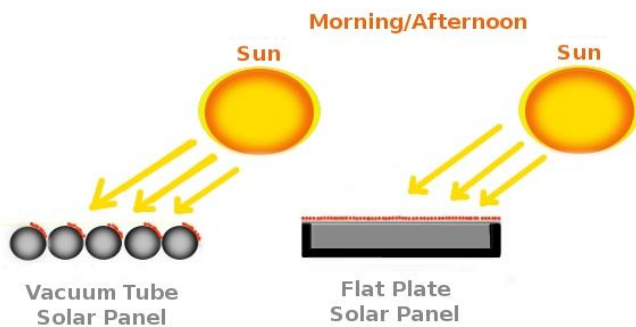
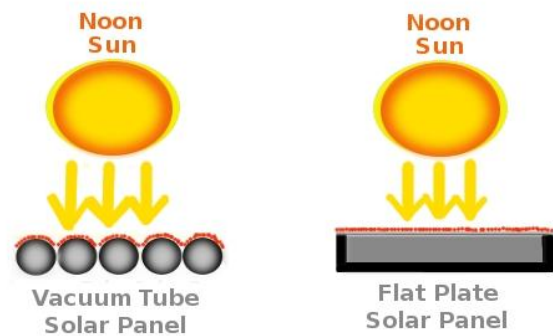


Vacuum Flasks

More efficient than figures at first suggest

Most flatplates and some vacuum tube systems show efficiencies of around 80%, but when you look at the EN certificates for most popular Chinese vacuum flask systems, they are often in the mid 60s or less. Many people assume that this reflects poor quality Chinese manufacture, but in fact it is a quirk in how we measure “zero loss efficiency” which is at noon, and ignores the effect of the sun facing tubes at different angles at different times of the day. This factor is included in test results, described as Transversal Incidence Angle Modifier, or IAM. However, it is often ignored or not understood.

The efficiency of a panel is usually given for noon when the sun is directly facing the panel. With a flatplate panel, efficiency falls off either side of noon, but with vacuum flasks, the efficiency actually *increases*. There are two reasons for this;

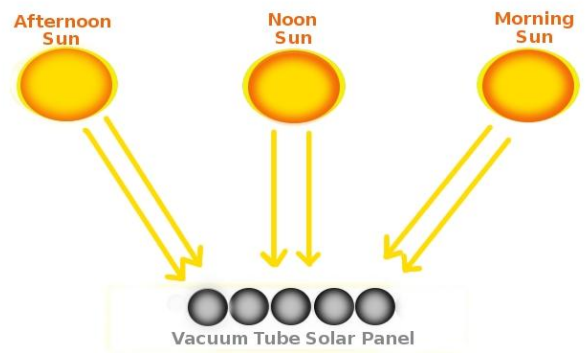


Firstly, the curved surface of a tube passively tracks the sun.

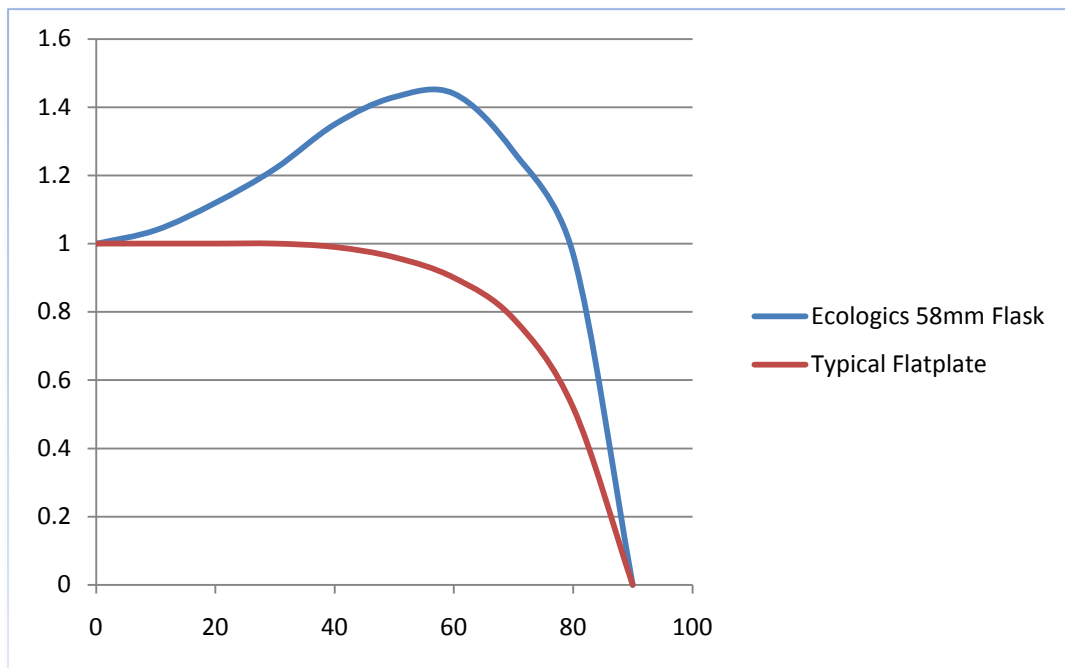
Secondly, whereas at noon, the sun shines between tubes, as the sun moves towards 40 degrees off due south, there is increased reflection from tube to tube, dramatically increasing absorption.



