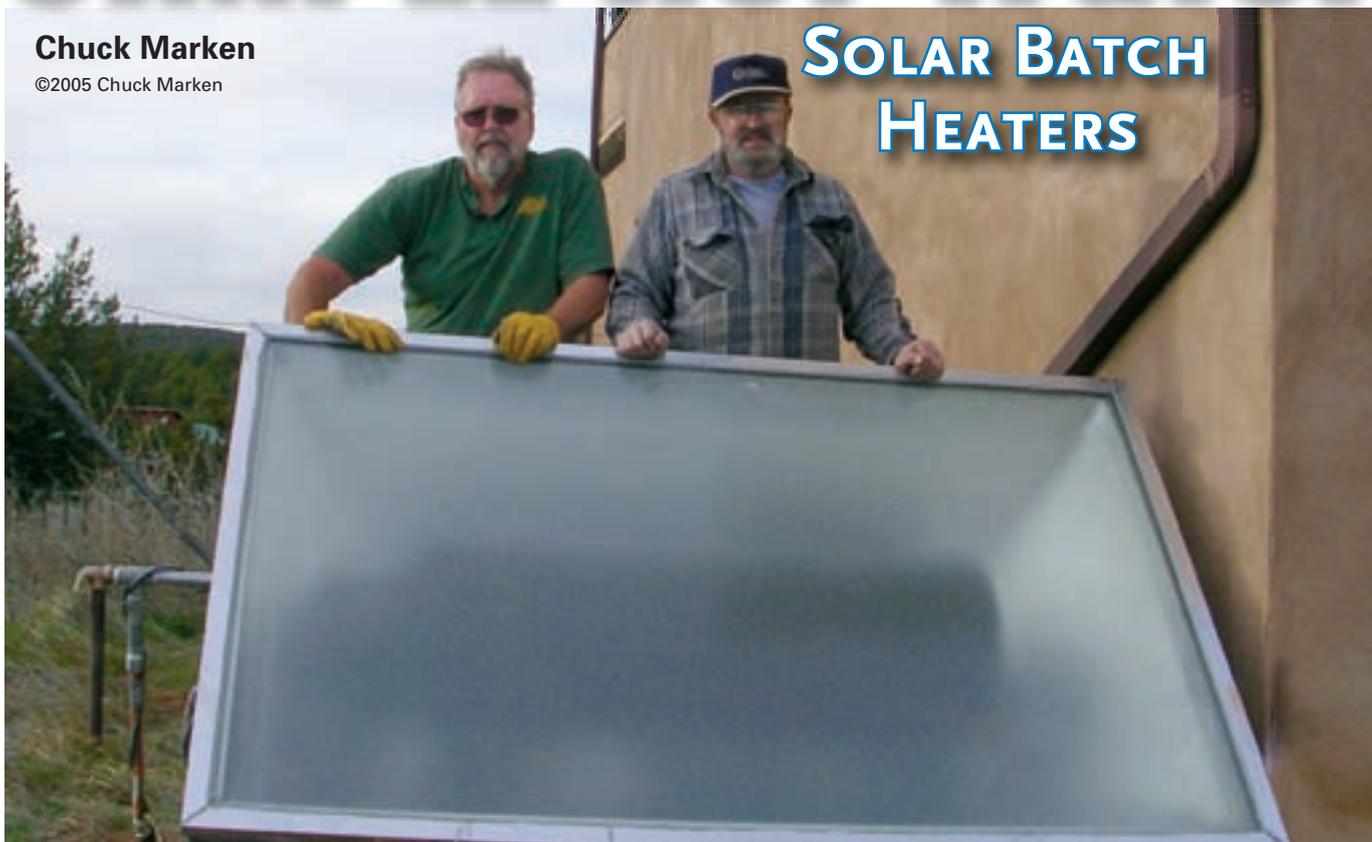


SIMPLE Hot Water

Chuck Marken

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SOLAR BATCH HEATERS



Author Chuck Marken and Don Keefe of AAA Solar rebuilt and reinstalled this Cornell batch heater.

My first experience with batch water heaters was almost 40 years ago, in Vietnam. Our company warrant officer was a savvy mechanic, and he made us a great water heater out of a scrounged wing tank from a fighter plane. He painted the tank black and put it up on some posts. We pumped water up to the tank. During the day, the black tank absorbed sunshine and, through conduction, heated the water in the tank. We took hot showers in the evening, after the workday had ended and the convoys had come in.

That wing-tank batch heater is emulated today in parts of Mexico. If you see a house with both a white and a black tank, chances are the black tank is a solar water preheater. In freeze-free climates, virtually nothing can go wrong with them—the simplest of all solar water heaters—except a lack of sunshine. Since the tanks are uninsulated and subject to ambient temperatures, after sunset these batch heaters tend to lose all the heat they gain during the day—hence the evening, instead of early morning, use of the hot water.

