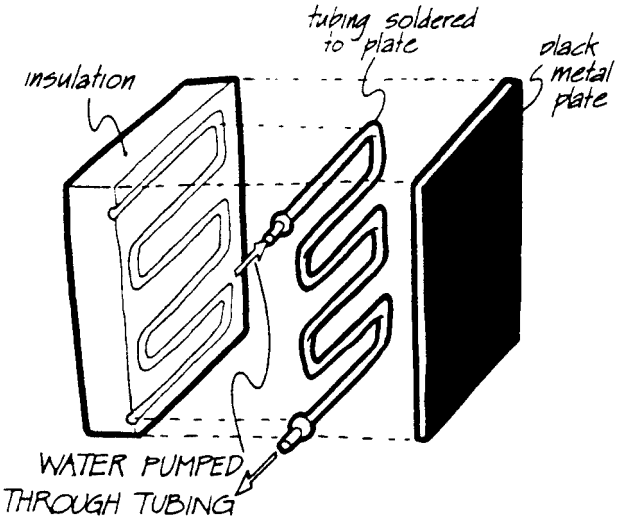
# A SOLAR HEATING SYSTEM 12

Not only do' we want to extract heat from our collector, but we also want to store this same heat to use after the sun goes down. We can accomplish both purposes by using transport heat flow. Our simple insulated plate collector can be modified by soldering metal tubing onto the back of the plate and pumping water through the tubing.

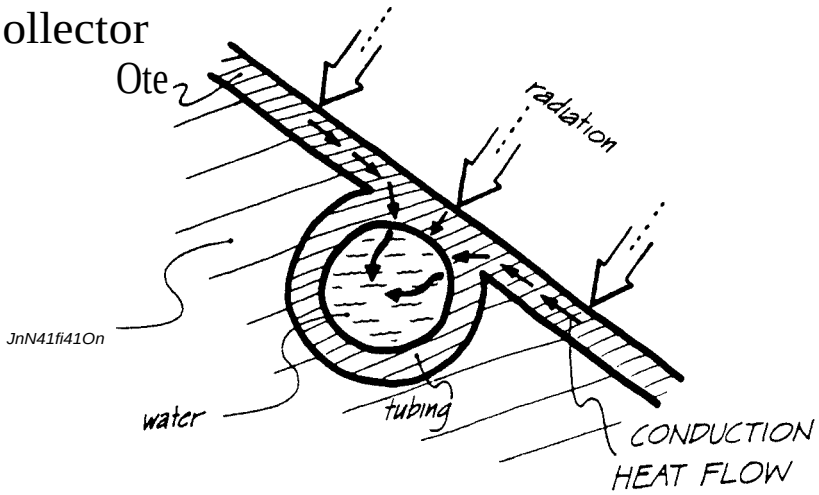
## Extracting Solar Heat by Transport Heat Flow




Using both metal tubing and metal plate is important, since heat flows easily through metal by conduction. In this case, the heat flows from where the sun hits the plate to where the tubing is soldered to the plate. Convection into a liquid, like

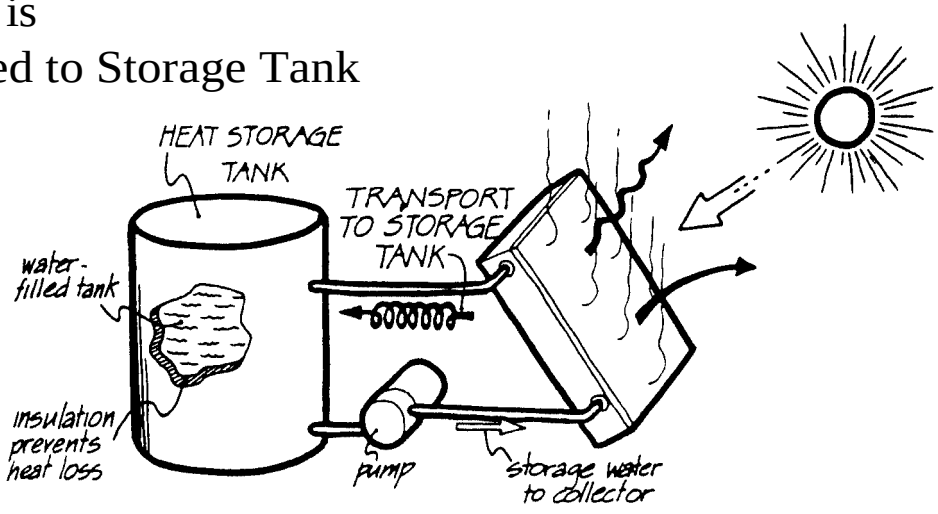
water, is excellent, so the heat flowing into the tubing easily heats the water. Insulation is again used on the back side of the collector to prevent heat from leaking away.

