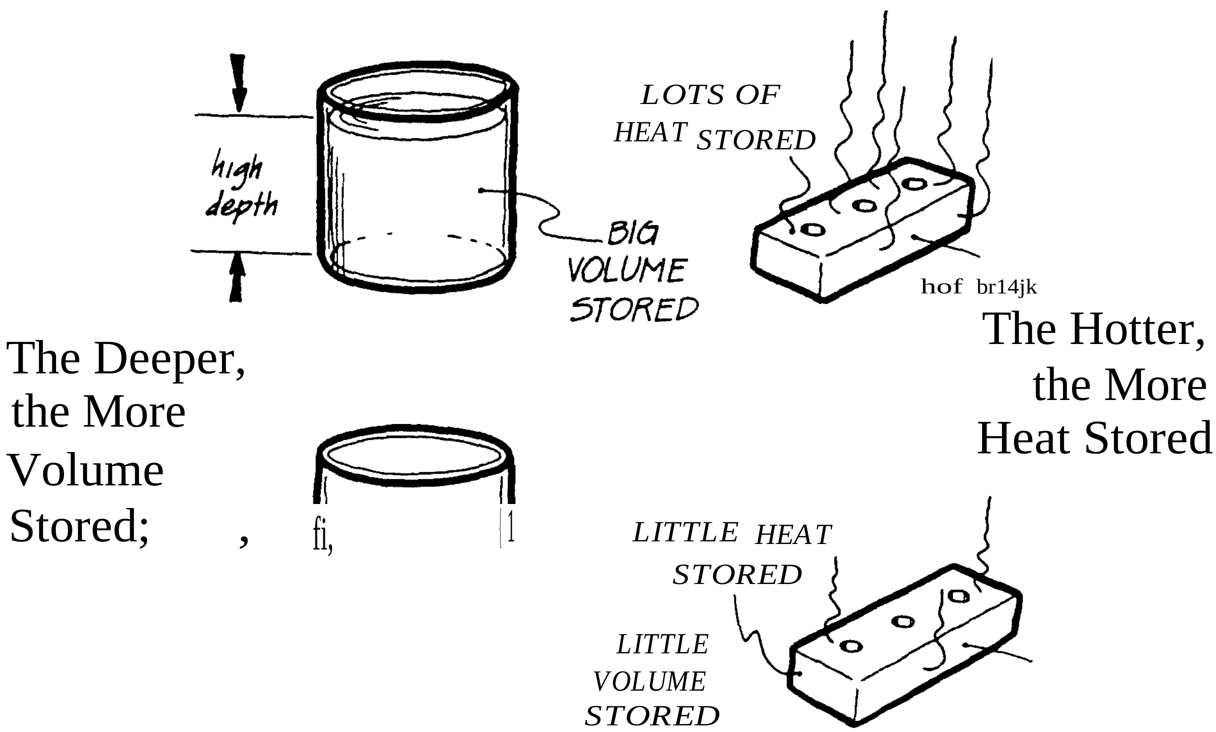
THERMAL STORAGE V

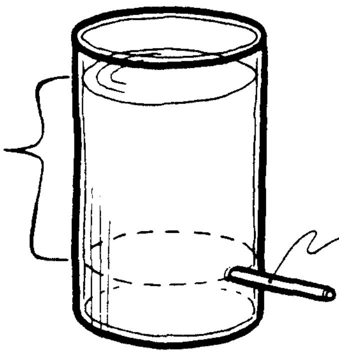
In solar energy heating systems, it's not enough to simply capture the sun's heat-it must also be stored. While heating a house during the day is useful, the house needs heat at night as well. Heat collected during the day must be stored until night. How is heat stored?

Storing heat is analogous to storing volume. If a cylindrical tank is filled with water, the amount that it holds-the volume stored-depends on how high its depth is. Similarly, the heat stored in a substance depends on how high its temperature is; a hot brick stores more heat than a warm one.



If a solar-heated house is to be kept at 70° F during the winter, heat stored at 50° F isn't useful. Only if the temperature of the storage material is above 70° F can the stored heat be used to warm the house. Thus, useful heat In terms of room heating is heat that is stored in a substance that is hotter than the room's temperature. By analogy, the useful water in a tank is the water stored above the outlet. Once the depth drops below the outlet, the remaining volume won't flow out, so it's not useful.

