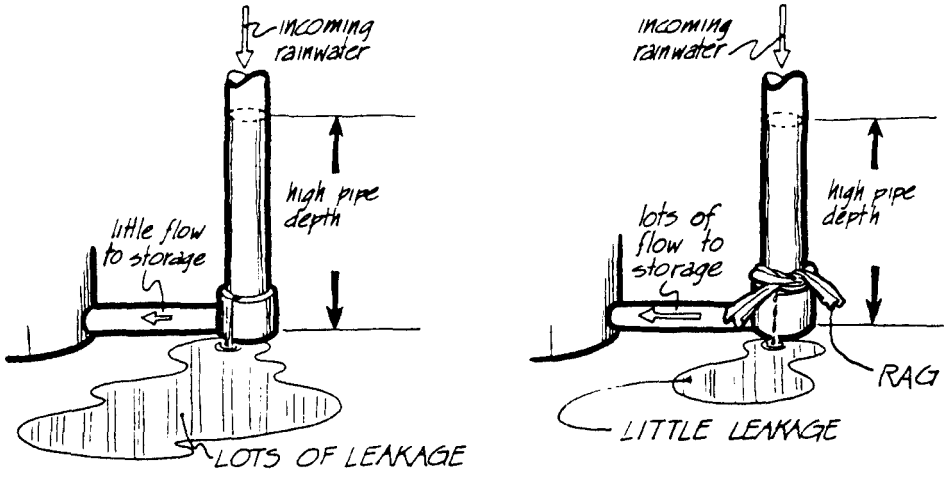
GLAZING AND SELECTIVE SURFACES 14

How do we get both high temperature and high efficiency from a solar heating system? We need high temperature (130° F) for house and hot-water heating, but we also want high efficiency so the system will be economical. If we were only gathering rainwater, it would be easy to see how to get higher efficiency: we would try to stop the leakage.

If we simply tied a rag tightly around the leaking pipe, it would be harder for the water to leak out. With less leakage efficiency is higher, since a greater fraction of the incoming rainwater flows into the storage tank.

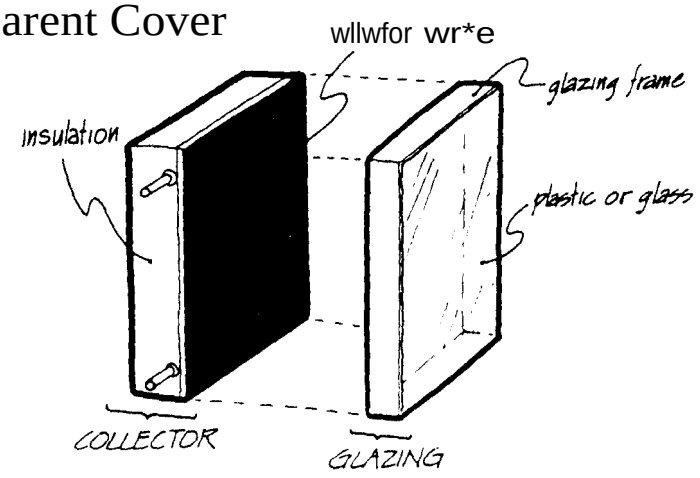
Rag Reduces Rainwater Leakage



Remember that the water depth in the pipe in the rainwater collector is equivalent to the collector temperature in a solar collector. High rainwater collection efficiency is equivalent to high solar collection efficiency. If we want high solar efficiency *and* hot collector temperatures, we'll have to stop heat from leaking from the collector; just as we would use a rag to stop rainwater from leaking out of the pipe.

Glazing is one way to reduce heat loss from a collector. Glazing is a transparent cover, usually made of glass or plastic. It is held a few inches from the collector surface by the glazing frame. Since solar radiation passes through glass or plastic, almost all of it is still absorbed by the black collector surface. But with glazing, heat can't escape as easily.