## Solar Heat is Conducted through Metal Collector




After solar heat flows into the water, it can be transported from the collector by pumping the heated water to a heat storage tank. A heat storage tank is a water-filled tank covered with insulation to prevent heat loss. The pump transports water from the storage tank to the collector, where it is solar heated, and is then pumped back to the storage tank in a continuous cycle. We

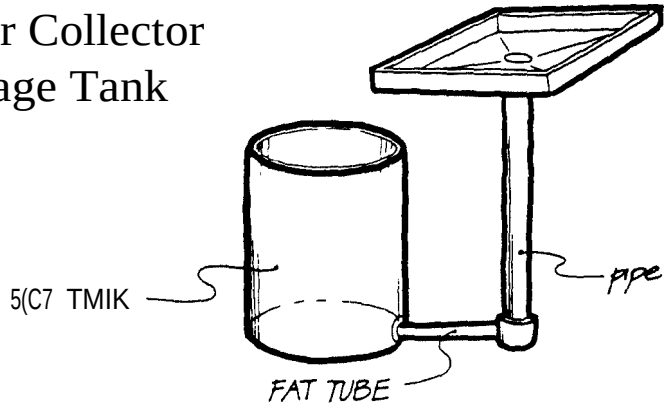
## Solar Heat is Transported to Storage Tank



learned earlier that transport heat flow depends on how fast the water is pumped. Let's assume that we've "sized" the pump so that the water flows fast enough to let heat flow easily out of the collector and into storage. At the same time, the pump won't be so big that the power needed to run it will be significant compared with the heat collected by our system.

To return to the water analogy: we don't want only a high depth in the pipe of the rainwater tray. We want to extract and store some rainwater for use when the rain stops. If we use a fat tube to connect the bottom of the pipe to a big tank, some of the rainwater will flow into the tank. The tube is fat enough so the water in the pipe can flow easily into the tank.

## A Rainwater Collector with a Storage Tank

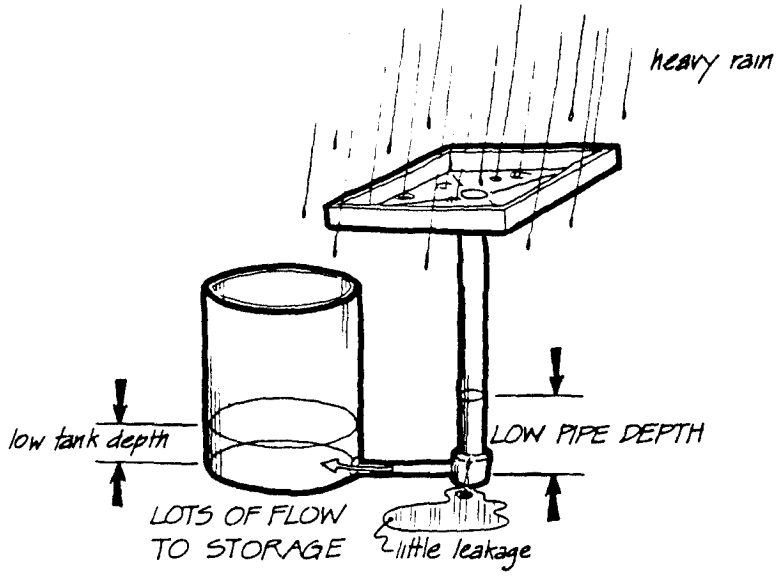



The fat tube is analogous to the pump used in the solar heating system. Just as the pump lets transport heat flow easily from the solar collector to the heat storage tank, so the fat tube lets volume flow easily from the rainwater collector to the rainwater storage tank.

