you will trim it after it dries
   - repeat with the other three panels

- lay panels out in your group's assigned area to dry.

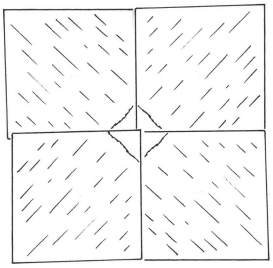
Second day:

- trim mylar on panels to the edges of the panel
- cut extra mylar off of 'uncovered' triangle 'glue area'
- place four panels as shown below
- spread glue on unpainted side of bottom board
- press into the middle of the four panels where they meet
- put cooker in your group's assigned area to dry.

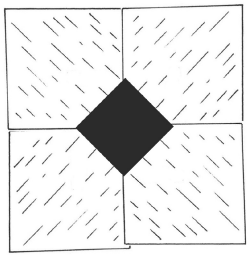
2. Explain any construction or material problems that you think the students may encounter.
3. Break the students into construction groups of 2 - 4 students per group.
4. Pass out the plans and help the students as needed during the construction phase.



Individual Panel



Layout of 4 panels



Panels with bottom plate glued on

Procedure (cooking day)

1. Note: Cooking must be done on a sunny or mostly sunny day for good results. Even though with experience, solar cooking can be done on mostly cloudy days, it isn't recommended for beginning student chefs.
2. Help the groups set up their ovens. Bring panels up and clip together at the overlap points to form an upturned 'lotus' shape. Set cooker facing the sun.
3. Assemble recipe ingredients and put them in a black pot with a lid or glass casserole with a lid. Put entire pot/casserole in a oven bag (or solar cooking bag) and seal tightly with a twist tie.
4. Place bag with pot into the cooker. Wait appropriate time for food to cook. When removing the pot use pot holders! Students sometimes forget that the pot will be as hot as if it was on their electric stove.
5. Enjoy!
6. Have the students compare their outcome with other groups. Lead a discussion on what factors could have led to the differences between the results that groups obtained *(difference in reflective capability of cooker, differing amount the panels were raised & clipped, different place cookers were set, different pot or casserole materials, different amount of water or ingredients in recipe, etc.)*

Key Words & Definitions

- **conduction** - the movement of heat or cold through materials that are solid
- **convection** - the movement of heat through air or in liquids
- **glazing** - the clear material (i.e. glass or plastic wrap) that lets in light and traps heat
- **insulation** - material used to reduce heat loss or gain
- **radiation** - the way we receive heat from the sun each day. The energy is emitted in the form of waves/particles, and can move from one object to another without heating the area in Students should complete questions 3 and 4 in their Science Journal between.
- **reflector** - shiny device used to alter the path of light
- **solar collector** - a device that collects and traps solar energy
- **solar thermal** - using the Sun's energy to heat something

Further Research

1. The Copenhagen Cooker is a panel cooker. Research what climate, latitude and weather conditions are best for this type of cooker. Research what types of foods cook easiest in a Copenhagen Cooker.
2. Convert a family or favorite recipe to be used in a Copenhagen Cooker. Change cooking methods (i.e. sauteing, pre-heating, etc) to methods that would work with this type of panel cooker, and modify the ingredients (i.e. cut smaller, use precooked, etc) as needed so that they will cook successfully.
3. Host a solar cooked lunch or snack for another class.
4. Create a video that details the construction and cooking processes that your class used. Post the video on a teacher/educational website for other classes to view.
5. Have a classroom Design Challenge! Have students working individually or in groups, take what they have learned about solar cookers and design their own–box, panel or parabolic. To test the designs you could either hold a Solar Cooking Day (have the students prepare a dish of their choosing in their cooker and then share the food with the other groups) or each category of cooker (panel, box or parabolic) could have a 'race' among the group to see which cooker can boil 100 mL of water first.

Related Reading

- ***Catch the Wind, Harness the Sun: 22 Super-Charged Projects for Kids*** by Michael Caduto (Storey Publishing, 2011)
  Twenty-two projects plus stories, background information, cartoons and photos covering solar thermal, photovoltaics, solar cooking, climate change, energy production and energy conservations–plus wind energy!
- ***Cooking With Sunshine: The Complete Guide to Solar Cuisine with 150 Easy Sun-Cooked Recipes*** by Lorraine Anderson & Rick Palkovic (De Capo Press, 2006)
  This book describes how to build your own inexpensive solar cooker, explains how solar cooking works and its benefits over traditional methods and then includes more than 100 recipes that emphasize healthy ingredients.
- ***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 five solar cooking projects, along with solar stills, a solar powered ice-maker and solar electricity projects.

Internet Sites

http://solarcooking.org/

Solar Cooking International Network, solar cooking archive includes solar cooking plans, documents and a list of resources and manufacturers.

http://www.sunoven.com/

Sun Ovens International. Includes solar oven history, recipes, and photos.

