

Session 4 Sun and Solar dryers

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Sun Drying

- Food drying is a very simple, ancient skill. It is one of the most accessible and hence the most widespread processing technology.
- Sun drying of fruits and vegetables is still practiced largely unchanged from ancient times.
- Traditional sun drying takes place by storing the product under direct sunlight.
- Sun drying is only possible in areas where, in an average year, the weather allows foods to be dried immediately after harvest.
- The main advantages of sun drying are low capital and operating costs and the fact that little expertise is required.

- The main disadvantages of this method are as follows:
 - contamination, theft or damage by birds, rats or insects; slow or intermittent drying and no protection from rain or dew that wets the product, encourages mould growth and may result in a relatively high final moisture content; low and variable quality of products due to over - or under-drying; large areas of land needed for the shallow layers of food; laborious since the crop must be turned, moved if it rains; direct exposure to sunlight reduces the quality (colour and vitamin content) of some fruits and vegetables.
- The quality of sun dried foods can be improved by reducing the size of pieces to achieve faster drying and by drying on raised platforms, covered with cloth or netting to protect against insects and animals.

Solar Drying

- Due to the current trends towards higher cost of fossil fuels and uncertainty regarding future cost and availability, use of solar energy in food processing will probably increase and become more economically feasible in the near future.
- Solar dryers have some advantages over sun drying when correctly designed.
- They give faster drying rates by heating the air to 10-30⁰C above ambient, which causes the air to move faster through the dryer, reduces its humidity and deters insects.
- The faster drying reduces the risk of spoilage, improves quality of the product and gives a higher throughput, so reducing the drying area that is needed.

- They can be constructed from locally available materials at a relatively low capital cost and there are no fuel costs.
- Thus, they can be useful in areas where fuel or electricity are expensive, land for sun drying is in short supply or expensive, sunshine is plentiful but the air humidity is high.
- Moreover, they may be useful as a means of heating air for artificial dryers to reduce fuel costs.
- Solar food drying can be used in most areas but how quickly the food dries is affected by many variables, especially the amount of sunlight and relative humidity.
- Typical drying times in solar dryers range from 1 to 3 days depending on sun, air movement, humidity and the type of food to be dried.
- **The principle that lies behind the design of solar dryers is as follows: in drying relative and absolute humidity are of great importance.**

Types of Solar Dryers

There are mainly three types of solar dryers (3):

1. The absorption or hot box type dryers in which the product is directly heated by sun,
2. The indirect or convection dryers in which the product is exposed to warm air which is heated by means of a solar absorber, or heat exchanger,
3. Dryers combining the principles of the above two, where the product is exposed to the sun and a stream of pre-heated air simultaneously.

1 Direct Absorption Dryers

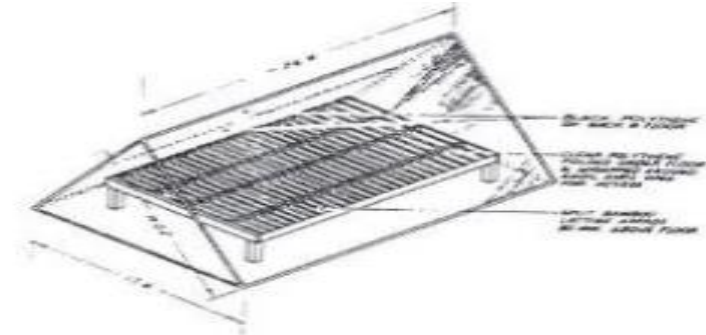
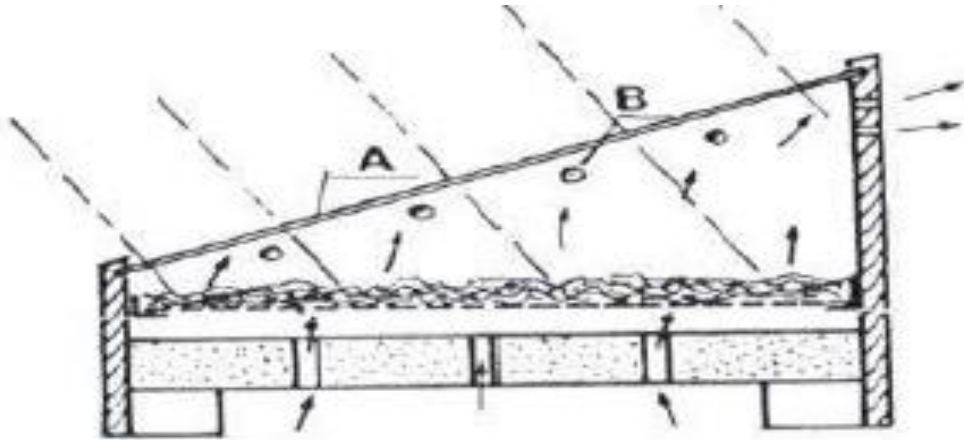