AKA Integrated Collector Storage

Batch heaters derive their name from how the water is heated—in a large batch, as opposed to collector-type circulation systems in which the water is heated continually

while passing through the collector. Batch heaters also are known as ICS (integrated collector storage) units, because the collector and tank are one and the same.

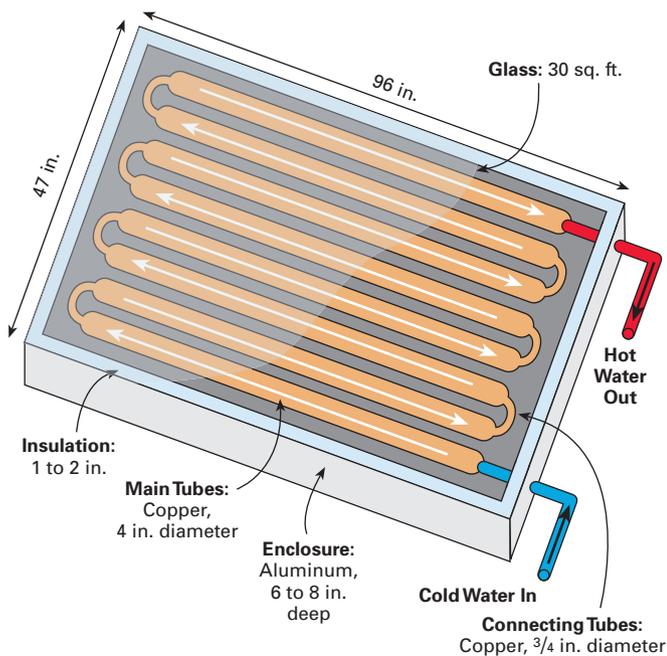
Most batch heaters are manufactured with a weatherproof enclosure (usually an aluminum or steel skin), up to 2 inches (5 cm) of polyisocyanurate rigid foam insulation on the back and sides of the box, and glass (typically double glazed) on the top, which faces the sun. All batch heaters are completely passive—they have no moving parts and require no additional energy inputs to operate. Two distinct types of batch heaters are available—the progressive tube and the single tank.

Progressive Tube Batch Heaters

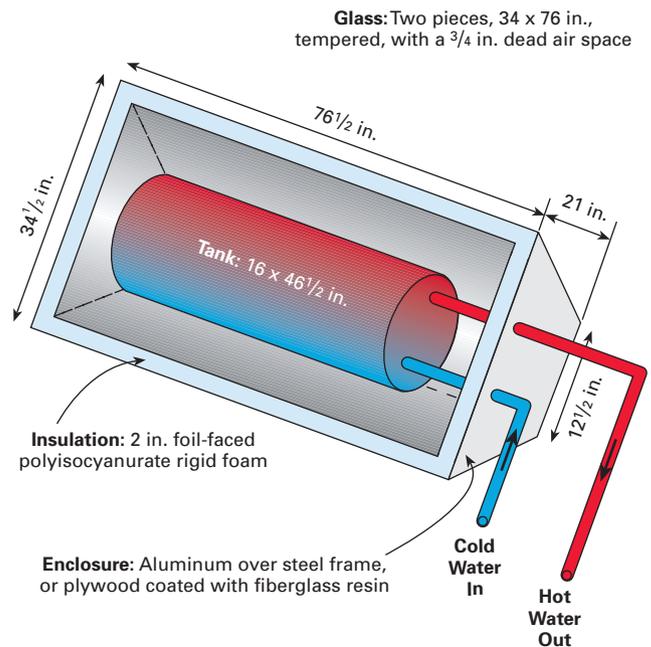
At only 6 to 8 inches (15–20 cm) deep, a progressive tube batch heater can easily be mistaken for a regular solar collector. A typical progressive tube heater consists of an aluminum enclosure, insulation, glazing, and six to twelve, 4-inch-diameter copper tubes in the insulated enclosure. The 4-inch tubes are connected together inside the unit with $\frac{3}{4}$ -inch-diameter copper tubing.

The advantages of progressive tube heaters compared to single-tank batch heaters are usually a larger ratio of glass area to storage volume and less mixing of the incoming

Progressive Tube Batch Heater



Single-Tank Batch Heater



cold water. The more sunlight that hits the collector, the more energy that is available to heat the tank or tube; more glass area means more energy collected. Most progressive tube water heaters have a volume of about 40 gallons (151 l). The glass size for this much 4-inch tubing is about 30 square feet (2.8 m²), a ratio of 3 square feet (0.3 m²) of glass to 4 gallons (15 l) of water. Most tank batch heaters have a ratio of 1 to 2.