useful water



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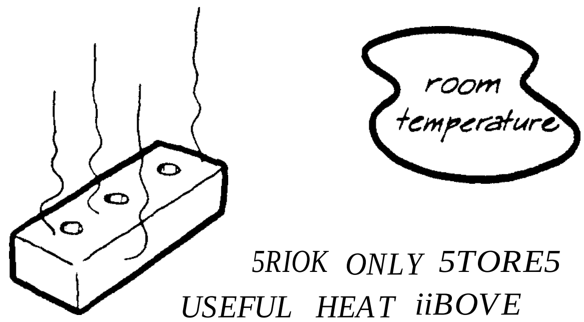
TANK ONLY STORES USEFUL VOLUME ABOVE OUTLET TAP



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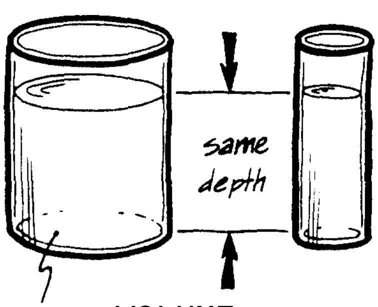
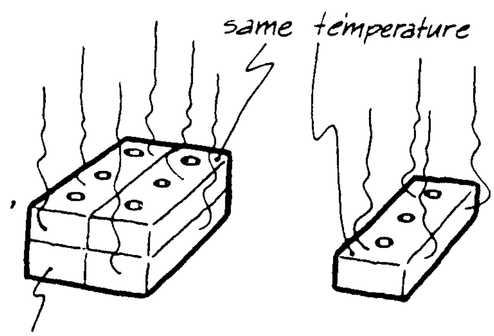
Not All Volume and Heat is Useful

The amount of heat stored also depends on how much material Is heated. The more storage material there is, the more heat can be stored at the same temperature above room temper ature. Similarly, a bigger tank holds more volume than a smaller tank when both are of the same depth.



MORE VOLUME STORED

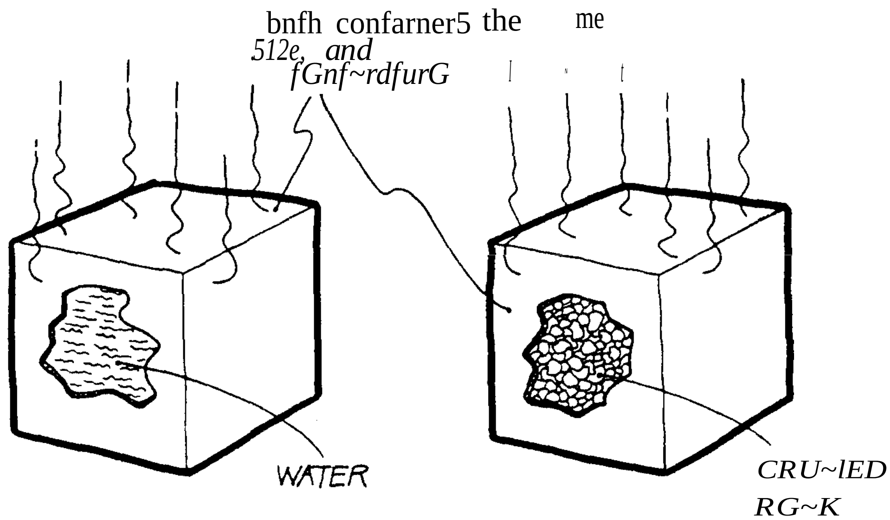


MORE HF11T STORED

Storage Depends on the Amount of Storage Material

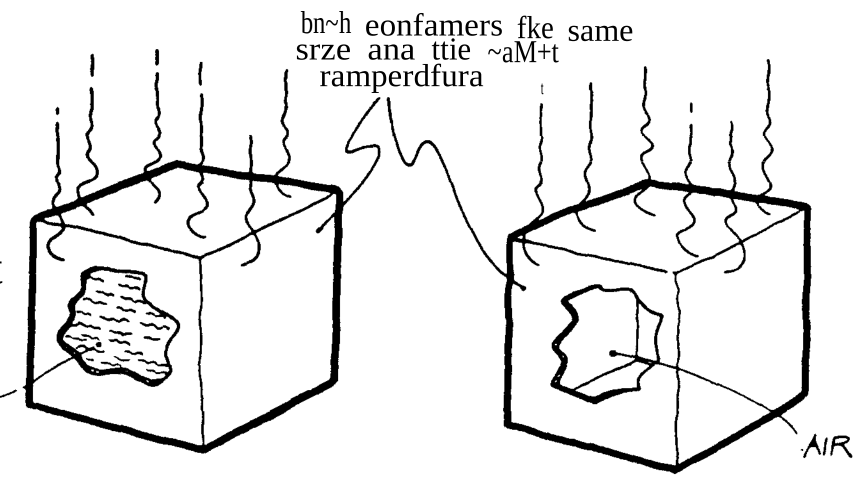
Often the amount of material Is measured by volume. Using volume as a basis of measurement, different materials can be compared as to how well they store heat. In solar heating systems, heat Is usually stored In water or crushed rock. Water stores heat somewhat better than does rock. A container of water can store two to three times the heat as the same-sized container filled with crushed rock.

