Container Test

SolarVenti Danmark

SolarVenti®

Luftsolfangere & Hybrid solfangere

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1. Introduction

The ship containers can be used for different purpose. One of these purposes is use a container as storage. The problem is that these containers do not have much insulation and some materials stored get damage by an excess of moisture (mould).

SolarVenti has a long history developing products (solar collectors) which help to avoid the indoor mould. These solar collectors have been already showed a great performance in different places like summer houses, garages, public places...even boats.

Figure 1. Boat with a SV collector (SolarVenti.UK)

Now, one of these collectors (SolarVenti) could be installed in a ship container avoiding the indoor mould.

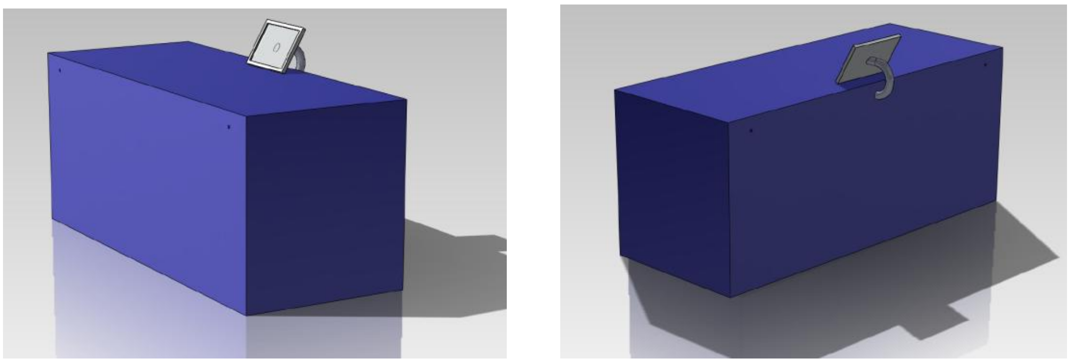
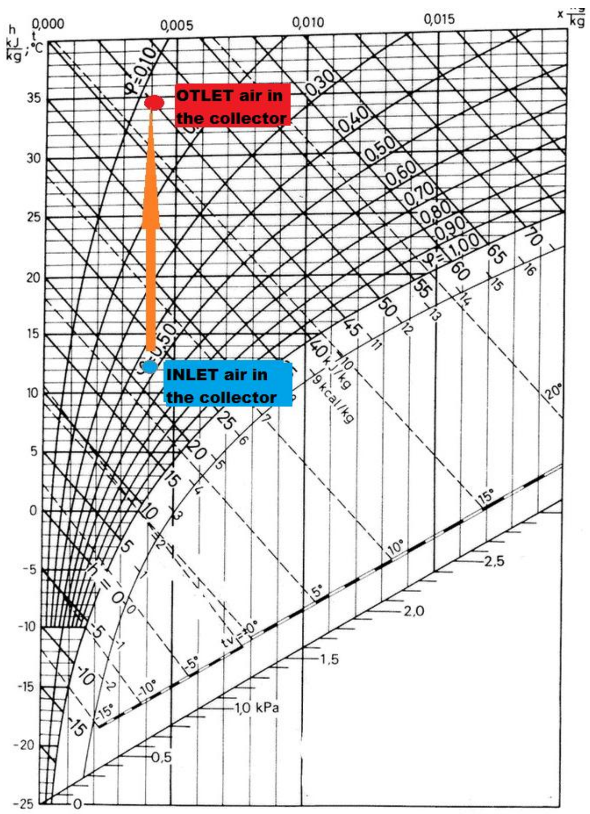


Figure 2. Model of the container with SolarVenti



The energy absorbed by the collector is blow inside the container as hot air. This hot air has less relative humidity than the ambient air. That produces the "*dry power effect*".

Figure 3. Mollier air diagram for a SV14 collector

Dry power effect: The air passing by the solar collector (SV14) decreases its relative humidity from 50% to almost 10%.

**data from FRAUNHOFER Institute, Germany*

2. Description of the tests

Several tests were carried out in order to find out the advantages of a container with SolarVenti solar collector. In these test, two ship containers 22G1 were used. For more information about these containers see link below.
http://www.baseventuresshipping.com/index.php?option=com_content&view=article&id=158&Itemid=113

One of the containers has been connected with a solar collector as the *Figure 2* shows. The other one haven't been modified acting as the container for control.

