How can you bring the sun's energy indoors?

A laboratory experiment from the Little Shop of Physics at Colorado State University

Overview

The sodium acetate heat packs that we use in the activity "How can freezing make something warmer" ultimately transfer the heat from one place to another. Rather than use heat from the stove or the microwave oven to melt these packs, we've worked out a way to use the heat of the sun. It's a simple way to save some solar energy for later—and a small-scale version of a process that can be done on an industrial scale.

Necessary materials:

- pizza box
- black construction paper
- aluminum foil
- plexiglass cut to size or an oven cooker bag
- aluminum foil coated bubble wrap
- glue, tape, scissors, ruler and magic marker
- wooden dowel
- bubble wrapped foil
- Reusable sodium acetate heat pack

Theory

When frozen water melts, it takes in energy to turn the water from a solid to a liquid. When you freeze liquid water, you need to take this heat back out again. Rather than do this with water, the heat packs use a sodium acetate solution that freezes at 60°C, and that can be supercooled to temperatures well below this. Start with a frozen heat pack; you need to add heat to melt it. You can do this by using a solar oven. The heat from the sun goes into the pack, and is stored. When you "pop" the disk at a later time and make the pack start to freeze, this energy is released. You've moved heat from one place to another! And here's the really cool part: When you use the heat pack, *the heat that warms your hand ultimately came from the sun!*

Capturing the sun's energy with a heat pack.

There are many ways to create a solar oven. We give directions for a box cooker, which is one of the most simple cookers and uses readily available and inexpensive supplies.

The foil on the oven reflects extra light into the interior, where it heats the contents. The plexiglas (or plastic film) top keeps the warm air from escaping, so the inside gets quite warm, warm enough to melt the heat pack.

Building the Solar Oven

Building this particular solar oven is quite straightforward. We've listed simplified directions below; more detailed plans are available at: http://www.solarnow.org/pizzabx.htm

1. Get a cardboard pizza box. (Used is OK. Smells more pizza-y!)
2. Draw a box on top of the pizza lid that is one inch smaller than the lid.
3. Cut three side. Do not cut the side closet to the hinge.
4. Completely cover the inside of the box lid with aluminum foil, shiny side out.
5. Tape the plexiglas into the opening of the box, insuring that there is a complete seal.
6. Cover the bottom and sides of the lower portion with foil-covered bubble wrap. (This reflects radiation and also insulates.)
7. Place black construction paper or fabric inside the box, where the heat pack will sit.
8. Face the open box towards the sun.
9. Angle the top of the foil covered inside so that there is a visible reflection onto the black construction paper or fabric inside.
10. You may need to use a dowel or pencil to adjust the box lid according to different times of the day and angle of the sun.

Doing the Experiment

Place the frozen sodium acetate heat packs into the solar oven and start heating. Depending on the sun's angle and time of day, the heat pack should be returned to a liquid state within one to two hours. You can then chose to release the sun's energy at any time in the future!

Additional Information

One of the big problems with using solar energy is that the sun doesn't shine all of the time. How can you capture and store the energy for later use? Interestingly, there are commercial schemes to do just that using molten salts! The salts used aren't normal table salts but, typically, a mix of sodium and potassium nitrate. The sun shines and melts the salts; when the sun goes down, the salts refreeze, releasing the energy. Just like the heat pack, but on a much larger (and much hotter!) scale.

For More Information

CMMAP, the Center for Multi-Scale Modeling of Atmospheric Processes: http://cmmap.colostate.edu

Little Shop of Physics: http://littleshop.physics.colostate.edu