BUILD YOUR OWN SOLAR WATER HEATER

What is this Action Sheet about?

This Action Sheet contains instructions for building a solar water heater, known as a batch heater. This system costs about US$70 to build and produces water temperatures as high as 66°C (150°F).

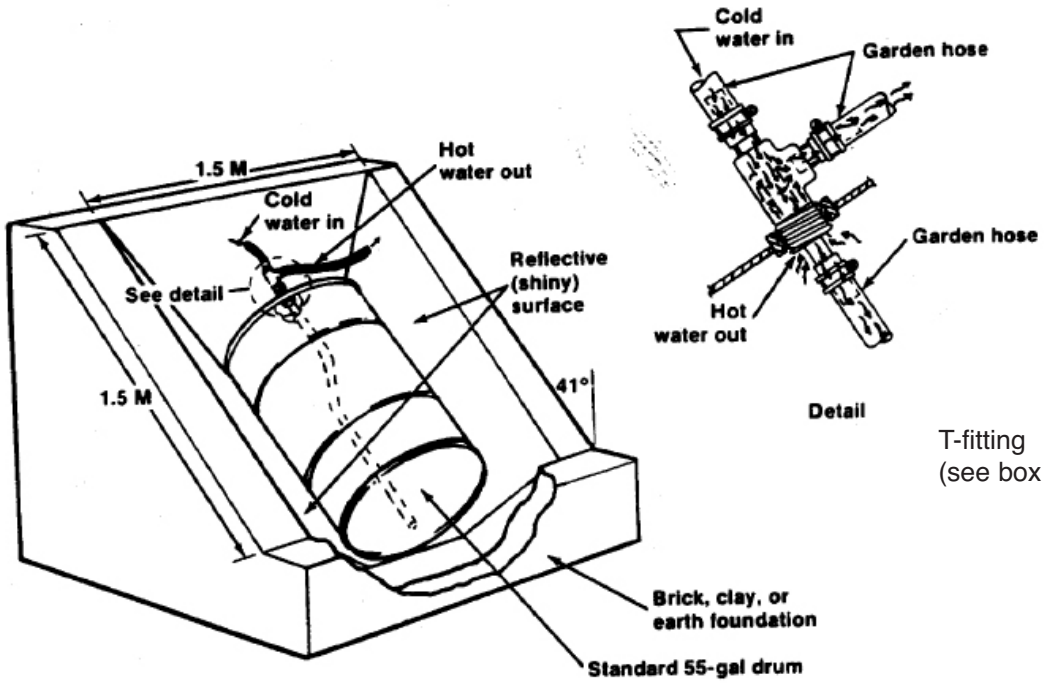

Figure 1

Remember, the batch heater is not designed to operate with pressurized water systems and should not be connected to a city water supply. If you are looking for such a system, consider manufactured solar systems, which have been designed to meet strict standards and aesthetic considerations. The solar batch heater is made with a steel drum. Since a standard 250 litre (55-gallon) drum cannot withstand city water pressure, but some pressure is needed to push water through the system, gravity flow is often used. This involves a second 250 litre (55-gallon) drum, filled with cold water and elevated above the batch heater drum. Gravity provides enough pressure to move water from the elevated drum (cold-water source) to the batch heater drum and finally to the hot water faucet in a sink, shower or other outlet. The exact drum size is not important, but for the design below it needs to be around that size.

In this design, the water flows in and out of the drum through a T-fitting with an internal tube. The internal tube allows cold water to flow to the drum from above, whilst the hot water flows out at the top of the drum, through the T-fitting, along the outside of the internal tube to the hot water outlet pipe. The cold water inlet pipe leads to the bottom of the drum. In the sun, the water heats up and rises to the top of the tank. When the hot water tap is open, hot water flows out along the outlet pipe under pressure of gravity. All the joints between pipes must be well sealed.

If you wish to experiment with an alternative design that does not use the T-fitting, you could make two openings in the top of the drum, one for the cold fill pipe leading to the bottom of the tank, and one for the hot water exit pipe leading straight out from the top of the tank.

Follow these simple instructions to build your own solar batch water heater.