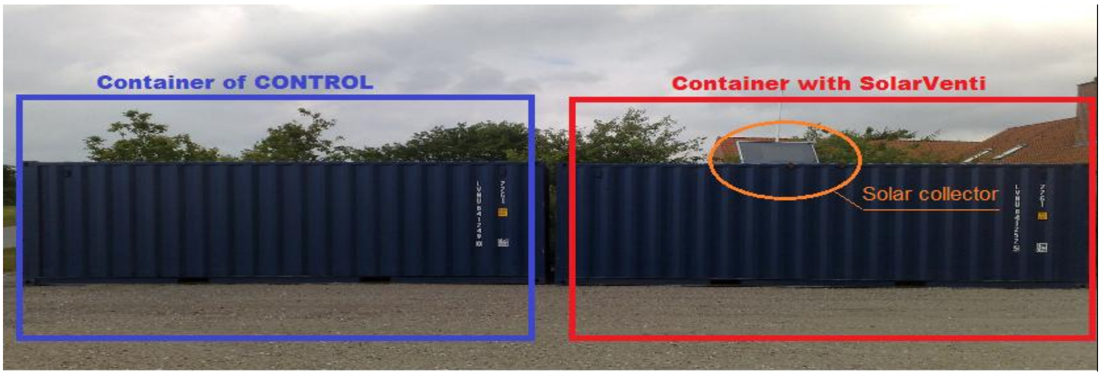


Figure 4. Containers for testing

Beside the solar collector, both containers have the same characteristics. They were fill with the same amount of wood pallet (12 dry wood pallets of 15Kg each) in order to simulate some mass inertia (ex. furniture that could be stored inside the tank).

Figure 5. LEFT: control container CENTER/RIGTH: container with SolarVenti system

2.1. Stress test

After the containers were tested in normal conditions, they were exposed to a stress test. Before start this last test both containers were opened and the solar collector was disconnected for a few days for equalizing the initial conditions inside the containers.

In this test both containers were exposed to a higher level of humidity. Besides the previous elements, now each container has a bucket full of water (31, 5 liters) and some wet cardboard (90 cardboard plates with 3 liter of water). The wood pallets were not modified.

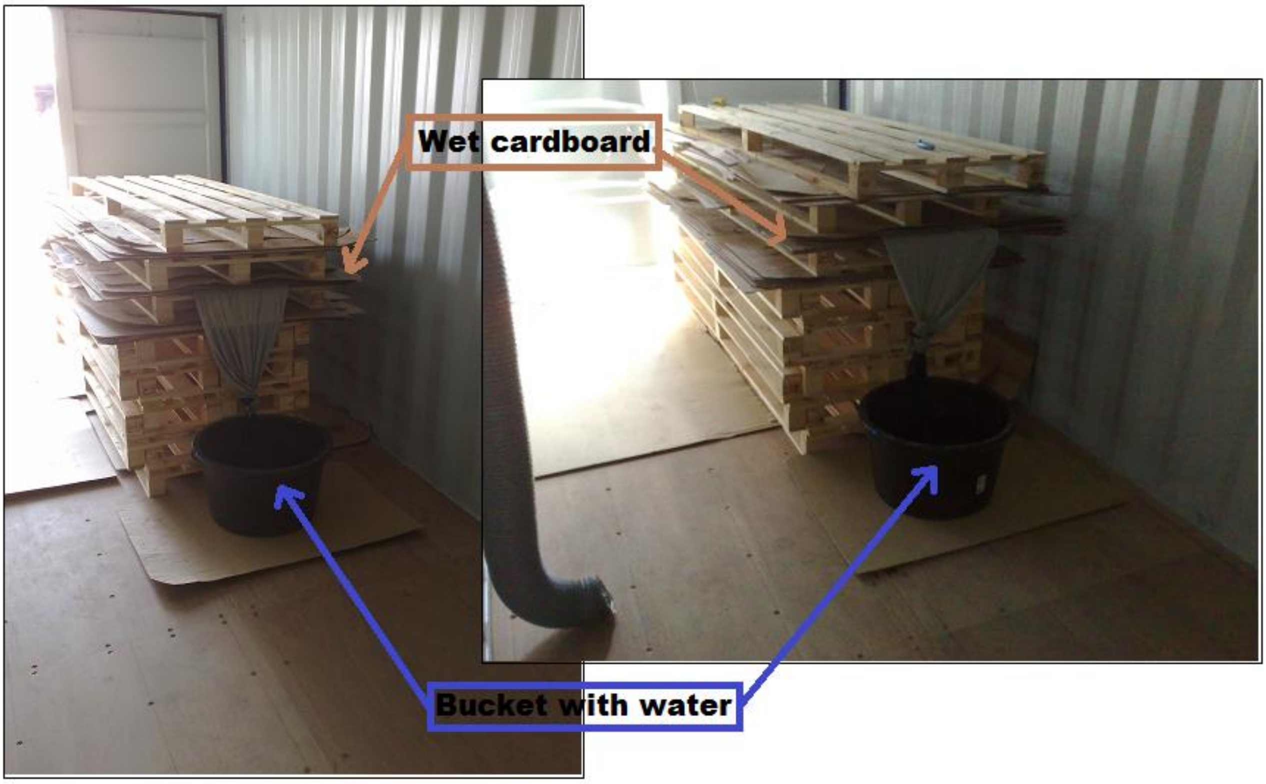


Figure 6: Elements for the STRESS TEST *LEFT: Control container* *RIGTH: SV container*

3. Metodology

There were placed two sensors by container, one on the pallets (half -height) and another on the floor /air_inlet (low-height).

