**UNWISE DESIGN DECISION MADE AT THE OUTSET BY MOST MANUFACTURERS OF WATER- TYPE COLLECTORS, AND REASONS FOR BELIEVING H. E. THOMASON'S DECISION WAS A WISE ONE**

*Excerpt from Shurcliff, William A., "New inventions in low-cost solar heating--100 daring schemes tried and untried", pp. 100-105, Brick House Publishing Company, Andover, Mass., Copyright (C) 1979*

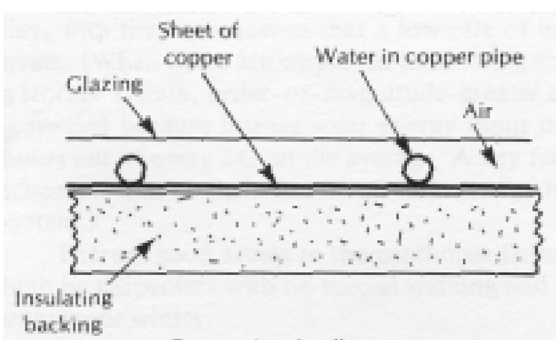
**SUMMARY**

In starting to design water-type collectors for use in solar heating systems in cold climates, most designers apparently have made the basic decision not to have a large area of water in contact with air . They decided, that is, that the water in the collector must be confined within pipes.

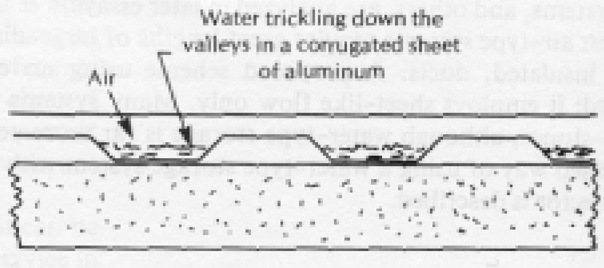
They reasoned, I suppose, that hot water exposed to air will evaporate rapidly, evaporation produces cooling, and cooling is just what you don't want in a solar heating system.

Was this decision wrong? Was it a serious economic handicap to the manufacturers involved? In many cases, yes. Here I marshal arguments in support of this dire thesis.

Harry E. Thomason made the opposite decision: in designing his trickling-water-type collector, he accepted having a large area of water in contact with air. Has that decision proved sound? I think so, and I give about 15 reasons for thinking so. Properly used, his collectors perform well; they avoid about a dozen complexities and pitfalls; and they cost, installed, only about 1/2 or 1/3 as much as typical, high-quality, conventional collectors.




Conventional collector: water is not in contact with air




Trickling-water-type collector:
water is in contact with air

**DETAILS**

Consider an inventor who is starting to design a water-type collector for use in cold regions. Although he knows that use of pipes in the collector can lead to many problems, *he makes the decision to use pipes.*

This decision--to incorporate many rigid pipes in the collector--starts him down a long and agonizing road. Difficulty after difficulty arises. Each is overcome but at a significant cost in complexity and money.

Here is a list of the difficulties. The list is long (unfairly long?) because I have tried, as a stimulating mental exercise, to ferret out *all* of the difficulties: major and minor, direct and indirect.

The piping had better be of copper. Aluminum might corrode in 10 or 15 years.

Extreme overpressure may sometimes occur and, accordingly, the wall thickness of the copper tube must be generous. Also overpressure-averting devices may be needed.

There will be a great many joints, or connection, because, for efficient energy collection, the pipes must be in parallel. There are many pipes, hence many joints.

The joints must be made with great care because high pressure may sometimes occur, certain coolants have great tendencies to leak, the panels are relatively inaccessible, and to make repairs is awkward.

A two-part absorber must be used: fins of aluminum (or very thin copper) and tubes of thick copper. Joining the parts is difficult; close thermal bond is needed; yet differential thermal expansion may pose a threat.

To keep the number of pipes from becoming fantastically large, the designer must place the pipes fairly far apart. Heat within the fin may have to flow as much as lor 2 inches in order to reach a pipe. This slightly reduces collection efficiency.

