



CONSTRUCTION AND INSTALLATION OF A BATCH-TYPE HOMEMADE SOLAR WATER HEATER— *An Inexpensive, Durable System*

GENERAL INFORMATION

This pamphlet describes a batch type design consisting of a tank in an insulated box with glazing to admit solar energy—sometimes referred to as a “bread box” water heater. It also serves as a hot water reservoir. Essentially it is a reflector-less, slant-faced, box cooker adapted to heat water.

This simple concept stands in contrast to the more complex flat-plate collector designs, which are vulnerable to freezing if tap water circulates through the tubes. These designs become complicated and quite expensive, and also less reliable, if configured for pumped circulation of anti-freeze heat transfer fluid. Note that a flat plate collecting design always requires an external storage tank and associated plumbing.

Batch-type homemade solar hot water heaters are among the most cost effective solar devices. They can be used alone with the understanding that water temperatures will fluctuate with the time of day and weather, or they may be used to preheat water feeding into a gas or electric water heater to reduce the fuel costs of bringing water to a preset temperature. The use of simple passive designs eliminates complications such as pumps, special heat-transfer fluids, electronic controls, and heat exchangers. Batch-type solar water heaters can be integrated into the plumbing of a house or may be built in isolation as field, shop or barn equipment. They can be built for filling with a hose or bucket in a passive, gravity flow set-up where plumbing is not convenient, such as with outdoor showers or camp facilities. A solar hot water bathing installation will require a cold-water source for mixing to comfortable temperatures. For example, this can be done with a double faucet bathtub fixture in a shower. In primitive setups, one may pour hot and cold water from two buckets into a third, and then use a cup to pour warm water for washing.

The tank may be a recycled 40 gallon tank or a 20 gallon recreational vehicle tank, either gas or electric. For non-pressurized systems, a 55-gallon drum or any other available container originally used for non-toxic materials will also work. If large quantities of hot water are needed, two or more tanks may be connected side by side or stacked one above the other in the same insulated, glazed enclosure, with the hot water outlet of one tank serving as the cold water intake of the second. This two-tank design also provides hotter water.

Tanks are usually installed horizontally, but may be slanted at the slope of the glazing (tall box tipped back toward the earth's pole.) At mid-latitudes, a 45-degree slant may be chosen to save lumber by the efficient use of a plywood sheet. The enclosure may be of any shape (vee-shaped, semi-circular or rectangular). It must be adequately large and well enough insulated to collect sufficient solar radiation. It should be double-glazed using glass to achieve the best heating performance. Specially treated UV resistant plastic sheet or film glazing material (acrylic or mylar) also gives good performance, but is generally not readily available. Ordinary untreated plastic will not stand up to the heat and solar radiation. The use of tempered glass for the outer layer is recommended for durability in any case. Recycled or seconds of patio glass doors are often used for this purpose.

Install a hot water heater where it receives direct sunlight for most of the day. Batch water heaters need not be configured as central systems. It may be preferable to locate a small solar water heater on the roof directly over each sink, bathroom or laundry. A distributed heating strategy is especially advantageous for outlying facilities. Having the heater close to the sink delivers hot water quickly without the waste of replacing excessive cold water in the pipes with hot. Using a 1/2-inch line rather than a 3/4-inch line, although it is slower, also brings hot water in with minimal water waste. Keeping the lines short minimizes the slowing effect of using

smaller diameter pipe. To support the weight of the tank and water, the strength of the roof should be calculated and reinforced if necessary.

A well-enclosed tank is freeze resistant. In this regard, the double-glazing is critical to retain heat overnight. During one stormy winter week when temperatures dropped to minus 27 degrees Fahrenheit for two nights in a row, our 40-gallon tank did not freeze. Pipes between the water heater and the point of use, outside and within the house, should be well insulated both to prevent freezing and also to conserve as much heat as possible.

Rain and wind will usually keep the glazing sufficiently clean. Over a 20-year period, maintenance may be an occasional fresh coat of paint or re-caulking the seams of the box. Manually eliminating trapped air may be required a couple of times a year. All water contains dissolved air, and when the water is heated this will be driven off and will collect in the top of the tank. If the tank is located below the point of use, the air will be automatically removed as water is drawn. However, if the tank is located above the point of use, the air builds up in the tank to the level of the outflow pipe and hot water may cease to flow. When this happens, the air pocket must be vented by opening a needle valve at the top of the tank.