Here we can see a sketch of the containers.

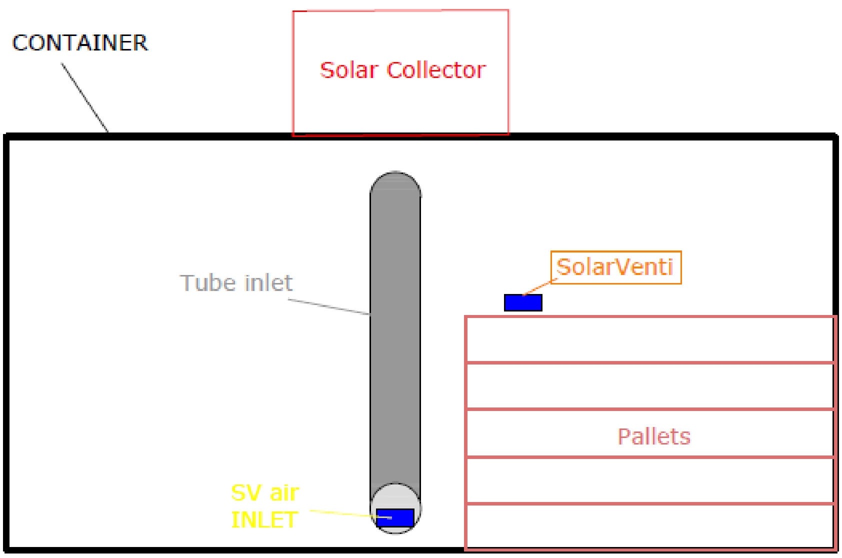


Figure 7. Container WITH SV collector

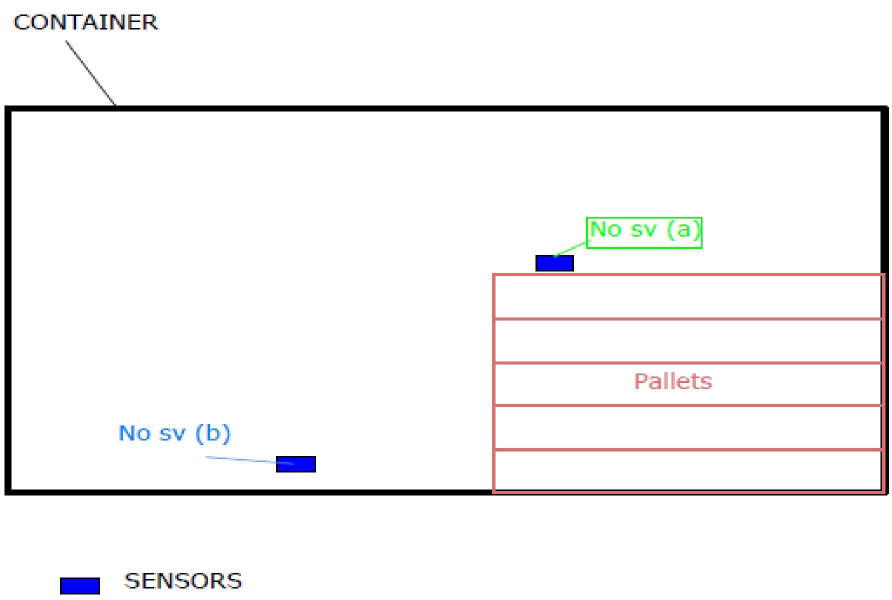


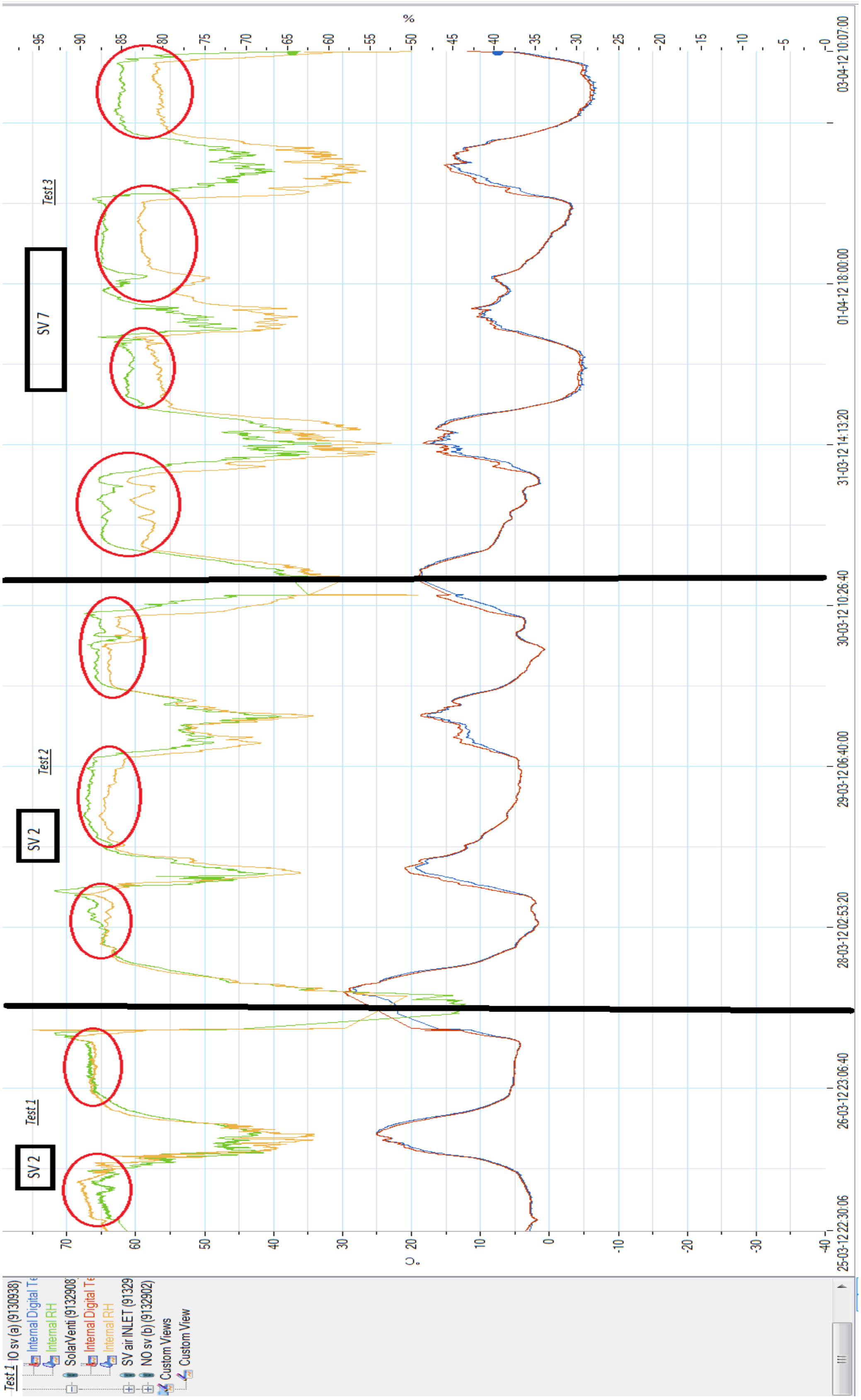
Figure 8. Container of CONTROL

Once the sensors were placed, the containers were close for same days (depending of the test). There were made different test with different solar collectors and weather conditions. The results are in the next pages.

4. Results

4.1. TEST ANALYSIS 1

Measurements from 25th March to 03rd April 2012.
Type of collector: ***SV2*** *and* ***SV7***