Glazing is a Transparent Cover Over the Collector

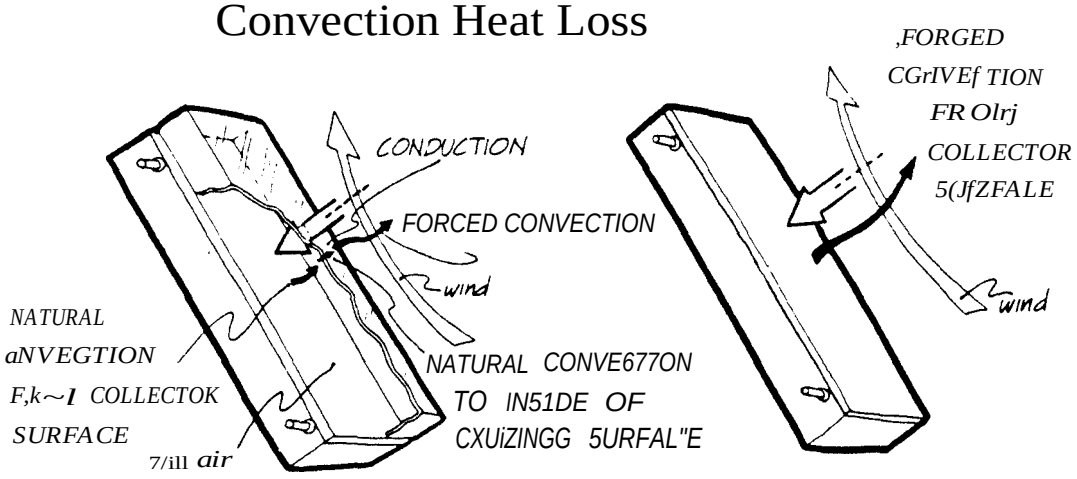


The biggest heat loss, by far, on an *unglazed* collector takes place by convection (although radiation losses can be one-fifth of the total). Convection losses are high mostly because the collector is exposed to the windy outdoors. As we have learned, when air blows over a surface, the surface loses heat easily. A collector on the roof of a house is seldom in still air.

Glazing prevents heat loss from the collector surface by isolating it from the wind. The air inside the glazing cover is "still" air; heat flows from the black surface by natural convection rather than by *forced* convection (the wind). First, some heat will leave the collector surface by means of natural convection; then it must flow into the inside surface of the glazing, again by natural convection. Next, conduction heat flow takes it through the glazing, and finally the wind blows it off the outer

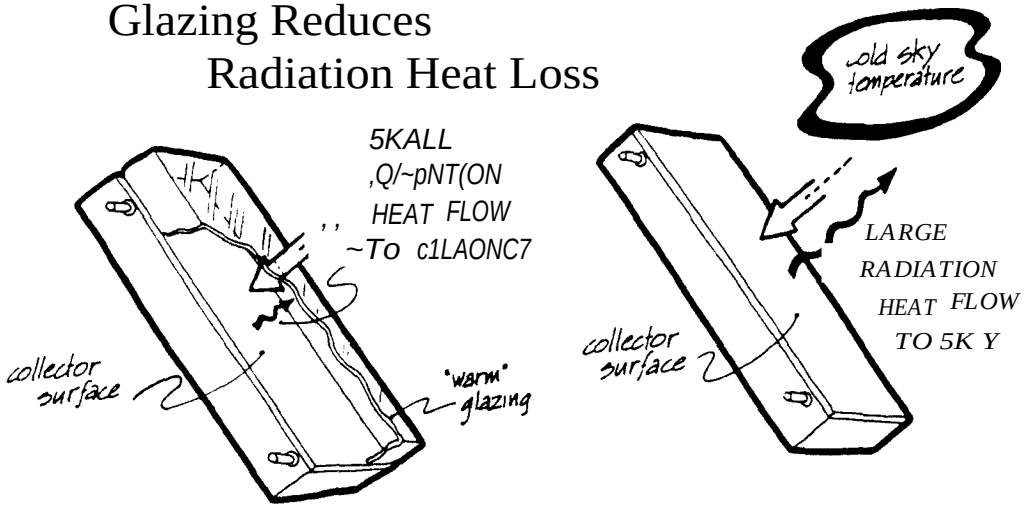
surface of the glazing by forced convection. You put pizza in a box for the same reason as a solar collector has glazing-the box prevents convection heat loss from the pizza.