Suppose a heavy rain is failing on the rainwater tray. The water will flow down the pipe and start filling the tank. Some of the Incoming rainwater will flow into the tank, and some will flow out the leak. Since we want to store as much rainwater as we can, we'd like as little as possible to leak away. When only a small fraction of the incoming rainwater leaks away, we say we have high *collection efficiency.* We're efficiently using the rainwater by storing lots of it and letting only a little leak away. By contrast, we have low collection efficiency when a large fraction of the incoming rainwater leaks away and only a small fraction is stored.

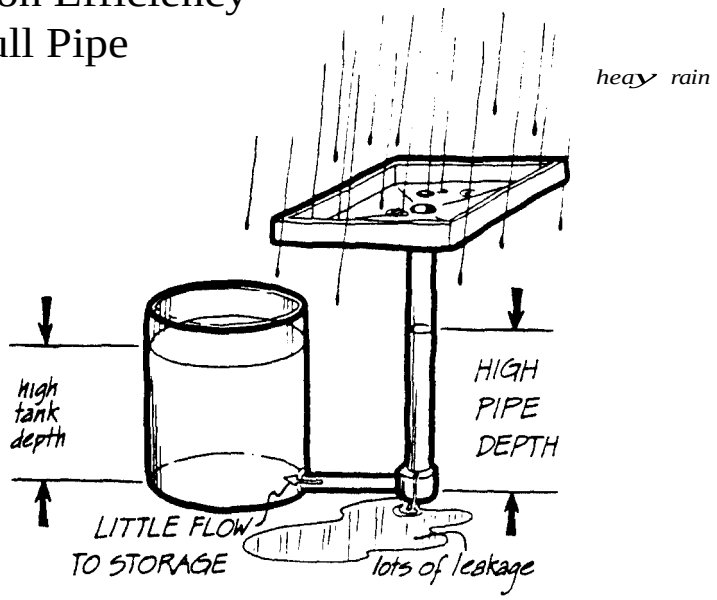
When do we get high collection efficiency and when do we get low collection efficiency? The easiest way to understand collection efficiency is to remember that *high* efficiency hap pens only when leakage is low. Leakage is low only when the depth of water in the pipe is low-a nearly empty pipe leaks less than a full one.

## High Efficiency Collection with Empty Pipe




In the rainwater collecting apparatus we're discussing, we could get high efficiency or low efficiency, depending on the depth of the water in the pipe. For example, if the water depth in the tank were low, the depth of water in the pipe would also be low (the fat tube makes sure both have about the same depth). A low pipe depth means high efficiency: little leakage and lots of flow to storage. The same apparatus would give us low collection efficiency if the storage tank were nearly full. A full tank would indicate that the water depth in the pipe was also high (the fat tube insures this), resulting in high losses. Of course, if most of what is coming into the pipe were lost through leakage, the collection efficiency would be low.