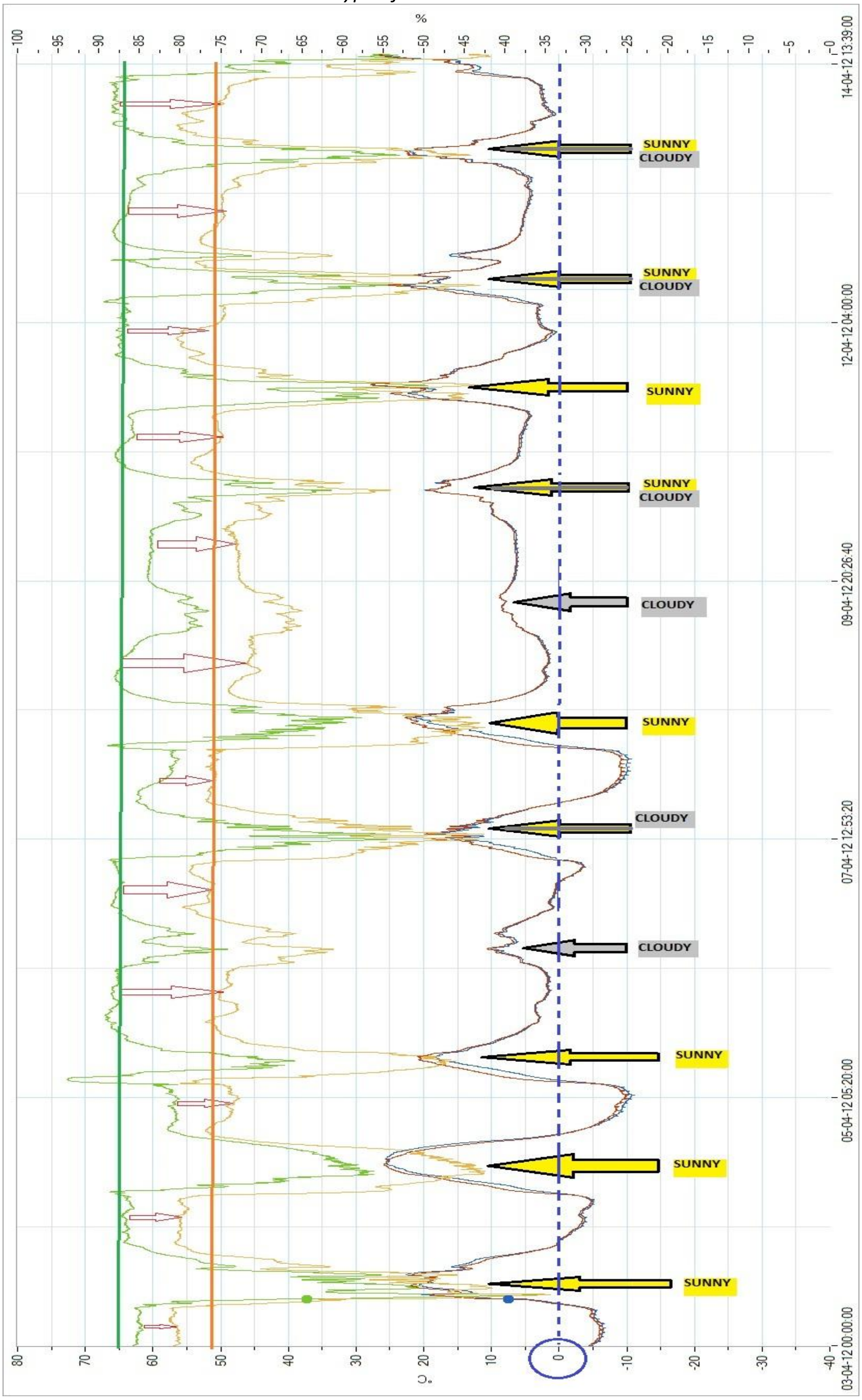
The graph shows how the container with SV has less relative humidity (at almost the same temperature) than the container without SV. That confirms the dying capacity of the SV.

Notice that this capacity is not instant but it could be seen along the days.

Also remark that the dying capacity is higher in the SV7, not only because produces higher temperatures but because provides more air flow, therefore evacuate more humidity from the container

4.2. TEST ANALYSIS 2

Measurements from 3rd April to 14th April 2012