The effect of this change in incidence angle modifier is measured as part of the test procedure for EN12975 certification. To show efficiency at any particular time of the day, the zero loss efficiency should be multiplied by the IAM.



The following chart shows a comparison between the IAM of a typical flatplate system and a 58mm flask system at different angles as the sun moves from Noon to evening. A mirror image of this graph happens between sunrise and noon.



At its most extreme point, with the sun at an angle of 60 degrees, the output of a flatplate would be reduced by 10%, whereas the flask system's efficiency is *increased* by 44%.

The difference between Flasks and Tubes

Chinese vacuum flasks are like a thermos flask with two layers of glass and a vacuum between these layers. There are many advantages to this;

- The vacuum element is a single piece of glass, whereas many other vacuum systems have a single layer of glass with a join between the copper heat pipe and the glass

forming a seal to maintain the vacuum. With extreme temperatures, especially in stagnation, this seal can fail.

- Flasks are modular. When they lose their vacuum (typically expected after 15 - 20 years) only the flask itself need be replaced. Tubes require the replacement of tube, heat pipe and collector as a single unit.
- Replacement flasks are in common sizes of 47mm and 58mm diameter, produced in numerous plants in China, so you are not reliant on one supplier for spare parts. By comparison, most tube systems are not interchangeable.
- Replacement flasks are typically about €5 each, whereas replacement tubes are considerably more expensive.
- Chinese flask systems may be more sustainable than either tube or flatplates. Flatplate panels usually have a life expectancy of about 35 years after which the entire panel needs to be replaced with enormous disruption. An aluminium or stainless steel manifold on a vacuum tube system should last as long as the roof, with just a requirement to exchange flasks every fifteen to twenty years. This also dramatically reduces the embodied energy of the components required to maintain the solar water heating system over the lifetime of the house.

For these and other reasons, Chinese flasks have been widely adopted, and many (but not all) are of excellent quality and durability.

BER Assessments

A problem arises when you try to use the figures for vacuum flask systems in DEAP for BER assessments and Part L compliance. Commercial solar simulation software takes the IAM figures into account, but despite requests to SEI going back almost two years, there is still no way to incorporate IAM in DEAP.

Modern houses with their improved energy efficiency could benefit more from vacuum systems because the central heating is operating for a shorter season, and vacuum systems have a longer operating season which complements this nicely.

You might think that you could simply take the ratio between the two IAMs as a multiplier. The reality is more complicated because the multiplier should reflect the amount of time that the sun spends at each angle, and efficiency will also change as fluid temperature and ambient temperature changes throughout the day. You also get different effects depending on the roof pitch and annual solar insolation.

We ran identical panels through simulation software with each of the IAM curves shown in the graph, using various roof pitches and locations in Ireland. These showed a nett increase in output of between 16% and 19% as a result of the altered IAM. It would be reasonable to suggest that until there has been a software change in DEAP, we could apply a 17.5% increase to the figures entered for this particular panel.

Not all vacuum flask systems have the same IAM curve, and you would need to develop a figure which could be used as a constant by which you might multiply the IAM at a given angle, say 50% (which is quoted on all EN certs).

In the example shown above, at 50 degrees the IAM of 43% gives a total increase in efficiency of 18%, it would be reasonable to suggest that the IAM at 50 degrees could be multiplied by $0.18/0.43$ (or 0.442) as a constant.

Thus, if you have an IAM at 50 degrees of 1.25, you would multiply the output by $1 + (0.44 \times 0.25)$

In the case of the example shown in the graph above, the multiplier would bring the zero loss efficiency from 66% to 78.4%. When you take into account the true efficiency, combined with the improved heat loss coefficient of vacuum systems, it becomes apparent that vacuum flasks systems are extremely efficient at all times, often at a lower capital cost, and with lower long-term maintenance costs.

IAM for tubes with an enclosed flatplate

Lastly, it should be stated that this situation does not apply to vacuum tube systems which have a small flatplate inside a single glass tube. Their IAM more closely resembles that of a flatplate panel.