FIGURE 1. Side and perspective view of solar radiation of hot box dryer. (From Phelan, B. L., Searles, C. B., G. L. Gentry, D. L. Martin, E. A. and Durr, G. R., Food Dehydration (ed. Food Research Society, R. E. Freeman, San Angelo, 1976, 46. With permission.)

Direct drying consists of using incident radiation only, or incident radiation plus reflected radiation. Most solar drying techniques that use only direct solar energy also use some means to reflect additional radiation onto the product to further increase its temperature. An example of direct absorption dryer is the hot box dryer as shown in Figure. The aim of this type of a dryer is mainly to improve product quality by reducing contamination by dust, insect infestation, and animal or human interference. It consists of a hot box with a transparent top and blackened interior surfaces. Ventilation holes in the base and upper parts of side walls maintained a natural air circulation.

2 Dryers with solar Air heaters

- The main idea behind this type of a dryer is to obtain a low cost multi-product system. The leads to choose a drying chamber able to accommodate different kinds of trays and act in it self as a solar collector.
- The drying chamber has the shape of a parallelepiped with its longitudinal axes in the North- South direction.
- A wooden frame supports a transparent polycarbonate hollow plate 4.5 mm thick. The wooden skeleton and polycarbonate plates are screwed together allowing the whole chamber to be disassembled easily.
- The construction is modular to permit variations of the drying chamber capacity. Trays have a shape that they can be piled easily without crushing the fruits and allow air circulation between them following the main axis.
- Four small windows located at the far ends of the chamber enable introduction of measuring devices and also control the air renewal in the system.
- Eight fans placed inside the chamber produce and internal recycling, and cause the air flux to be uniform. The drying system has six solar collectors made of blackened iron plate, protected by a glass cover, which also helps to decrease heat losses