*Type of collector: **SV7***



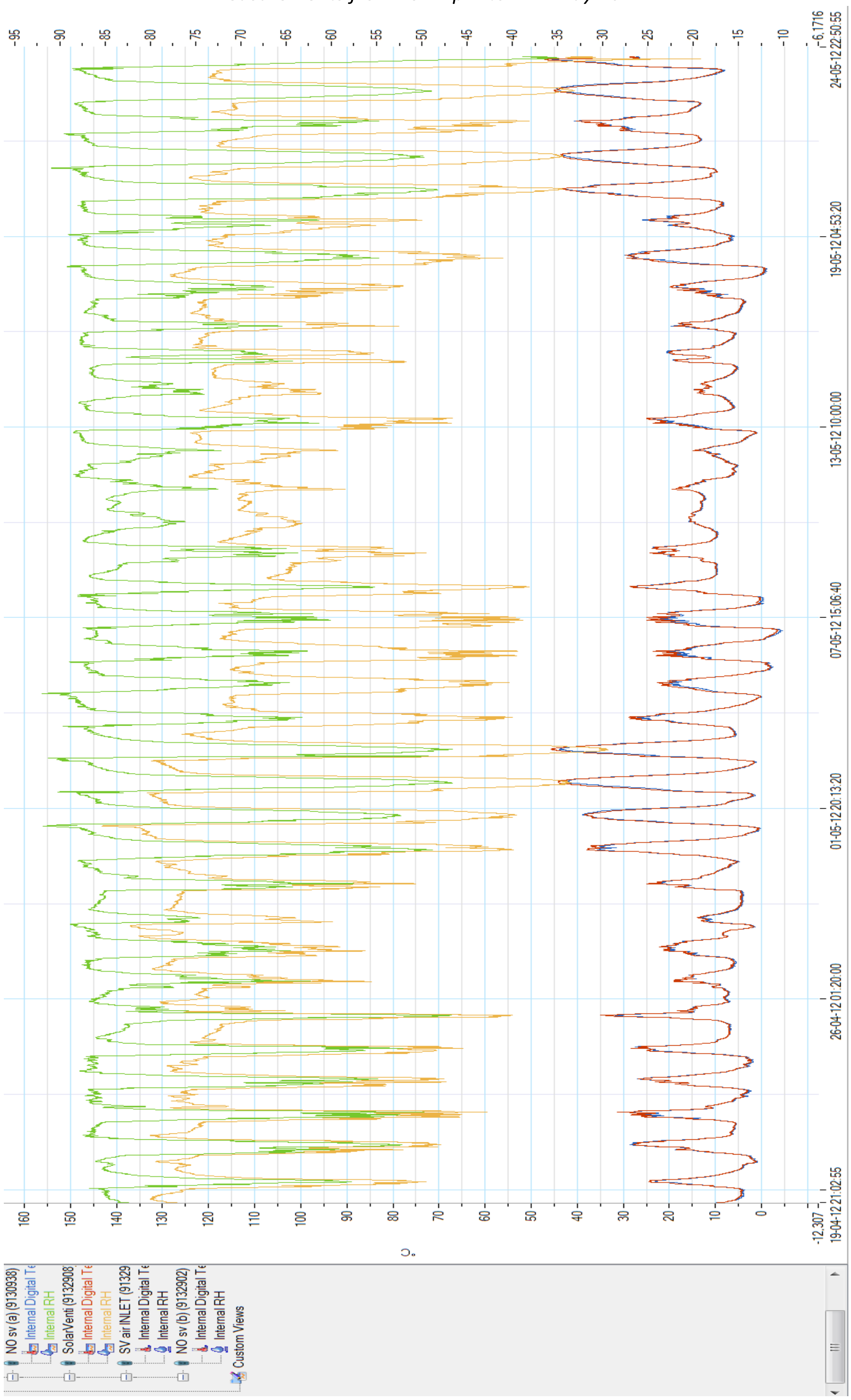
It is easy to see that the different humidity between the two containers, SolarVenti and NO SV, is increasing with the time but there is a point where that difference doesn't change so much. The reason is that the pallets inside the SolarVenti container can not get any dryer. The containers are almost empty; therefore there is no mass inertia that "stores" the dry effect of the SolarVenti. With more mass inertia this difference in the humidity will increase until bigger limits.