Water Stores More Heat than Rock



Some materials store heat very poorly. Air, for example, stores almost no heat. A container of air stores one-thousandth the amount of heat as the same-sized container of water does.

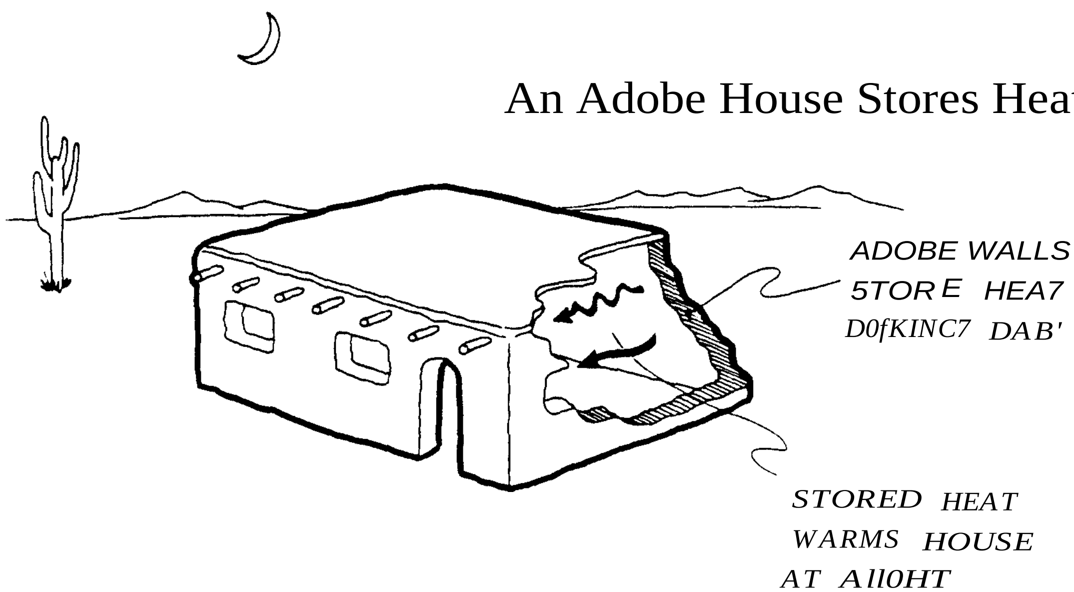
Water Stores Much More Heat than Air



WATER

To understand heat storage, consider the following example. When you turn off your furnace on a cold day, your house doesn't get cold Immediately because heat Is stored in the walls, the floor, and the furniture (very little Is stored in the air). The stored heat leaks out slowly and keeps you warm for a short time even when the furnace is off. Adobe houses In the Southwest have very thick walls that store the day's heat well i nto the night.