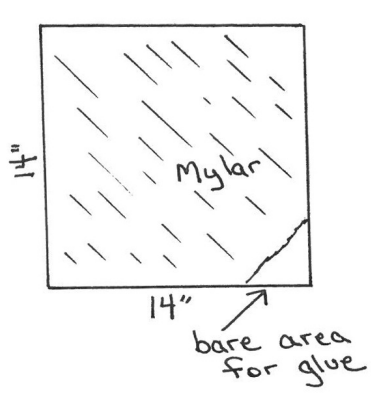
Copenhagen Cooker

Materials

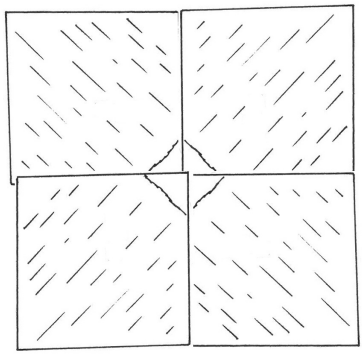
- 14" x 14" sheet vinyl, posterboard or sheet cardboard (4 pieces per cooker)
- sheet mylar–available as camping 'space' blankets
- 8" square 1/8" plywood or other stiff material (an 8" diameter metal or ceramic plate can also be used)
- glue
- sponge brushes or disposable type paint brushes
- high temperature black spray paint (grill paint)
- paints to decorate outside (optional)
- binder clips or clothespins (4 per cooker)

Procedure

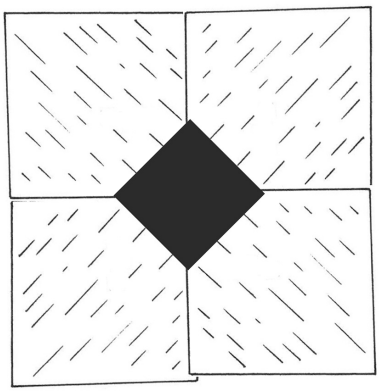
1. Spray paint one side of plywood with high temperature grill paint.
2. Glue mylar to one side of vinyl (or poster board) leaving 3" triangle on one corner uncovered, and working out all the bubbles to make the finish as smooth as possible. A rubber craft roller or a plastic identification card works good for this. Let dry.



Single panel



Layout of 4 panels



Panels with bottom plate glued on

3. Decorate the other side of the four panels if desired.
4. Lay out the four panels with the uncovered corners meeting in the middle (see diagram below). Glue the plywood bottom piece in the center. Let dry.
5. When cooking, draw the four panels up and clip. The angle can be adjusted for the sun conditions.

How to cook in your Copenhagen Cooker

1. Set up the cooker and place it facing the sun.
2. Mix or prepare the food to be put in the cooker according to the recipe.
3. Put the food in a covered black pot and put the whole dish in a high temperature baking bag. Seal tightly. Do not cover your food/pot with aluminum foil–it will reflect the sunlight away from your food.
4. If you do not have a black pot, you can paint the outside of a pot or canning jar black with paint designed for barbeque grills.
5. Place the pot in the center of the cooker. Draw up the sides and clip. Check the cooker periodically (every 20 minutes or so) to make sure it is still capturing the sunlight as the sun moves across the sky.
6. When food is done, be sure to use a pot holder to remove the pot. **Solar Cookers can get extremely hot!**

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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						
Earth in Space and Time	**Big Idea 5**	**SC.3.E.5**		X						
Earth Structures	**Big Idea 6**	**SC.3.E.6**	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						
Forms of Energy	**Big Idea 10**	**SC.4.P.10**	X							
Energy Transfer & Transformations	**Big Idea 11**	**SC.4.P.11**	X	X						
Grade 5										
The Practice of Science	**Big Idea 1**	**SC.5.N.1**		X						
Forms of Energy	**Big Idea 10**	**SC.5.P.10**	X							

Third Grade Benchmarks

Science–Big Idea 1: The Practice of Science

- 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.

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 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.10.4 - Demonstrate that light can be reflected, refracted, and absorbed.

Fourth Grade Benchmarks

Science–Big Idea 1: The Practice of Science

- SC.4.N.1.2 - Compare the observations made by different groups using multiple tools and seek reasons to explain the differences across groups.

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.

Science–Big Idea 11: Energy Transfer and Transformations

- SC.4.P.11.1 - Recognize that heat flows from a hot object to a cold object and that heat flow may cause materials to change temperatures.
- 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.1.2 - Explain the difference between an experiment and other types of scientific investigation.

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.

National Next Generation Science Standards

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.

What's Cooking - 2

1. In the space below, draw a diagram of the solar cooker your team built and label its parts.

2. Explain the functions of each of the parts labeled above.

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_____

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_____

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_____

_____

_____

3. What was the highest temperature you observed in your cooker? _____

4. What are some advantages of using the sun's energy for cooking?

_____

_____

_____

_____

5. What are some disadvantages of using the sun for cooking?

_____

_____

_____

_____

6. What are some other applications for solar cookers? (Hint: think about recreational/weekend activities or after a hurricane)

7. What ideas do you have to improve your cooker?

8. What did you cook in your cooker? _____

9. Was there a difference in how well the cookers in your class did or in how well every group was able to cook? _____

10 If so, what do you think caused this difference? _____

_____

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