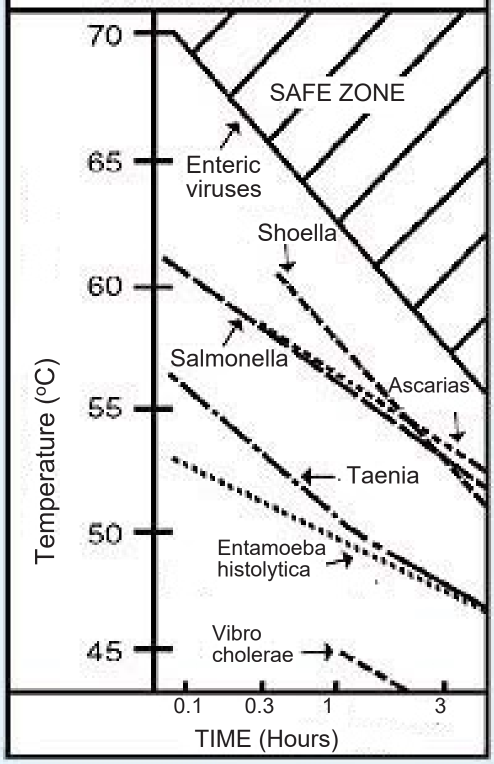
Solar pasteurisation

Both water and milk, when contaminated by human and animal waste will spread diarrhoea, cholera, TB, giardia, hepatitis, typhoid, and other diseases. Heating water and milk and keeping it hot for a certain amount of time kills disease-causing organisms, making them safe to drink. This Action Sheet explains how you can use the heat of the sun to do this.

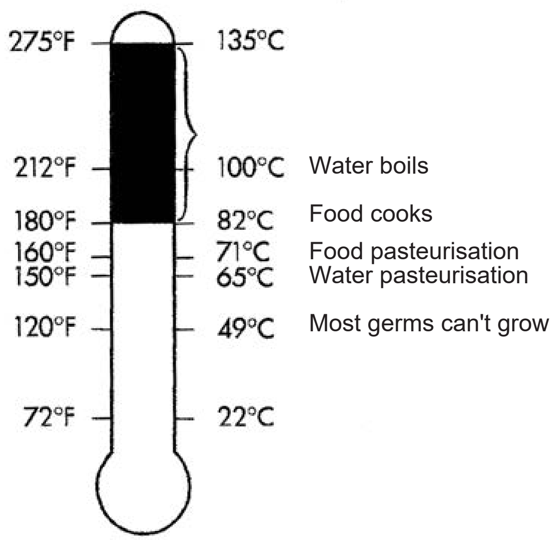
What is solar pasteurization?

Pasteurization was named after Louis Pasteur from France. Around 150 years ago, Pasteur discovered that many diseases are caused by germs. These are organisms so tiny that they can only be seen with a microscope. Other disease organisms called viruses and parasites are also carried in water and milk. Pasteurization means heating milk or water up and keeping it hot enough for long enough to kill the germs, viruses and parasites. If the heat of the sun is used to do this, it is called solar pasteurization.

Temperature - time chart for safe water pasteurisation.



Simple solar cookers



Images, www.solarsolutions.org, from R. G. Feacham et al, 1983.

This graph shows how long it takes to kill various disease-causing microorganisms at different temperatures. In general, the higher the temperature, the shorter the time required to kill the organisms. Heating water to 65°C (149°F) for 6 minutes (0.1 hours), or to a lower temperature for a longer time, will kill all germs, viruses, and parasites that cause illness in humans.

Solar pasteurization disinfects drinking water but does not remove other contaminants without additional filtration or treatment. If the water is muddy or contains chemicals, see Action Sheet 23: Making drinking water safe for drinking and cooking.

What are the benefits?

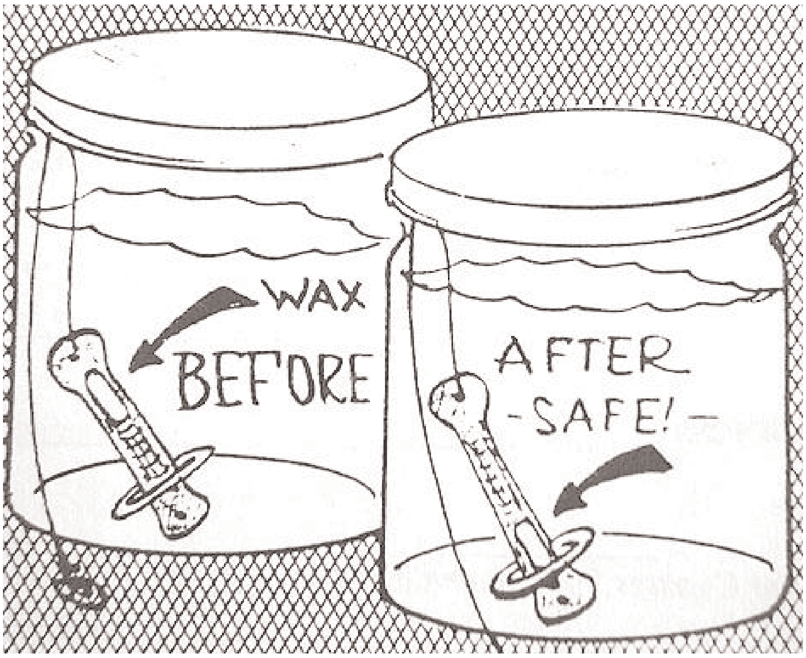
It is especially dangerous for young children and old people to get the kinds of illnesses that are carried in water and milk that has not been treated to remove disease organisms. Because it doesn't depend on fuel, electricity or expensive equipment, solar pasteurization is one of the least expensive ways to make sure that the water and milk you and your family drink is safe.