Dirt may clog a pipe during assembly or later and may halt the flow of coolant in this pipe. If a pipe does become clogged, this fact may escape notice for months or years. Meanwhile the performance of the collector suffers. To unclog a pipe may be difficult.

The risk of freeze-up and rupture of pipes is great and must be avoided by one of these procedures:

Use drain down. But this presents problems:

Inlet of air (or nitrogen) must be arranged.
Drain-down could be defeated by airlock in a pipe.
It could be defeated if a pipe is clogged with dirt.
Filling a pipe with air can sometimes aggravate corrosion problems.
If some defect in the control system or hydraulic system were to prevent drain-down, serious freeze-up might occur.

Use ethylene glycol. But this presents problems:

The material is poisonous. Special precautions must be taken to make sure it never gets into the main water sup- ply system.
It is extremely prone to leak.
It degrades chemically if kept at high temperature for a long period; occasional testing, or complete replacement, is needed:
It has lower specific heat than water .
It is expensive. If, accidentally, it all leaks onto the ground, the owner must buy a new quantity.
If it somehow becomes diluted with much water, freeze- up can occur .

Use silicone oil. But this presents problems:

It has such high viscosity that the designer may feel compelled to order pipes, fittings, and pumps of extra-large size.
Its specific heat is only about half that of water. Thus faster flow rate (and more pumping power) is needed.
Its surface tension is so low that it may leak unless all joints are extremely tight.
Its cost is high--about $2 per pound or $16 per gallon.

Corrosion risk can exist unless silicone oil is used as coolant. Stagnation temperatures in summer could cause damage. If the coolant is water, the water might boil and cause rupture. If the coolant is ethylene glycol and water, the ethylene glycol may deteriorate chemically; also boiling might occur.

Because the absorber assembly must be made of expensive materials and must be assembled with great care, it had better be made in a high-technology factory. This entails:

Paying enough to cover the manufacturer's profit, the distributor's profit, etc.
Shipping the equipment many hundreds of miles, in a special truck,

say.

Crating may be required in some instances.

The panels must be of small size in order that they may be applicable to large buildings or small buildings.

Therefore the weight of the frame relative to the weight of the panel proper is large; and a similar argument applies to the *cost* of the frame- it too is relatively high.

The panel may be too heavy for convenient lifting. Special hoists may be needed, especially when mounting the panel on a high steep roof.

When the panels are installed on such a roof, many connections must be made and must be made very reliably.

Therefore experts may be needed to make the connections, e.g. , high-salaried workers whose home base is far away.

The installation expense may amount to a considerable fraction of the cost of the panels themselves.

Because the panels are small in area and there must be many of them, the total linear amount of panel edge, or framing that must be carefully sealed is very great. At 20 ft. per typical 7 ft. x 3-ft. panel, the total amount of panel edge for a typical installation may be 500 ft. Aside from the weight and cost of so much edge or frame, the sheer task of insuring tightness of seal (of glazing, of insulating backing, etc.) along such an amount of edge is a formidable one.

Because the panels are mass produced in a factory, the tempta- tion to use metal framing is irresistible. But metal is expensive. Also it is a thermal conductor and must be insulated.

In some instances the designer feels obliged to use:

pH control equipment
flow meter
surge tank
air separator
check valve
weep holes in collector panels, to avoid pressure build-up from condensate

If the reader thinks these arguments are overdone, let him read:

*The Solar Decision Book* by Montgomery and Budkin (Dow Corning Corp., 1978, $10). The authors stress repeatedly the need to use highest-quality, high-performance components and the most durable materials; otherwise, various serious troubles may arise within a few years.

Some Steps to Solving Solar System Problems", by H. Orlow- ski, *Solar Engineering,* July 1978, p. 31-34. Scores of pitfalls are indicated.

No wonder conventional systems intended to last 20 years are so very expensive. As a corollary , no wonder the public shies away.

