14 April 2009

Flat plate versus Evacuated tube solar collectors – by Riaan Honeyborne.

As with many products on the market one can find considerable contradicting articles with regards to different types of solar collectors. The two main types being the Glazed flat plate (commonly referred to as only Flat plate) and the evacuated tube heat pipe solar collector.

Through the years we have heard many "sales pitch" stories like "Evacuated tube collectors are too efficient" and "Flat plate collectors don't work". Even test reports from reputable solar test facilities do not always give a clear picture. Reputable test reports give the incident angle modifier but few know how to translate that to the actual efficiency of the collector in a real life scenario.

Another problem with test facility results is that the tests are done using ideal conditions. It does not take into account bad installation practices often encountered. We have seen all too many installations with problems in the area of collectors not facing the correct heading, tilt angle, pipe insulation, anti-siphoning loops, non return valves etc. Many of these errors will simply reduce the overall efficiency irrespective of the type of collector, but reverse siphoning will for instance have a much worse effect on a Flat plate system, through actually cooling the geyser overnight.

We have therefore set out to do an unbiased comparative test of our ITS 58/1800 series evacuated tube collector and our ITS-FPC series flat plate collector. The collectors selected occupy the same aperture area on the roof, and were placed alongside each other on a 20° pitched tiled roof – See Fig 1. Inside the roof are two identical direct circulation 100 litre pumped systems with a ITS-CtrlPro3050 controller managing both and logging the data. A Apogee SP-110 precision Pyranometer was used to measure the solar radiation levels, but these have not been calibrated to give absolute values, but are displayed as a scaled value for reference only.

Figure 1: Solar collector placement.

Measurement results are presented for a sunny and a cloudy rainy day, both taken in summer.

The collectors used in these test are:

Model	ITS-58/1800-12	ITS-FPC20
Type	Evacuated tube heatpipe	Glazed flat plate
Spec sheet	www.its-solar.com/downloads/	www.its-solar.com/downloads/
Recommended retail price	R 3368 excl VAT	R2875 excl VAT