Glazing Reduces Convection Heat Loss

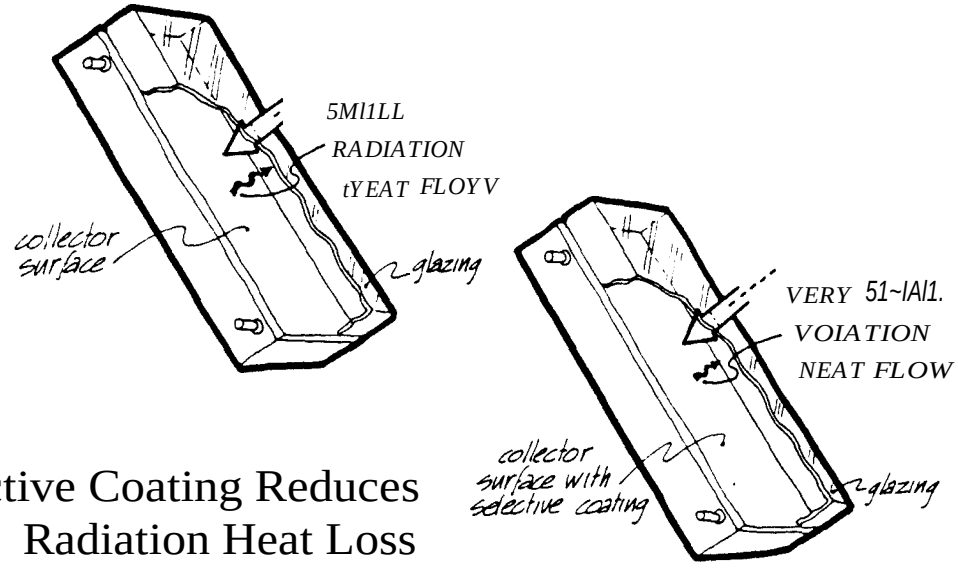


The glazing also reduces the amount of radiation heat flowing from the collector surface. Since radiation heat flow is mostly blocked by glass (and partially blocked by plastic), the radiation heat flow "sees" the inner surface of the glazing rather than the sky. The inner surface of the glazing is hotter than the "sky temperature," so radiation heat loss is less with the smaller temperature difference.

Glazing Reduces Radiation Heat Loss



Another way to prevent heat loss from a collector is to coat its surface with *a selective* coating. The coating absorbs the high-pitched solar radiation just as black paint does, but it prevents most of the low-pitched radiation heat flow from leaving the collector surface. These special coatings are called selective because they react differently to solar radiation than to radiation heat flow. Usually they're used with glazing. A bare unglazed collector loses only one-fifth of its heat by radiation, whereas four-fifths of its heat is lost by wind convection. A glazed collector, though, has very low convection heat loss, so the radiation portion of heat loss becomes a substantial part of the total--about half. By further reducing the radiation portion of the heat loss from a glazed collector with a selective surface, the total heat loss of a glazed collector can be cut down substantially.

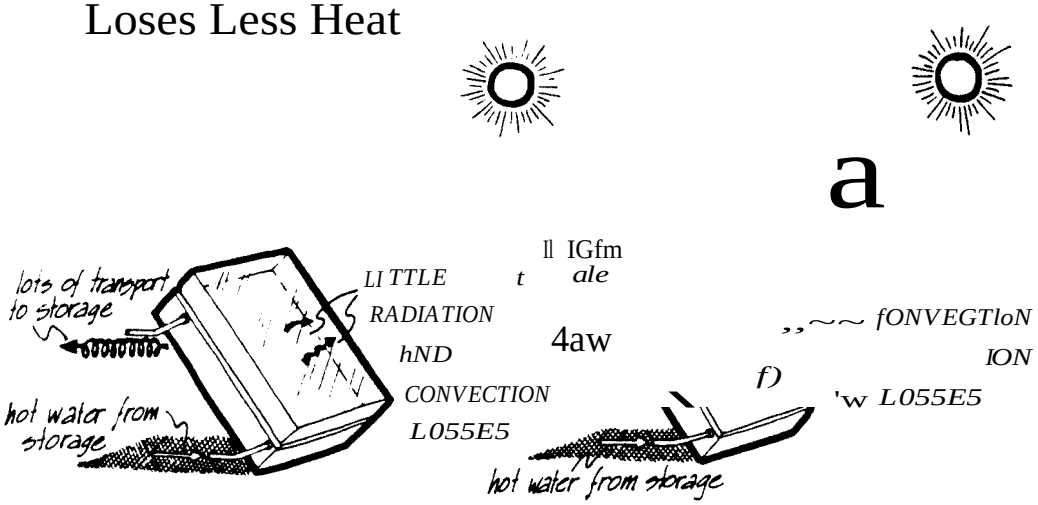


Selective Coating Reduces Radiation Heat Loss

The net effect pf glazing and selective coatings is that they allow solar radiation in but prevent heat losses from the collector, just as the rag prevents rainwater from leaking away from a pipe.

A collector with glazing delivers high temperatures at high efficiency-exactly what is needed for house heating and hot-water heating. A glazed collector loses less heat to the out doors than an unglazed one at the same temperature, just as the pipe with the rag leaks less rainwater than one without a rag at the same water depth.

Glazed Collector Loses Less Heat



Whether or not glazing is needed depends simply on the temperature required from the solar heater and the outside temperature at which it must operate. Solar house heaters and solar hot-water heaters must deliver high temperatures and usually operate in cold weather, and they are commonly glazed. Solar pool heaters don't need to deliver hot water and usually operate in mild weather, so they are commonly unglazed. However, pool heaters used In winter are often glazed, and hot-water heaters used in warm climates (parts of Israel, for instance) are often left unglazed.