Note: Although the glazing of conventional collector panels is impervious to water, and although the edges are well sealed, the glazing performs one less task than it could perform- besides confining warm air and trapping 4-to-40-micron radiation, it could be used to confine water or water vapor . But it is not. A wholly separate system, involving an enormous number of pipes and joints, is used for this purpose.

**THOMASON MADE THE OPPOSITE DECISION**

About 20 years ago Harry E. Thomason made the opposite decision-he decided that it *is* permissible to have a large area of water in contact with air .
As nearly everyone now knows, Thomason employs a corrugated black sheet of aluminum and arranges for water to trickle down the valleys of this sheet. He relies on a sheet of glass, situated about 1/2 in. above the trickling water, to trap or confine the high- humidity air that is immediately above the water. At the start of a sunny day, a pump starts the flow of water to the feeder pipe along the upper edge of the collector: water starts trickling, solar radiation warms the black aluminum and the water, some water evaporates, and the confined air soon becomes almost 100 % humid, i.e., becomes practically saturated with water vapor. Throughout the rest of the day there is practically no change in the humidity; some water evaporates and an equal amount condenses. Some of it condenses on the glazing, warming it, and the glazing in turn loses energy to the surrounding air. This is one of the overall heat-losses of the system. But if the collector is used properly, i.e., in conjunction with a storage system and heat distribution system designed to perform well even when the storage system is at only about 90 or 100 or 110°F, collection proceeds (on not-very-cold days) with an efficiency of about 35 to 65%, according to my interpretation of a very recent report by J. Taylor Beard' 'Engineering Analysis and Testing of Water-Trickle Solar Collector," Final Report, Report ORO/4927-78/1, from University of Virginia.

SOME ADVANT AGES OF THIS SYSTEM

The collector proper includes no pipes, except one distribution pipe along the upper edge.

It includes practically no copper .

No high pressure can be built up; nothing has to be sturdy enough to resist high pressure.

No seals are subjected to any appreciable pressure.

No special drain-down procedure is needed. Just turn off the water-pump.

Air-lock cannot occur .

No antifreeze is needed-no ethylene glycol, no silicone oil, no pH control.

No heat within the corrugated aluminum sheet has to flow more than 3/4 inch in order to reach the trickling water. Nearly half of the black surface areas is *directly* in contact with this water.

The wetted surface can be inspected at any time. It could be repainted, should this ever be necessary.

If any valley became clogged by dirt, this fact would be readily apparent.

If a valley became clogged, the trickling water could readily detour around it.

A single-part absorber suffices-a single sheet of black corrugated aluminum.

Because sheets are available in lengths up to 36 ft., a single sheet can extend the entire way from peak of roof to gutter at bottom. Sheets are easily cut to length.

Even a very long sheet is so light that one man can lift it.

Use of wood frame members is permissible. Wood is a thermal insulator.

No horizontal frame members are needed, except at the very top and bottom of the entire system.

The collector can be built by persons with only moderate skill, assuming that proper instructions have been received and a licence has been obtained.

The glazing does triple duty-it excludes rain, snow, leaves, dirt, etc.; it confines moist warm air; it confines 4-to-40-micron radiation--that is, it performs *all* of the confinement tasks.

No heat exchanger is needed.

No flow meter, no surge tank, no air separator, no check valve, and no weep holes are needed.

If, by chance, some coolant escapes and is lost, the financial penalty is negligible. Water is practically free.

The amount of initial testing needed is very small.

**DISCUSSION**

This general analysis is not entirely fair. In some situations, especially where high storage temperature is necessary and outdoor temperature is very low, use of conventional collectors employing hundreds of pipes or other relatively costly collectors may be highly appropriate. Also, some designers of systems employing many pipes have found ways of avoiding some of the difficulties listed above.

Yet is it not true that, once the designer has elected to use scores of rigid pipes, a long parade of technical problems arises? Is it not true that trickling water systems avoid most of these problems? Has not the low cost and long life of such systems been clearly demonstrated?

If so, was not the initial decision by most designers--that large interface areas between water and air must not be permitted--unwise? Has not that decision often jeopardized their chances of producing a system that is reliable, durable, and inexpensive?

End of Excerpt.