How can we use the sun to pasteurize drinking water?

The SODIS method of SOlar DISinfection is described in more detail on Action Sheet 23: Making water safe for drinking and cooking. It involves leaving water out in the sun in clear plastic or glass bottles. Fill the bottle _ full and shake it to create air bubbles, before filling it up to the top. Leave outside in a safe place for at least 6 hours in full sun, or 2 days if it is cloudy. After the sun has done its work, drink straight from the bottle to avoid contamination. When used with a WAPI (see below), you can save time, as you are able to tell when the water has been pasteurized.
Another simple way to use sunshine to make drinking water safe is using a solar cooker (see Action Sheet 60: Solar Cooking).

Use the solar cooker to heat your drinking water or milk in the middle of the day when the sun is hottest. Put the liquid in a jar covered in black paint, or a black cooking pot with a lid, and then put the container in the cooker. A general rule is to heat the liquid in the solar cooker for 1 hour per litre. For example, heat 1 litre for 1 hour, 2 litres for 2 hours, 4 litres for 4 hours.

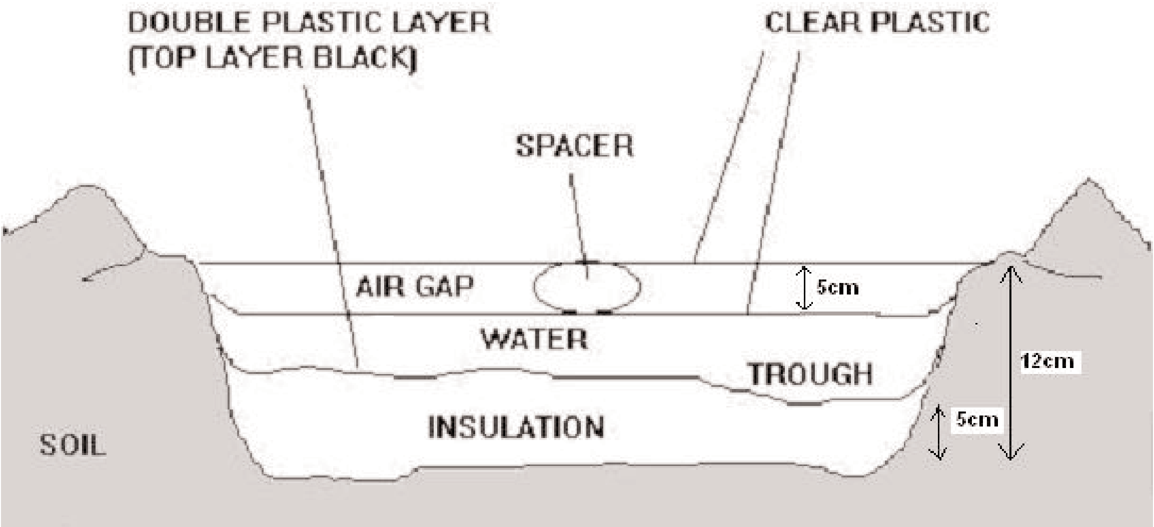
Putting a Water Pasteurization Indicator WAPI into the cooking pot or water jar can help you to know whether the germs have been killed. A WAPI is a re-useable tube containing wax or a fatty substance that melts at 69C. When the wax melts, it flows from the top to the bottom of the tube, to indicate that the water has been pasteurised. WAPIs can be purchased for $9 from Solar Cookers International, but you may be able to find a cheaper one through a local water project. If you use a cooking stove to heat and pasteurise water, a WAPI can help you save fuel, as you will know when the pasteurisation is complete.



WAP. Image, solarcooking.org.

With a solar cooker in a sunny climate, you can pasteurise about 4 litres of water a day, enough water for a family of 4 to use for drinking. However, for real safety from waterborne diseases, it is wise to use pasteurised water to wash dishes and drinking vessels as well, so you may wish to investigate larger scale solar pasteurisation methods like the Solar Puddle.