LIST OF MATERIALS

- 250 litre (55-gallon) drum (Be sure the drum has not contained any toxic materials.)
- Flat-black paint (made to adhere to metal surfaces)
- 75 (approx.) concrete blocks for frame
- Foil-faced insulation, two 1.22m x 2.44m (4 ft x 8 ft) sheets (Do not use polystyrene sheets — they will melt. Use Thermax, Rmax or another isocyanurate insulation.)
- Reinforced garden hose or automotive heater hose, 3 sections - 1.3cm (½-inch) inside diameter
  - a 91cm (3-ft) section for inside drum
  - a section leading to the cold water inlet valve *****
  - a section leading to the hot water outlet valve *****
- Hose clamps, 3
- 1.9cm (¾-inch) fitting, copper or CPVC ****** (1.9cm x 1.3cm (¾-inch x ½-inch). 1.3cm sweat (½-inch sweat)
- Pipe, copper or CPVC ****** (30.5cm (1 ft) long, 1.3cm, (1/2-inch) outside diameter)
- 1.52m x 1.52m (5ft x 5ft) sheet of window glass
- Duct tape or reflective tape - 5cm (2 inches) wide
- "Rat tail" file, rotary grinder or other tool for grinding
- Solder
- Cement
- 4 sections of plywood or other wood 2.5cm x 15.2cm x 1.52m (1 inch x 6 feet x 5 feet) each
- 4 pipe clamps or c clamps

*****Hose lengths vary depending on distances from the system to the cold water inlet and the hot water outlet.

******If you use plastic pipe instead of copper, be sure to get CPVC, not PVC. PVC cannot withstand as high temperatures as CPVC.

WASH AND PAINT THE DRUM

1. Wash the inside of the 250 litre (55-gallon) drum. Use a bleach/water solution to get rid of any mildew; then rinse thoroughly.

   A word of caution: do not use a drum that has contained any toxic materials. Some toxic substances cannot be washed away and could poison your whole family

2. Once the drum is clean and dry, paint the exterior with a flat-black paint made to adhere to metal surfaces.

CONSTRUCT THE CONCRETE-BLOCK FRAME

1. Site your system where it can receive as much sunshine as possible and is not shaded by trees or other structures. The drum itself should face due north (for the Southern hemisphere)* and should be tilted. (See NOTE in step 12 for more about this).
2. To build the walls of the frame, mark off an area 1.52cm x 1.52m (5 ft x 5 ft) square. For a secure foundation, dig a trench three or four inches deep and lay the first square of blocks in the trench. You need to lay some blocks lengthwise and some crosswise to fit the dimensions. Pack the soil around them.
3. Add a second layer of blocks atop the first.
4. Set the third row of blocks on only three walls (west, south and east) to begin the incline of the west and east walls (see Figure 1).

   Starting on the west wall, set the first block about ½ block-length in from the north end. Continue setting blocks around the south and east walls, ending ½ block-length in from the north end.

5. Set a fourth row of blocks, decreasing another ½ block-length at the north end of the east and west walls, and so on, until the frame is seven blocks high.
6. At the sixth level, leave a space in the south wall (back) for the outlet hose and another space in the east wall for the inlet hose.

FINISH THE WEST AND EAST WALLS OF THE FRAME

The tops of the west and east walls have a step-like shape. To create a flat incline for the glass cover to rest on, fill in the “steps” with cement.

1. To make braces to support the cement while it dries, use 2.5cm x 15.2cm x 1.52m (1 inch x 6 inch x 5 foot boards) (plywood or other wood). Lay one board along the inside face and another along the outside face of one of the inclined walls (lining up the top edge of the board with the top of the wall).
2. Hold the boards in place with pipe clamps or c clamps — one at the top of the incline and one at the bottom.
3. Make a second brace along the other inclined wall.
4. Use ready-mix cement, mortar or a cement/sand mixture to fill in the step-like spaces, forming a smooth surface along the tops of the inclined walls.

The finished frame’s east and west walls will have a 40-45 degree incline from top to bottom (south to north). (See Figure 1.)

NOTE: Depending on the latitude, you may want to adjust the walls’ tilt so that the drum can be positioned to receive the maximum sunlight available. A good rule of thumb is to set the drum at an angle equal to the site latitude plus 15 degrees. In the example system, designed for Botswana, Africa (latitude 26 degrees), the drum has a 41-degree tilt (26 + 15 = 41 degrees) towards the north.