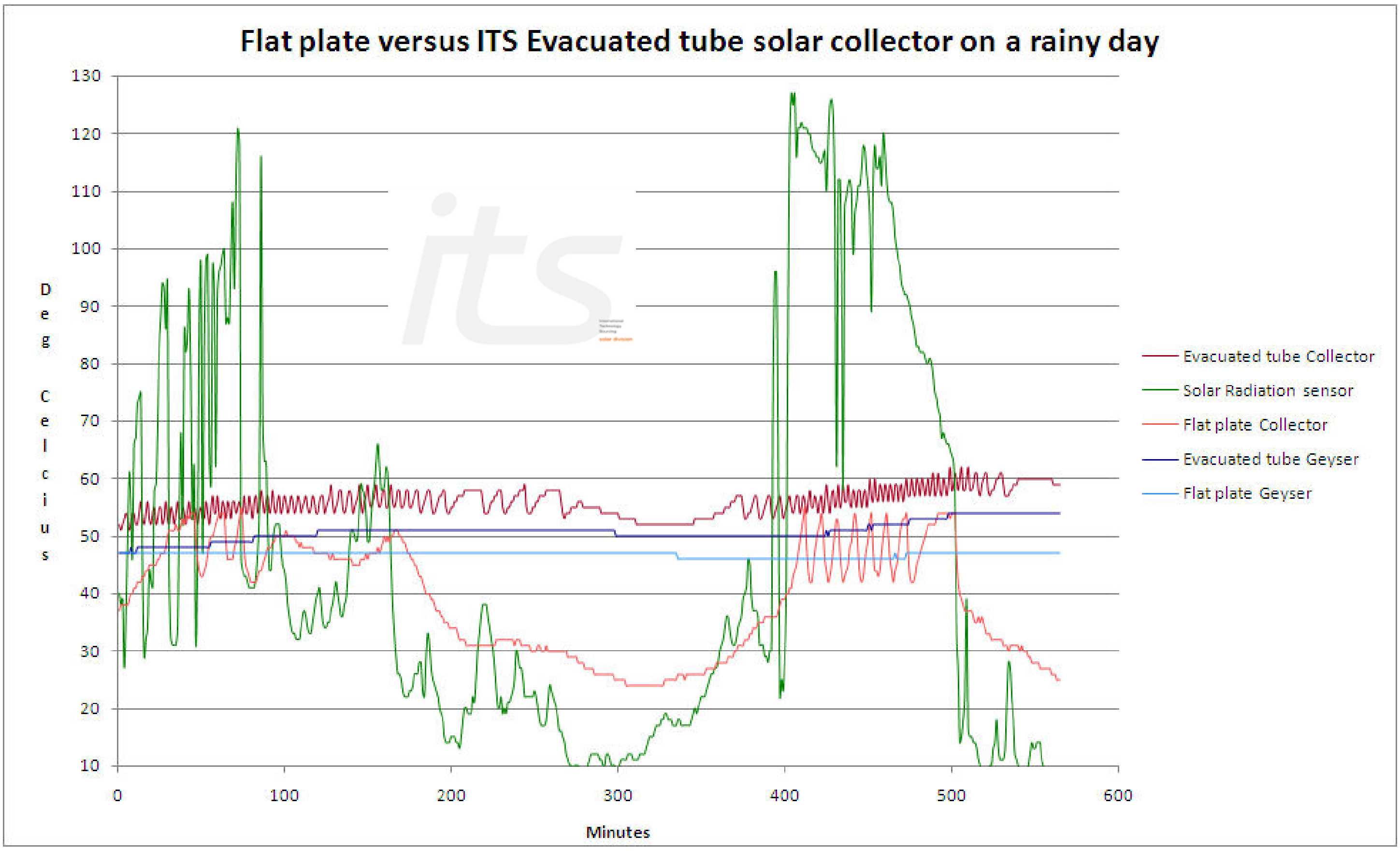

Figure 2: Rainy day – very low and fluctuating solar radiation levels.

Fig 2 observations: Even in extremely low radiation levels the evacuated tube collector still managed to compensate for the geyser standing losses and contribute sufficient energy to increase the geyser temperature by 7°C while the flat plate collector only managed to compensate for the geyser standing losses but made no further contribution. So the evacuated tube collector produced roughly 830W/h more than the flat plate on this day. Please also note that this measurement was done on a rainy day in summer so the radiation levels are low but the ambient temperature was relatively high (22°C). In winter the flat plate collector would be even more sensitive to the ambient temperature. It can also be seen that the flat plate collector itself cools down during overcast and rainy periods whereas the evacuated tube collector continues to deliver energy.

