

Modelling of a solar dryer for food preservation in developing countries

Food insecurity has proven to be a significant problem in many developing countries, which in some cases occurs due to inadequate techniques for food preservation. To counteract this problem, an ongoing study suggests that improved methods of solar drying of foods could be a simple and cheap method for preserving foods in developing countries. But before any solar dryers can be built, the choice of design must be considered to assure a good quality of the dried foods. To find a more optimal design choice, a calculation tool has been created to estimate various temperatures as well as the drying rate of a solar dryer. The calculation tool was used to find out which parameters that will affect the solar dryer performance the most, where several different parameters could be identified.

A popular science article by Joakim Olsson

Among the world's developing countries is Mozambique, where almost one-third of the population suffer from chronic food insecurity. This problem is not caused by insufficient harvests, but rather that there is currently no adequate method of preserving the harvested fruits. This generally results in vast amounts of post-harvest losses of the fruit. The Mozambicans are currently using so called direct solar drying of the fruits, where the fruits are placed on sheets and left out in the sun to dry. This leaves the drying fruit exposed to rain, pests, diseases and other contamination which has a chance of causing the fruit to become inedible.

To find new ways of eliminating the food insecurity problem, an ongoing project at Lund University in Sweden aims to find simple, robust and cheap methods for preserving foods. Instead of using direct solar drying, it is suggested that indirect solar drying could be the solution, where a solar collector is used to heat air which is transported into a drying chamber according to Figure 1. This means that the foods will

be more protected from the environment, as well as direct sunlight which can cause uneven heating of the fruits.

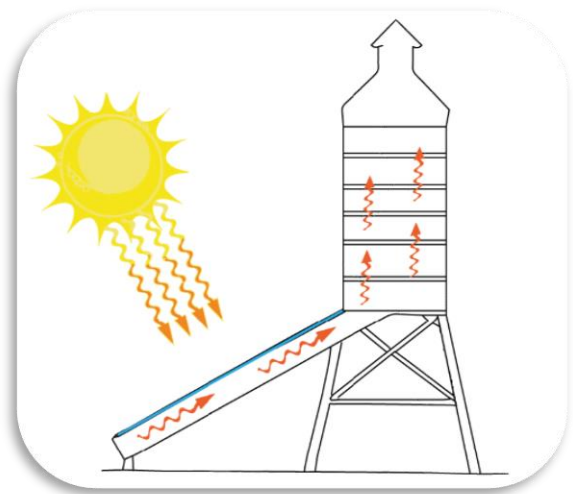


Figure 1. A principal design of an indirect solar dryer.

To obtain a good product quality, the design of the indirect solar dryer used needs to be considered. A faulty design will result in the foods being exposed to either excessive heat, which will degrade nutrients such as Vitamin C, or exposed to insufficient heat which could result in growth of mold or bacteria.

For this reason, a calculation tool was created using Maple 2016, a software used to solve mathematical problems. The purpose of the calculation tool was to use parameters of a suggested design regarding e.g. insulation thicknesses, absorber properties and size and then estimate the generated air temperature. If the selected design of the solar dryer would generate a drying temperature between 50 °C and 65 °C, the design can be regarded as functional.

To find ways of increasing the air temperature and improve the solar dryer efficiency, a parametric study was performed. The results of the parametric study indicate that there are several rather simple ways of increasing the collector air temperature. The simplest ways of improving the drying temperature include improved insulation, i.e. increasing the U-value of the sides and bottom of the collector, but it's important to remember that more insulation isn't always better. At some point, the heat losses from the collector sides are nearly eliminated by the thick layer of insulation. The remaining heat losses are occurring through the glazing, meaning that additional layers of glass would improve the insulation more than adding more insulation to the bottom and sides of the collector.

Other simple means of improving the drying temperature are adding fins and designing a flatter collector. Fins could be attached to the absorber plate, increasing the convective heat transfer to the air flow, which proved to have a significant impact on the air temperature. The collector could also be designed to be more flat, which would increase the absorber contact area with the air flow relative to the air volume. Both solutions appear to be cheap and effective ways of increasing the drying temperature.

The collector material could be improved, using low-emittance materials, which would increase the amount of heat transferred from the collector to the air stream. Fans could also be used to create a more turbulent air flow and assist the collector in transporting away the generated humidity by the drying products. However, these solutions would either require more advanced materials or a source of electricity, of which neither can be taken for granted in a developing country.

As a conclusion of the study, there are several parameters worth considering when designing a solar dryer for a developing country. All choices of dimensions and materials of the solar dryer matter and can be optimized for a higher efficiency. But it's also worth keeping in mind that the materials and required energy sources must be well-adapted for usage in a developing country.