The multiple tubes in a progressive tube heater keep the hot water stratified much better than a single tank, delivering more consistent hot water to the taps or a backup heater. Progressive tube water heaters prevent the cold

water from mixing with the hot water—cold water enters the bottom tube and hot water exits the top tube. The weak point of progressive tube water heaters is the 3/4-inch tubing that connects the 4-inch tubes. All batch heaters have the piping to and from the collector as their Achilles heel, but the piping *outside* the collector can be protected with heat tape in colder climates. The smaller tubes inside the heater cannot be protected easily and, even in moderate climates, can freeze and burst during a hard freeze. Several bursts in piping inside a collector can sometimes make it economically unrepairable.

Batch solar water heater in Santa Theresa, New Mexico.



Single-Tank Batch Heaters

Single-tank heaters usually have a smaller ratio of glass to liquid-storage, so the daytime heat gain and heat loss at night is not as great. In addition to being more tolerant of internal freeze damage, single-tank batch heaters also usually cost less—the difference being the cost of steel-lined tanks versus copper tubes. Generally, 40-gallon tank-type heaters cost less than US\$1,500, while 40-gallon progressive tube heaters *start* at US\$1,500.

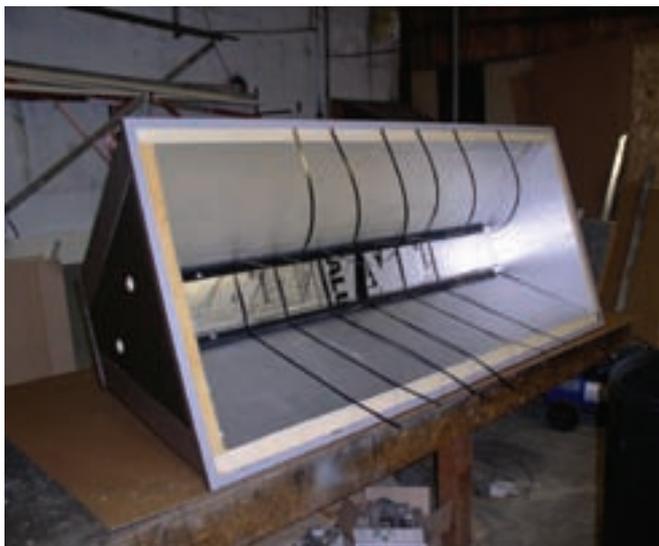
The big advantage for many is that the simple construction makes this heater a good candidate for a low-tech, do-it-yourself (DIY) project. A DIY homebuilt, 40-gallon batch heater can be made for between US\$500 to \$600.

Build It Yourself?

A homemade single-tank batch water heater is a project for those with a medium level of DIY skills. If you fit this description, the drawing above will help you get started on the project.



The welded steel frame of a tank-type batch water heater.



Steel strapping holds the tank in the batch heater.



Adding glass and trim will complete the batch heater.

Probably the toughest thing for a do-it-yourselfer is fabricating the enclosure. Long-lasting enclosures for batch heaters can be made from wood, steel, aluminum, and fiberglass. Most batch heaters manufactured in the United States use an aluminum enclosure, but unless you have welding skills and access to inexpensive aluminum skin materials, you should probably stick with building a simple plywood enclosure. A coating of fiberglass resin on the exterior, and a layer of a good-grade exterior paint on both the interior and exterior surfaces will help the box last many years.

Foil-faced polyisocyanurate rigid foam insulation (available at most home improvement stores) is the best choice for insulating the heater because of its durability and ability to withstand high temperatures. (Lower temperature foam insulations, such as Styrofoam, are prone to melting.) Plus, the foil helps reflect sunlight onto the black tank.

You can fashion a storage tank by modifying an electric water heater tank. Strip off the insulation on the water heater, along with the exterior steel skin, and remove the elements along with the thermostats. (Most element ports can be sealed with a 1-inch-diameter galvanized plug.) Two, $\frac{3}{4}$ -inch-diameter pipe nipples, about 16 inches (41 cm) long, serve as the cold and hot pipes to and from the batch heater. It's as simple as cold on the bottom and hot on the top. Leave the dip tube on the cold inlet in the tank along with the anode rod. The dip tube will help stratify the tank water.

Old, used tanks are cheap—many times, free—but they can be a risky choice, since the older they are, the more prone they are to leaking. And changing a leaky tank in a batch heater is not an easy job.