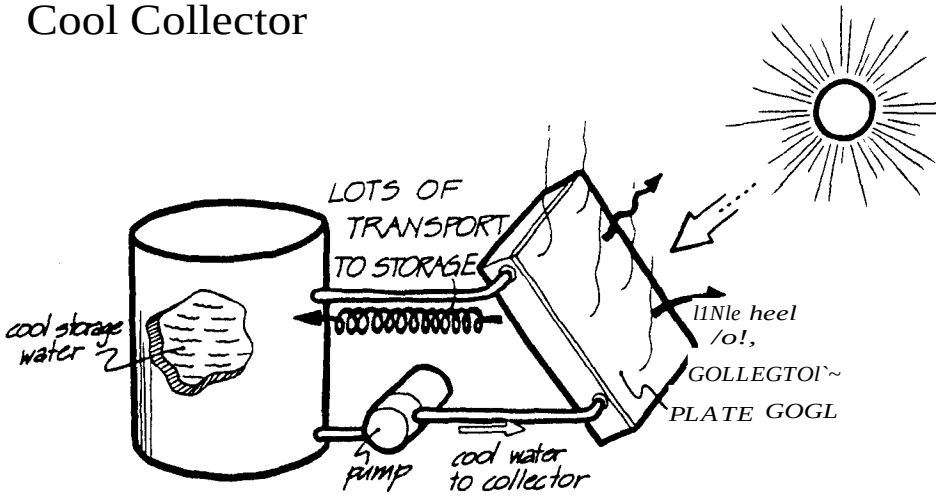
## Low Collection Efficiency with Full Pipe




Now that you have some understanding of collection efficiency, lets's return to the solar heater. We'll assume it's about noon on a bright, sunny day: the collector is absorbing lots of solar radiation.

When the heat storage tank is cool, then cool water is pumped through the collector. The sun warms it somewhat, so it comes out a little warmer than it went in, but on the average the

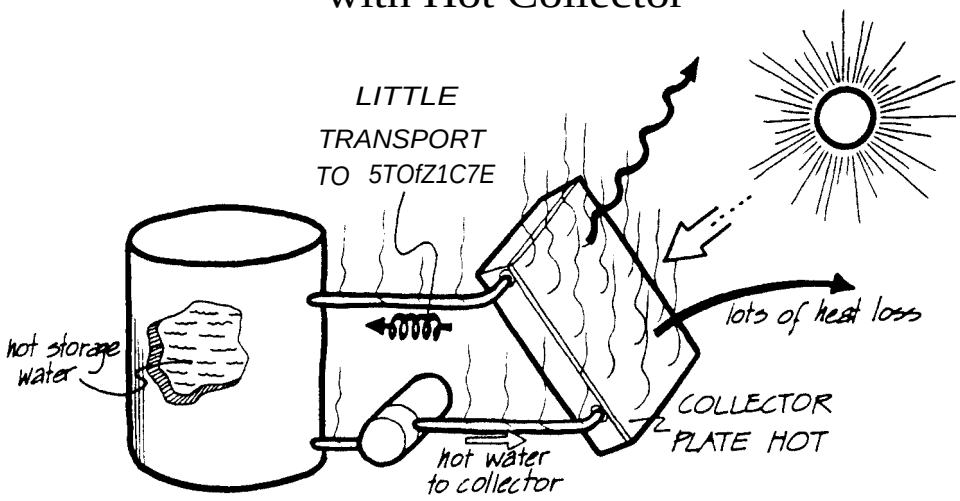
## High Collection Efficiency with Cool Collector



solar collector plate stays fairly cool. With a cool solar collector plate, heat losses by radiation and convection are small, so little heat is lost. Lots of heat goes to storage and efficiency is high. Similarly, when the rainwater tank has little water in it, the depth in the pipe is low, so little rainwater is lost through the leak. Lots of water goes to storage and efficiency is high.

When the storage temperature is hot, the water being pumped to the solar collector is also hot. The collector, In turn, gets hotter. But when the collector gets hot, it loses more heat from its front plate by radiation and convection. Since more solar heat is lost, less heat is stored and the efficiency Is low.

## Low Collection Efficiency with Hot Collector




A hot collector means low-efficiency solar collection. We learned earlier that the hottest a collector can get is its stagnation temperature. But at its stagnation temperature its efficiency is precisely zero-it loses all the solar radiation It absorbs. If the water pumped to the collector is cooler than the stagnation temperature, some solar heat can be stored: the cooler the water, the higher the efficiency. The highest efficiency Is achieved when very cold water is pumped into the collector. The tendency for efficiency to depend on temperature is an inherent feature of all solar heaters. It has an important effect on how solar energy can be applied to various kinds of heating needs.