CUT AND INSTALL FOIL-FACED INSULATION

Four sections of foil-faced insulation form a “dish” for the drum, sloping from the top of the block frame down into the centre of the enclosure.

1. Cut two sections - mirror images of one another - to fit on either side of the drum as shown in Figure 2. Dimensions are: 1.5m x 76cm x 1.04m x 90cm (4 ft. 11 in. x 2 ft. 6 in. x 3 ft. 5 in. x 2 ft. 11 in.) Cut side A-D on an angle as shown.
2. Cut a third section of insulation to fit under the top of the drum as shown in Figure 3. Dimensions are: 1.5m x 90cm x 58.5cm x 90cm (4 ft. 11 in. x 2 ft. 11 in. x 1 ft. 11 in. x 2 ft. 11 in.) Cut sides A-B and C-D on an angle as shown.

3. Cut a fourth section of insulation to fit under the base of the drum as shown in Figure 3. Dimensions are: 55.9 cm x 1.5m x 55.9cm x 91.5 cm (1 ft. 10 in. x 4 ft. 11 in. x 1 ft. 10 in. x 3 ft) Again, cut sides A-B and C-D on an angle as shown.
4. Set the insulation inside the frame so that it slopes from the top of the blocks down into the centre of the enclosure. You may need to add dirt or sand to support the insulation (and the drum, once it is in place). Remember, the drum must be lower than the concrete frame in order for the glass cover to fit on top.
5. Use duct tape or reflective tape to hold the sections of insulation together. Do not worry if they overlap somewhat or do not meet exactly at the centre. The important thing is to form a curved “dish” to hold the drum.