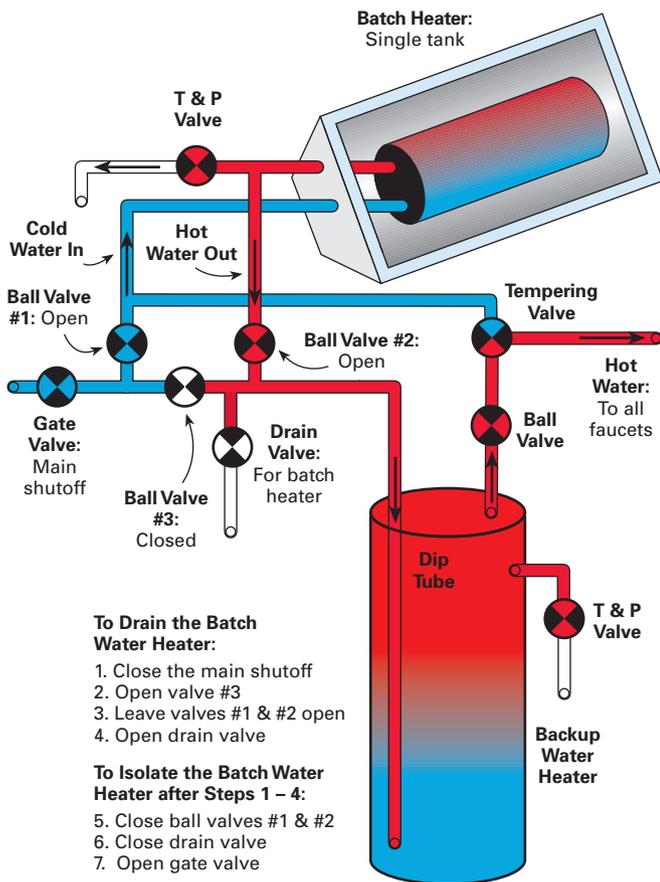
For the glazing, low-iron tempered glass is recommended because it transmits 6 to 7 percent more light than regular glass. On a double-glazed collector, using low-iron glass increases the performance directly proportional to the amount of light transmitted—by 12 to 14 percent. If you can't find low-iron glass, you can substitute regular tempered glass. A common size that accommodates a 40-gallon batch heater is patio door glass, which measures 34 by 76 inches (86 x 193 cm). This gives a ratio of a little less than 1 square foot (0.09 m²) of glass to 2 gallons (7.6 l) of water, but still works well in milder, sunny climates.

Installation

Installation of either type of batch heater is straightforward and relatively simple, compared to active solar water heaters. The cold water from the home is piped into the bottom of the batch heater and the heated water exits from the top of the heater to the house. On progressive tube heaters, the cold inlet and hot outlet can be located on the same side of the heater or on opposite sides. On tank-type heaters, cold and hot always sit on the same side.

Hot water from the batch heater is piped to the cold inlet of a backup water heater. If the sun has heated the water, the conventional water heater thermostat senses hot water and the burner or element does not come on. If cloudy or inclement weather has limited the solar gain, the backup

Normal Piping with Isolation/Drain Valves



heater will heat the water to the set temperature. But even in cloudy weather, a batch heater can heat groundwater up to half of the desired temperature.

Batch heaters can be placed just about anywhere that has good solar access—on the ground or on the roof. Although the units can weigh up to 450 pounds (204 kg), the weight is distributed over such a large area that the load of a full water heater seldom causes problems for roofs. (Older mobile homes may need structural additions to support the load.) If the home's water system is unpressurized (gravity), the batch heater is normally placed on the roof.

If any valves are installed between the batch heater and backup water heater, the batch heater should have a pressure-relief valve. Isolation valves are usually included in batch heater installations too. The weak link in a batch system is the piping to and from the heater. If either or both pipes freeze, the home could be left with no hot water at all. Isolation valves can direct the cold water directly to the backup water heater until the frozen pipes can be thawed.

Limited to Milder Climates

Water stored in batch water heaters is subject to overnight ambient temperatures. Only two layers of glass and a dead air space separate the tank or tubes from outdoor air temperature—

as far as insulation goes, this isn't much. The colder the night, the colder the batch heater will get. This limits batch heaters to year-round use mostly in the southern United States—at 35 degrees north latitude or below. There are exceptions to this, of course—mostly based on altitude and coastal areas—but it's a good rule for most of the interior states.

A 40-gallon, tank-type water heater will not freeze in almost all of the lower 48 states—the volume is too large. But in cold climates, the batch heater will produce almost no usable heat in the winter. Progressive tube water heaters are not as tolerant. Their territory is generally limited to Florida, Texas, Arizona, Hawaii, and California.

Although batch heaters have limitations for year-round use in colder climates, they can be a good choice for seasonal use. Day camps, seasonal parks, and other summertime-use facilities can and do use batch solar water heaters. When the season is over, the tank and piping are drained and ready for the next year.

Batch-type solar water heaters are simple, reliable, and long lasting. Installation is easy and regular maintenance is nil. People who live in mild climates find that batch heaters, with their passive design, no moving parts, and relatively low cost, are an attractive option for solar water heating.

Access

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Past articles on batch-type solar water heaters can be found in *HP93, HP84 & HP76*