Also it can be seen that the SV system works in cloudy days too but the *drying effect* is not so good in sunny/rainy days. The fact is that the difference of humilities between SolarVenti and NO SV is higher after a few consecutive sunny days but decrease when sunny/rainy days. This is because the solar collector takes the ambient air, heat it and blow it in with less relative humidity (*drying effect*). This means that the *drying effect* will be higher when the ambient air has low absolute humidity (after some sunny and dry days). For the other hand, the *drying effect* will be no so high (sometimes negative) when the sun is shining after the rain. In this situation the sun will heat the ambient air and this warm air will absorb the water from the previous rain increasing its absolute humidity.

The issue of the sunny/rainy days is not a big problem in the case of containers (the humidity in the SolarVenti container reminds lower than in the NO SV) but could be some cases where this represent a real problem. For these cases the solution would be as simple as never blow air inside when the absolute humidity outside is higher.

4.3. STRESS TEST

Measurements from 19th April to 24th May 2012



The relative humidity, HR, have the same tendency than in previous test but with a small difference. The humidity in the SV container (SolarVenti) deceases with time while the humidity in the control container (NO sv) increases a little bit.

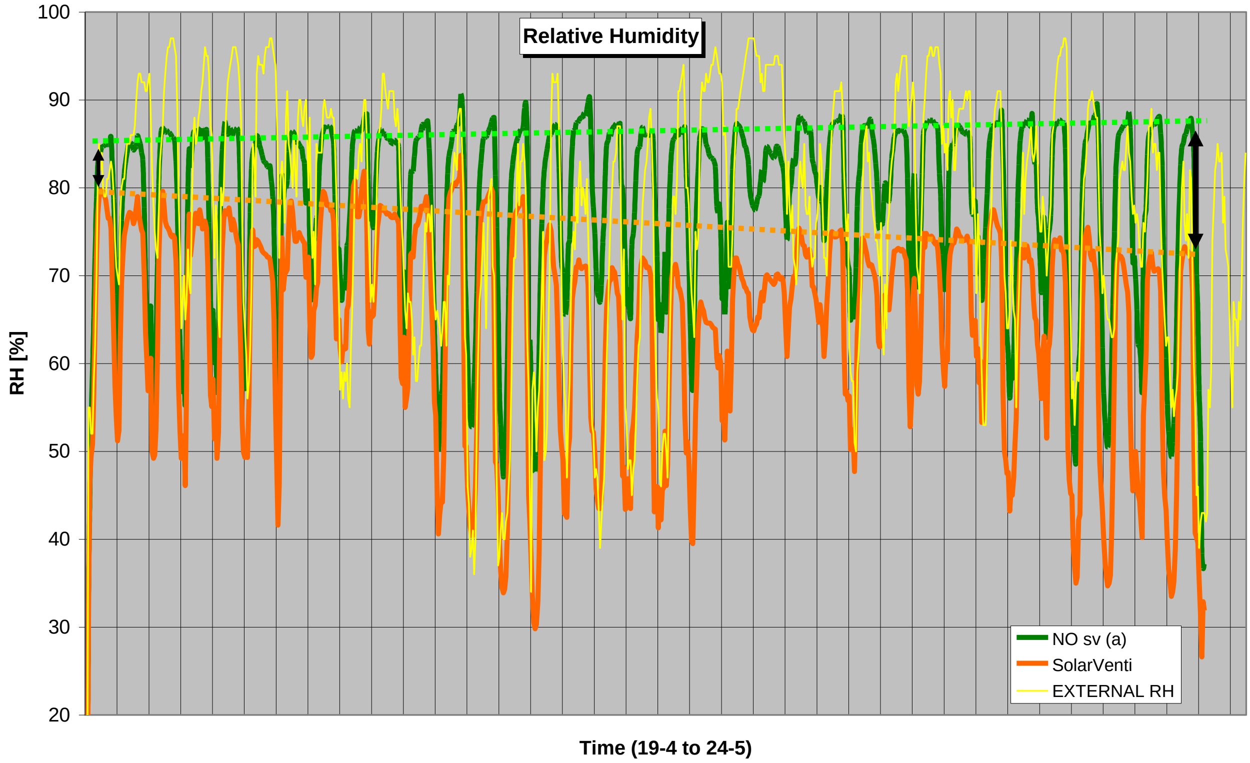


Chart 2: Relative humidity during the STRESS TEST (from 19.4 to 24.5)