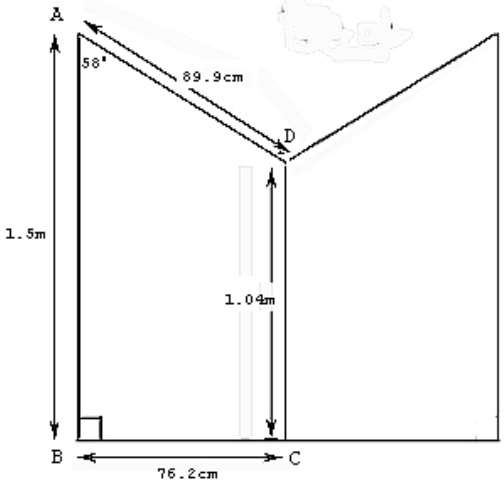

Figure 2

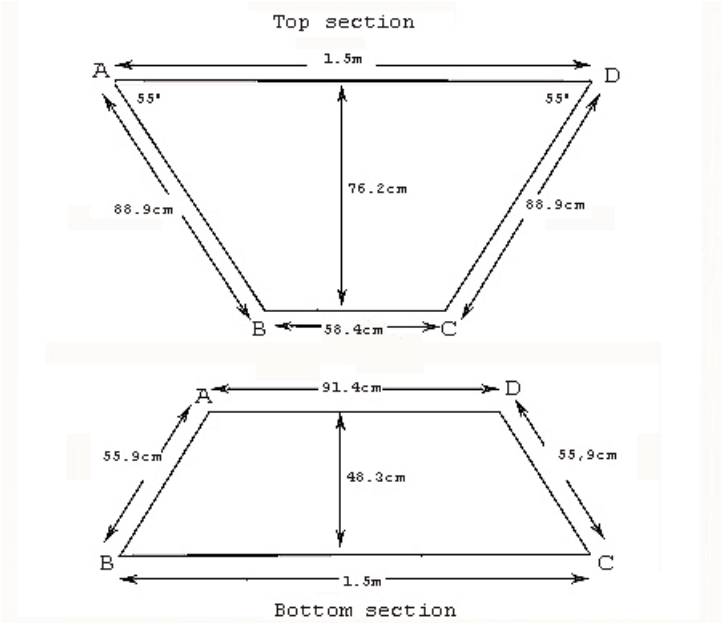

Figure 3

CONNECT THE FITTING, PIPES AND HOSES

1. Putting the internal pipe through the T-fitting: Cut a 17.8cm (7 inch) section of pipe (to be inserted through the fitting so that it protrudes about 5.1cm (2 inch) on either end). Before you can insert the pipe, you must use a “rat tail” file or rotary grinder to grind away the ridge inside the 1.3cm (½-inch) sweat at the top of the fitting (opposite the threaded end).
2. Closing off the top of T-fitting: Solder or sweat the pipe and fitting at the top 1.3cm (½-inch) joint.
3. Putting in the hot water outlet pipe: Cut a 3-inch section of pipe, insert it in the other (side) 1.3cm (½-inch) opening and, again, solder the joint.
4. Fitting the cold water inlet hose drum section: Use a hose clamp to attach a 91.4cm (3-foot) length of garden hose to the pipe at the threaded end of the fitting. This clamp must be tightened really hard so that the garden hose is pressed hard into the internal tube to keep the hot water from going up into the cold feed line when the hot water tap is open.
5. Putting the fitting in: Feed the hose into the drum’s 1.9cm (¾-inch) hole and thread the fitting into the hole. (The drum will also have a 3.8cm (1-½-inch) bung hole. This hole should be plugged.)
6. Fitting the cold water inlet hose feed section: Use a hose clamp to attach a second section of garden hose to the pipe extending from the top of the fitting. This hose should be long enough to reach the inlet (cold) water supply.
7. Fitting the hot water outlet hose: Connect a third section of garden hose to the other (side) piece of 1.3cm (½-inch pipe). This hose should be long enough to reach the outlet (hot) water valve.

NOTE: If you wish to experiment with an alternative design which does not use a T-fitting, you could have two openings in the top of the drum, one for the cold fill line, which would lead to the bottom of the tank, and one for the hot water exit pipe. All the joints between pipes must be well sealed.

POSITION THE DRUM AND COMPLETE THE INSTALLATION

1. Place the drum on top of the insulation so that the fitting and pipes are at the highest point of the drum. (The 3.8cm (1-½-inch) bung hole should be at the lowest point on the top of the drum.)
2. Mark where the inlet and outlet hoses need to pass through the insulation and out of the concrete frame. Cut holes and feed the hoses through.
3. Connect the hose leading out the top pipe to the cold water inlet; connect the hose leading out the side pipe to the hot water outlet.
4. Open the cold water inlet valve and fill the drum with water. Check for leaks and tighten any clamps if necessary.
5. Place the glass cover over the frame.

OPERATING THE SYSTEM

Your solar batch heater is not under city water pressure, but does need some pressure to move water through it. If you use a second 250litre (55-gallon) drum, filled with cold water and elevated above the batch heater drum, gravity provides that pressure. The top drum can be filled by hand using a bucket or with a hose attached to the mains water supply.

As you open the outlet valve and draw hot water out of the batch heater drum, gravity draws cold water down from the elevated drum. When you close the outlet valve, the drum is sealed. Water in the batch heater drum prevents water in the elevated drum from continuing to flow down.

Since heat rises, the hottest water collects at the top of the drum. That is why the outlet hose extends only a few inches into the top of the drum — to draw off the hottest water when you open the outlet valve. The inlet hose extends to the bottom of the drum, so that the cold water coming in does not mix with and cool the hot water at the top.

Try to schedule your hot water use for late afternoon and early evening when water in the batch heater will be hottest. Then you could check the top drum each morning and fill it with water as required.

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OTHER SOLAR WATER HEATER DESIGNS:

The Integral Passive Solar Water Heater Book by David Bainbridge ($10.95 plus $1.50 for shipping and handling from The Passive Solar Institute, Dept. TMEN, P.O. Box 306, Bascom, Ohio 44809). The book contains 99 pages of informative, copiously illustrated guidance in all aspects of IPSWH design and use.

Another good sourcebook, Passive Solar Water Heaters: How to Design and Build a Batch System by Daniel K. Reif, Brick House, $12.95: 208 pages of valuable passive solar building instruction, available from Mother's Bookshelf, 105 Stoney Mountain Road, Hendersonville, North Carolina, 28791 for the price listed plus $1.25 for shipping and handling.