Back-up for Solar Driers with hygroscopic Calcium Chloride

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Solar driers often need a back-up for periods without sunshine. A simple system is presented, using liquid and solid CaCl2*(H2O)x as a recyclable absorbent for excess humidity. The authors used this system successfully to dry plums in a 2m x 1m solar tunnel drier in Germany under changing weather conditions.

1. Summary

When the sunshine fails during the drying process in a solar tunnel drier, the fruits or vegetables can get spoiled. In Germany, on several occasions we used food grade hygroscopic Calcium Chloride salt in combination with an internal fan for closed loop air circulation to keep the air in the drier dry on rainy or overcast days. That way the the drying process was continued and spoiling was prevented.

2. Introduction

In our Garden in a village in southern Germany we have a number of Apple trees and plum trees and one way we employ to preserve these fruits for consumption is drying them in small solar tunnel driers of 2m by 1m size. The apples we cut into slices about 5mm thick, and in sunny weather they dry in one to two days. The plums we cut in two halves remove the kernel and place them with the skin at the bottom. Plum have a high moisture content and very soft flesh. We don't use any chemical treatment to make the skin porous. In sunny conditions drying plums takes a minimum of 4 days. During harvest season there are cloudy or rainy days in between, and then the still wet fruits can easily spoil with fungus.
During bad weather the air moisture inside the drier is high enough to allow fungal growth on the fruit. This is because no moisture is removed due to high outside ambient air moisture and low circulation of the fan. The fruit is still wet and spoils.

3. Background

Calcium Chloride is commercially sold as part of equipments for air dehydration. When there is a moist corner in a house, containers with solid Calcium Chloride packages on top are sold to keep the room a bit dryer. The salt can

absorb some moisture and the liquid which forms in the process drops into the container and is then discarded.
Calcium Chloride is a permitted food additive (E509). It is used in food processing where it acts as flavour enhancer and stabiliser. It is available in different grades (food grade, industrial grades)
At the University of Hohenheim in Stuttgart in Germany a large commercial system with Calcium Chloride was developed as a back up for a large solar dryer. The excess moisture was absorbed by a concentrated Solution of the salt which was sprayed into the air-stream. Solar generated hot air was used in the same way to increase the concentration again.

4. Project

From this two applications we got the idea to remove moisture from the air inside the drier during bad weather conditions through the use of hygroscopic calcium chloride. We place it as a dry solid (salt) on stainless steel trays and place these trays in the preheating section of the tunnel drier. To have a good air circulation (to transport humidity effectively), an extra electric fan is placed inside the drier and kept running all the time.

Dryer with tray with Calcium Chloride, fan and apples

Solid Calcium Chloride

All external openings of the drier are sealed with plastic foil, to keep moist outside air from entering. Now the Calcium Chloride is absorbing the excess humidity, and pools of water are forming around the crystals which slowly dissolve. This way we manage to keep the plums and other fruit from spoiling during unfavourable weather conditions.

After some time of operation

Calcium Chloride with absorbed water

To recycle the diluted solution back to solid Calcium Chloride, we use solar energy. We boil it in a stainless steel vessel on a 2m² Scheffler Reflector and evaporate the water until a thin solid layer starts to form on the surface. At this time the temperature of the solution is 140°C. The solution is then poured out onto the stainless steel trays where it solidifies immediately on cooling down and can be used again. For storage of dry calcium chloride it is advisable to keep it in a sealed container. Otherwise it slowly absorbs moisture from the air.

5. Conclusion

This is a quite simple approach to secure the continued drying during unfavourable weather conditions. It is an extra effort to use an additional ventilator for the internal circulation, but a configuration should be possible which is using the same ventilator as during daytime operation. It might be also possible to leave the trays with the calcium chloride solution just always in the dryer, where it gets more concentrated on sunny days and absorbs moisture during the night and bad weather.
Compared to other ways of providing back-up energy for drying processes this method allows a 100% solar back up. It is possible to use the solar dryer for recycling the calcium chloride, only it will not dehydrate as much as with the high temperatures of the solar cooker.