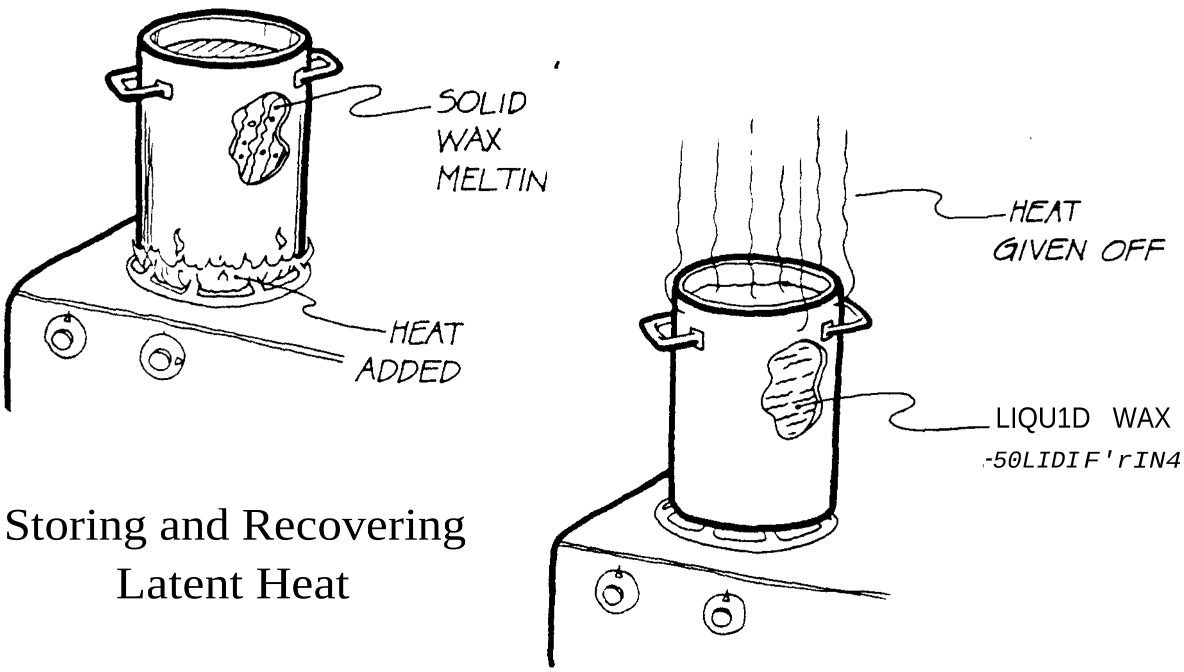
An Adobe House Stores Heat



Another form of heat storage is called latent heat storage. I nstead of storing heat simply by getting hotter, some materials store heat by melting. Ordinary wax is such a material. Let's take a piece of solid wax. As we heat it, it gets hotter as does any other material. But when it gets so hot that it begins to melt a curious thing happens: even though we continue to add heat to the wax, It doesn't get any hotter. All the heat goes into melting the wax, and it stays at nearly the same temperature until all the wax is melted. Melted dr liquid wax again acts like any other material-the more heat added, the hotter it gets.

When melted wax loses heat, Its temperature naturally drops. But when It begins to solidify again it stops getting cooler. As it solidifies, It gives back all the extra heat-the latent heat-that was put into it when it was melted. While the wax is solidifying, its temperature remains nearly constant. Once it has completely hardened, it once again behaves like any other material, dropping In temperature as it gives up heat.

Suppose we use wax to store heat. As the wax melts, heat will be stored. Later, if we want the stored heat, we'd let the wax solidify again, giving up Its latent heat. Materials like wax are called *phase change material* because they store heat by changing phase-that Is, by melting or solidifying.

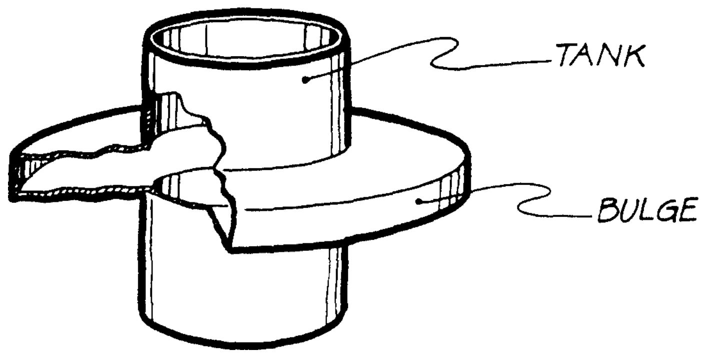


Storing and Recovering
Latent Heat

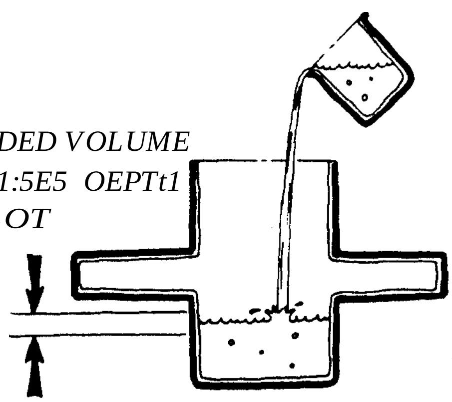
Why would you go to the trouble to use wax to store heat rather than water or crushed rocks? Because wax and other phase change materials can store a lot of heat. Wax can store several times the amount of heat of an equal volume of water and many times the heat of an equal volume of crushed rock. Wax itself is fairly expensive to use to store heat. Other phase change materials are cheaper and don't pose a fire hazard that wax might.

The water analogy to a phase change material is a tank that has a bulge in Its sides. When the water depth is below the bulge, adding volume only Increases the depth, as It would in any other tank. But when the depth reaches the bulge, a lot more volume is needed to raise the depth. Extra volume is stored in the bulge just as extra heat is stored in the wax when it melts. If the tank is drained the extra volume can be recovered, just as the latent heat in the wax can be recovered when it solidifies. When the water depth in a tank is at the level of the bulge, volume can be added or taken away without changing the depth much. Similarly, when wax is near its melting temperature, heat can be added or taken away without changing the wax's temperature much.

Tank with Bulge is Like Latent Heat Storage



DEPTH BELOW BULGE



Extra Volume is Stored in Bulge

DEPTH AT BULGE