DESIGN PARAMETERS

- Allow at least 2 inches of clearance around the tank. Larger sized glazing, which gathers more solar radiation and yields more heat, will result in space around the tank considerably larger than 2 inches in several directions.
- The double-glazing layers should be spaced 1/2 inch apart and sealed to the box.
- Insulate the bottom and sides with 2 inches or more of insulation. Rigid foam sheet material (poly-isocyanurate or polystyrene) is easiest to use in construction. Another good choice is the polyester batt material sold for making quilts or stuffing pillows.
- Line the inside of the box with kitchen-grade aluminum foil, applied shiny side out.
- Provide a simple way to access the interior of the box to check on the equipment or perform maintenance. Maintenance usually consists only of releasing air that builds up in the tank periodically, but may include repair of leaks. A full-sized insulated plug door at the back with four butterfly closures works fine.
- Alternatively, frame the glazing and screw it to the basic box at only 4 points. It should be sealed with silicone caulking from the outside only, so screws can be removed and sealant cut for maintenance. This would be an undesirable access method for large designs, as the removed glazing would be quite heavy and unwieldy to handle, not to mention vulnerable to breakage.
- Another way to seal removable glazing is to use felt strips sold for weatherizing windows, which would be easier to deal with than cutting silicone sealant, if the heater must be opened. A possible problem with this method might be rain-water leakage into the enclosure unless good exterior drainage or water shedding is provided. Again, removable glazing is more practical for small heaters.
- For water heaters installed on the roof, one might consider placing a metal tray under the heater so that water drains off the edge of the roof over a window. This provides easy visibility if leakage should ever occur.
- Allow about one square foot of glazing per two gallons tank capacity. Our main heater has a collecting aperture of 18 square feet for a horizontal 40-gallon tank, and it performs very well.

INSTALLATION PROCESS

ORIENTATION

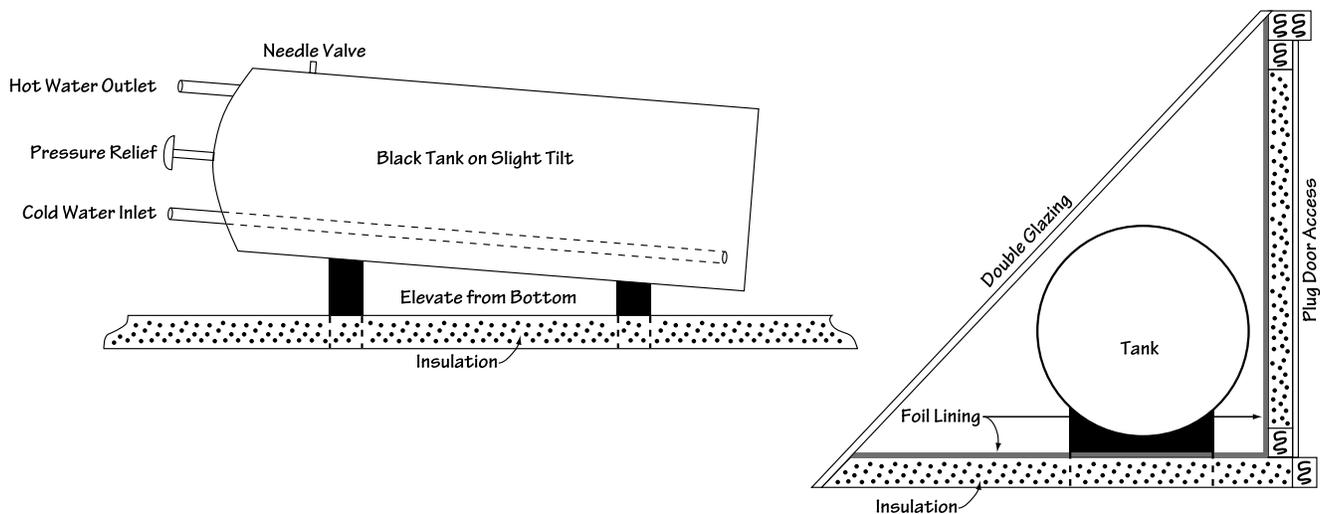
- The glazing should face directly south in the northern hemisphere and north in the south hemisphere. The aim should not deviate more than 15 degrees from this.
- The heater should be located where trees or adjoining buildings do not shade it, particularly in mid-day. If necessary some shade may be allowed, but it will definitely lower the function of the heater.
- The angle of the glazing must be local latitude plus or minus 15 degrees. Steeper angles give best winter performance when the need for maximum heat collection is greatest.
- Our heater, installed at 34 north latitude with glazing at 45 degrees has given excellent results all four seasons.
- Tanks installed horizontally are more easily secured. Brace the tank fore and aft in case of earthquake or accidents.

PREP THE TANK

- Strip off insulation.
- Check for leaks.
- Sand and paint the tank dull black using whatever composition of paint is available.

PLUMBING

- A horizontal tank should be elevated 2 to 3 inches off the bottom of the enclosure using two supports.
- The rest of the tank (top, bottom, sides and ends) must be exposed to absorb heat.
- Identify the outlet at the end of the tank; it has a white circle inside the fitting. This is the end of a plastic pipe going to the base of the tank. Place this outlet lowermost and plumb as the cold water inlet.
- The fitting at the top of the same end is plumbed as the hot water outlet.
- If the tank is installed higher than the faucets, drill and tap a hole on the highest curve of the tank for installation of a needle valve. Especially for pressurized tanks, refer this task to a qualified installer such as a plumber.
- Lay a horizontal tank at a slight slant upwards toward the needle valve to facilitate bleeding air.
- The pressure relief valve can be on the hot water line, or separate fitting onto the tank itself.
- Plug any remaining tank openings.



Front View, Kerr-Cole Main Solar Water Heater



Rear Access, Plug Door Removed for Maintenance