After the 35 days, the water in the buckets decreases 5 liters in the control container and 9.5 liters in the SV container. The SolarVenti system dries out almost the double of water from the bucket. In the control container, only a small fraction of the evaporated water from the bucket left the container (because of the natural ventilation created by the holes of the container) increasing its humidity as *chart 2* shows. But there was another important aspect, when the containers were opened a strong smell of black water emerge from the control container but not from the SV container. This was the result of high temperatures inside the control container and almost no ventilation (the natural ventilation is negligible compared with the forced ventilation by the SV collector).

Figure 9: Water at the end of the test. The water fro the control container is much corrupt and has a strong smell of black water.

The temperatures in the two containers are similar. These temperatures are more influenced for the solar radiation that for the external temperature.

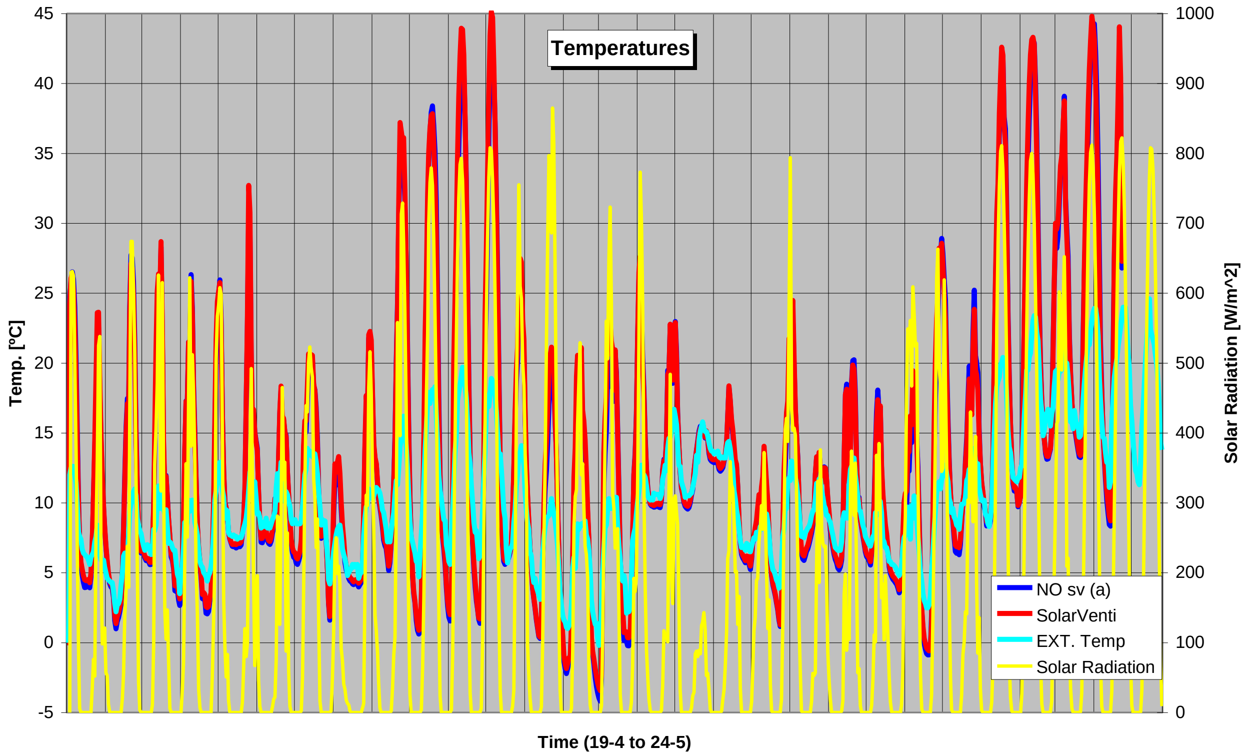


Chart 3. Temperatures (internal/external) and solar radiation

The HR in the SV container increase in sunny days after a rain period. That is because after the rain, the sun radiation increases the ambient temperature and the ambient air absorb the water from the previous rain. In consequence, the inlet air in the SV container has higher absolute humidity than the air in the container.