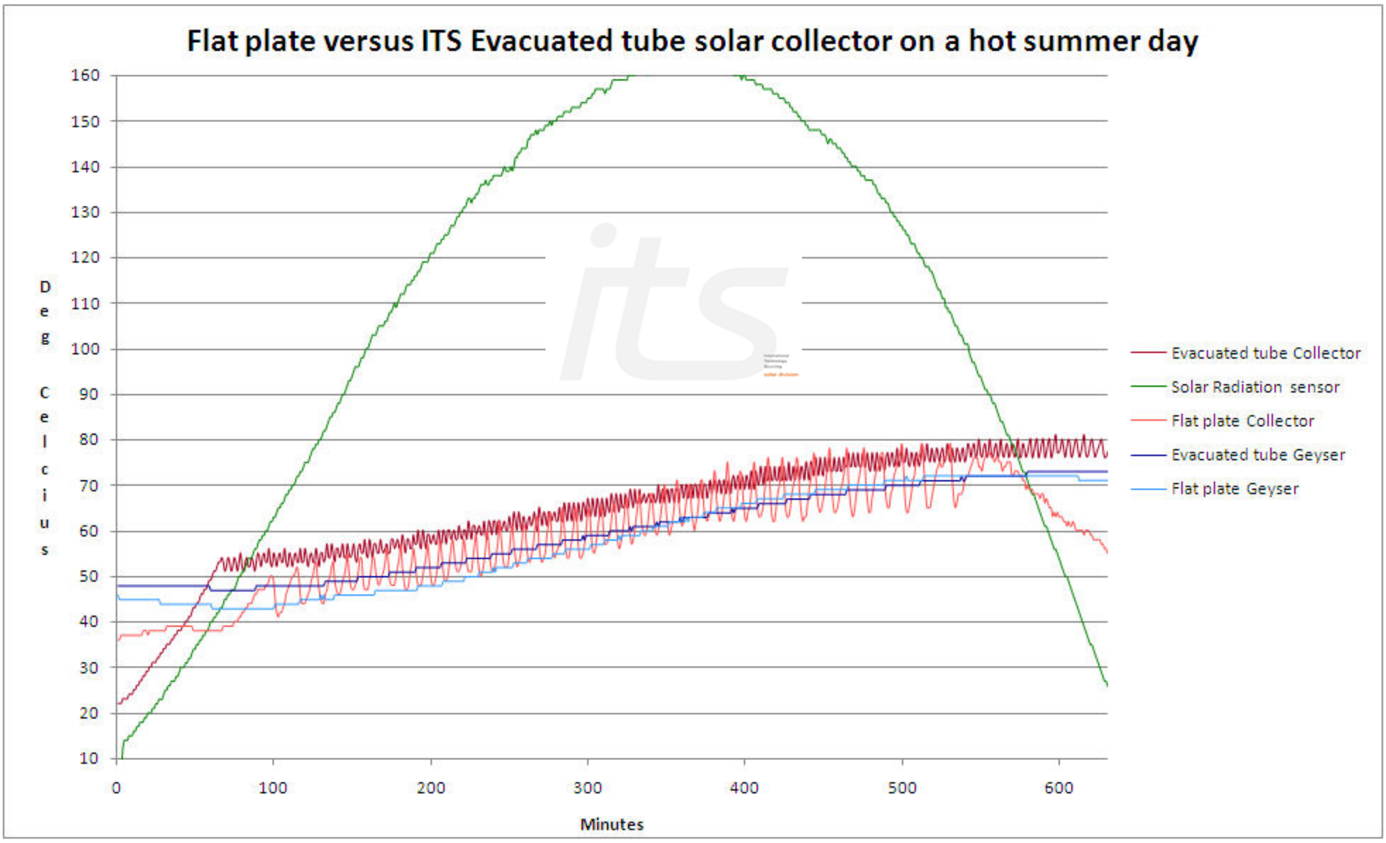

Figure 3: Hot summers day – high peak solar radiation levels.

Fig 3 observations: As it was a warm summers day with a relatively high ambient temperature the thermal insulation of the evacuated tube collector does not give as large a difference as before. Further, due to the spacing between the evacuated tubes the actual aperture area of the evacuated tube collector is less than than the aperture area of the flat plate collector. This can clearly be seen by the slope of the flat plate collector geyser temperature. The much larger aperture area causes the mid day performace of the flat plate to perform better than that of the evacuated tube collector. However, even though the much larger aperture area of the flat plate collector should cause it to be much more efficient than the evacuated tube collector, the passive tracking charactaristic of the evacuated tube collector ensures that it starts heating earlier and continues much later. Therefore the evac tube collector effectively has a “longer” solar day. So on a hot summers day the evacuated tube collect added 26°C to the geyser and the flat plate collector added 27°C.

Conclusion:

Using these “real life” measurements above it can be seen that if this flat plate collector would be installed in an area that is relatively warm and is sunny most of the year it would perform very well. If however the area experiences rain and cloud cover, even for only a few weeks per year, the evacuated tube collector would perform better.

Notes: These measurement where done in the Western Cape, South-Africa. If the tests were done in a frost prone area (Gauteng) the flat plate would need to be connected to an indirect system with antifreeze to avoid the pipes bursting when frozen. Heat exchangers used in indirect systems reduce the system efficiency by at least 10%. The evacuated tube collector on the other hand is not prone to freezing and can therefore be kept in the direct circulation configuration ensuring higher efficiency and lower cost. Therefore in a frost area the evacuated tube system will perform better.

After these test we replaced the evacuated tube collector with a flat plate from another manufacturer. The ITS-FPC20 outperformed the other flat plate by about 2 deg C per day. Both these flat plates are fairly high quality compared to what is available on the market.