What is a solar puddle?
A solar puddle is a pool of water kept under two clear plastic sheets. The heat from the sun gets trapped under the plastic, and so the water heats up enough for pasteurisation to take place. A solar puddle is the cheapest way to pasteurise a large quantity of water, as it can be built out of low cost materials at the size needed.
One design for a solar puddle is shown here. Many designs are possible. For example, the ‘puddle’ could be put inside a wooden box on top of a table or a roof.



A basic solar puddle. Image, solarcooking.org

How do you make a pit solar puddle?
Materials: Cheap plastic sheeting or special UV stabilised plastic (would last longer), 1 or 2 siphon tubes (pieces of hosepipe). Plan the size of the solar puddle in advance to work out how much of each material you need.

1. Build a shallow pit about 12cm deep. A family-size solar puddle is about 1m x 1m. Choose a higher area near your home, or build up a mound so that the pit is higher than the surrounding area. If you need to pasteurise more water, pits can have a larger area, but the depth of the pit should remain the same.
2. Fill the bottom of the pit with 5cm of insulating material (eg. newspaper, straw, grass, leaves or twigs). Make the insulating layer flat, except for a slightly lower area in one corner, shown as trough on the diagram.
3. Cover the insulating layer with one layer of clear plastic, and then one layer of black plastic. The edges of the plastic must extend up and out of the pit. Two layers are used in case of leaks.
4. Put some water in to a depth of 1cm. The water should be about 3cm deep in the trough.
5. Add more water until it is 2 to 7cm deep, depending on the sunshine expected that day.
6. Fill a new siphon or new hosepipe with pasteurised water. Block one end with a clip, plug, clamp or siphon tap. Block the other end with your thumb and place underwater in the trough. Fix the collecting end in place in the trough with a weight or rocks. When the other end of the siphon is held at a position lower than the end in the solar puddle, and the tap is undone, water should flow out from the puddle until it is nearly empty. For now, leave the clip on the pipe.
7. So that you can tell when the water is safely pasteurised, put a WAPI into the trough.
8. Cover the puddle with a sheet of clear plastic. Then place some lightweight spacers, such as wadded paper, on top of this layer and cover with another layer of clear plastic to make an insulating air gap. The thickness of the air gap should be at least 5cm.

1. Weigh down the edges of the 4 sheets of plastic with rocks. If there are likely to be short showers of rain during the day, the top layer of plastic can be raised up in the middle to form a shallow tent shape so that the rain runs off.
2. Wait for the sunshine to do its work! When the WAPI indicates that the water is safe to drink, unblock the end of the drain siphon and place the exit end in a container held lower than the end in the trough. Pasteurised water should flow out into your container.
3. Keep using the puddle by resetting the WAPI and pouring more water into the tank. Either fold back the top layers of plastic sheeting, and pour water in using a bucket, or use another hosepipe as an entry pipe to the puddle. Do not use the drain siphon to pour water in to the tank, as it must be kept clean.

Depending on the weather, you could treat up to 68 litres per day with this system. If you have a water thermometer, you can experiment with the system to see what temperatures can be reached.

How much does it cost to make a solar puddle?
The costs will vary around Africa, but if cheap plastic sheeting is available, a family-size solar puddle might cost around US$6. Over the long-term, the number of litres of pasteurised water that you could produce per dollar of investment would be around 1800 litres. A larger solar puddle (3m x 7m), costing US$25 to make, could produce around 3500 litres per dollar of investment.

Can you buy ready-to-install solar pasteurisation systems?
If you have the resources and a piped water system, you could buy a solar pasteurisation system from a company. For example, this is the SunRay 1000 Solar Water Pasteurizer (Safe Water Systems), which costs about US$1,950. It has a flow-through system that automatically disinfects 1,000 or more litres of water every sunny day. Based on 2 litres per person per day, that's enough drinking water for 500 people. Safe Water Systems also produce a smaller portable SODIS system called SunRay30. This costs about US$195, and can produce 30 litres of safe water on a sunny day.

SunRay 1000 Solar Water Pasteurizer.
Image, Safe Water Systems.

Acknowledgements
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For more information
Contact Safe Water Systems,
Solar Cookers International.

Feacham, RG, Bradley, DJ, Garelick, H & Mara, DD 1983, Sanitation and disease : health aspects of excreta and wastewater management, World Bank studies in water supply and sanitation, Chichester [West Sussex] ; New York : Published for the World Bank by Wiley.

www.solarsolutions.info has information and advice on solar water pasteurisation techniques and sells a ready-made solar pasteurisation device called the Aqua-pak.

To learn more about PACE please view our website www.paceproect.net, e-mail pace@tusk.org or write to PACE, Tusk Trust Ltd, 4 Cheapside House, High Street, Gillingham, Dorset, SP8 4AA, UK.