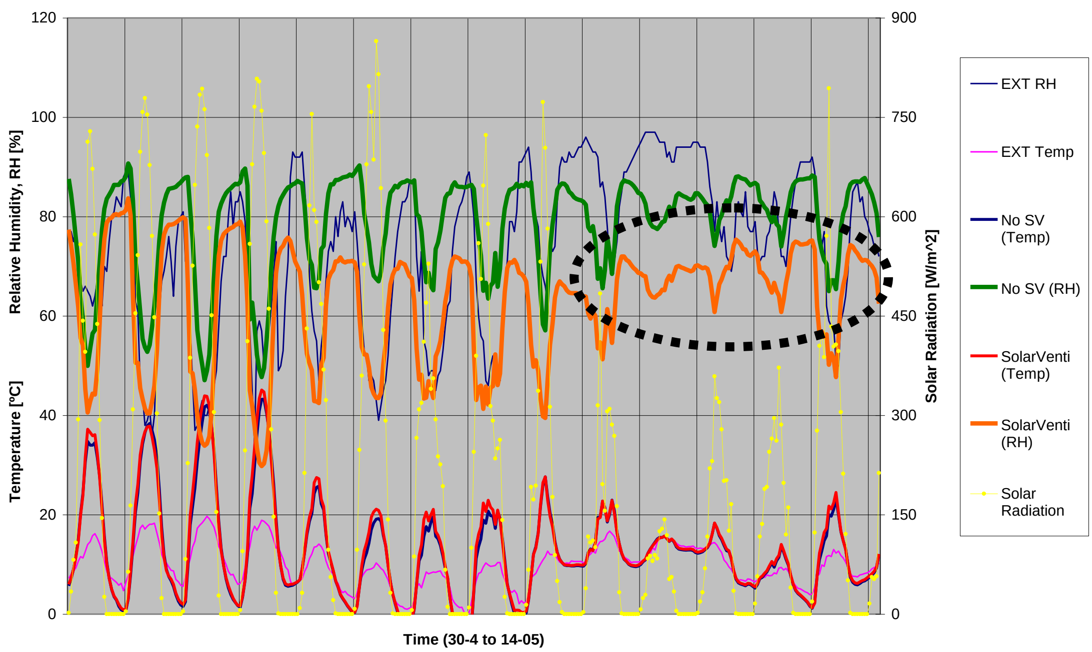


Chart 4. Temperatures, RHs and solar radiation from a sunny/rainy period from 30th of April to 14th of May.

5. Conclusion

In all the different tests performed during more than 2 months the SolarVenti collector has decreased the humidity inside the container proving its efficiency as dehumidifier.

It should be noticed that the temperatures inside the two different containers were almost equal during all the tests. The reasons are the characteristics of the container (no insulation) and the locale where the containers were placed (exposed to full sun radiation). When the container was exposed to solar radiation its wall act as solar collectors with lower efficiency than the SV collector but much more exposed area. Therefore the influence of the SV collector in the temperature was much lower than the influence of the walls of the container. This fact makes the temperatures in the two containers almost equal.
In this case, the air flow giving by the SV collector has much more importance for the *drying effect* than the solar radiation absorbed by the SV collector.

For the other hand other situations must be considered where the SV collector has bigger influence in the inside temperature.

- -The container has some kind of insulation: With enough insulation the walls of the container will not act as solar collectors.
- -The container is not exposed (full exposed) to solar radiation but the solar collector is. It is common that these containers are storage side by side. In this situation the containers give shadow each other reducing the area exposed to solar radiation.

It is an important remark that the inlet air flow in the SV container (giving by the SV collector) was more than double when the door of the SV container was open than when the door was closed. The area of the inlet air hole was bigger than the total area of the outlet air holes. That creates an additional pressure drop in the outlet air holes which is the reason of the drastic reduction of the air flow in the SV container when the door is closed.
Since, in this test, the most relevant factor for the *dry effect* was the air flow, increasing the air flow will increase the *dry effect*. In other words, the result of this test does not show the full potential of the SV collector. With bigger outlet air holes the performance of the SV collector would be higher, giving more air flow and therefore more *dry effect*.

If it is sunny after a rainy day, the SV collector could lose all its *drying power.* When the external absolute humidity is higher than the internal the SV collector should not work otherwise the inside humidity will increase. This could be done with a control system that switch off the fan of the SV collector when the absolute humidity outside is higher than inside.