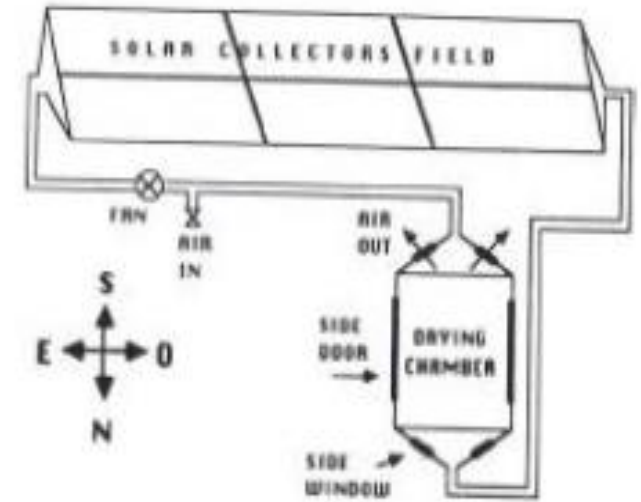


Fig. Greenhouse type solar drying system

3 Combined Direct and Indirect dryers

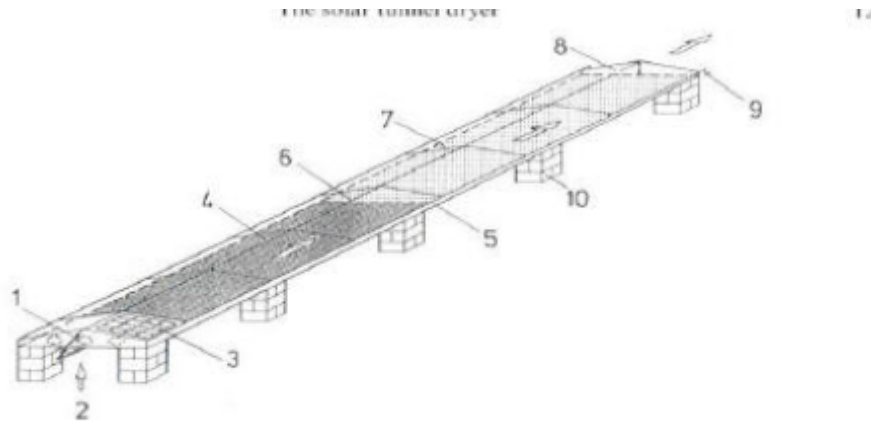


Figure 3. Solar tunnel dryer: 1.Fan, 2. Inlet air, 3.solar cell module, 4. Solar collector, 5. Metal frame, 6. Outlet of the collector, 7. Drying tunnel, 8. Outlet of drying, 9. Rolling bar, 10. Concrete block substructure

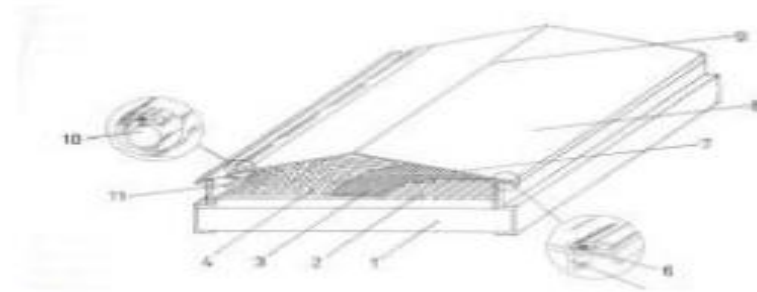


Figure 4. Drying tunnel: 1.Back insulator, 2. Wire mesh, 3. Plastic net, 4. Product to be dried, 5. Metal frame, 6. Fastening plastic profile, 7. Metal strip, 8. Air bubble plastic sheet, 9. String for supporting sheet, 10. Metal tube for rolling the sheet, 11. Rolling bar

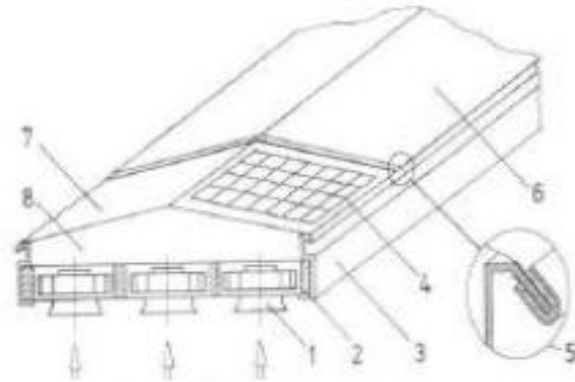


Figure 5. Solar collector: 1. Fan, 2. Back insulator, 3. Metal frame, 4. Solar cell module, 5. Reinforced plastic clamp, 6. Transparent plastic sheet, 7.-8. Metal sheet

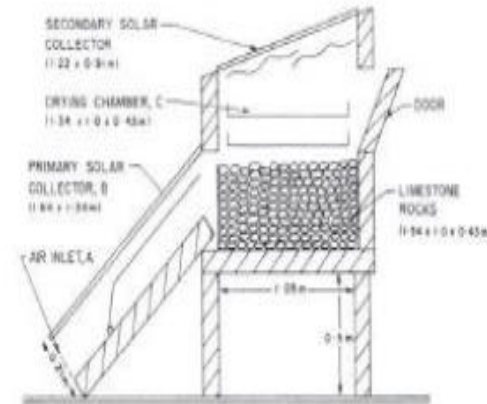


Figure 6. Rock-bed solar dryer.

Fig 6. Rock bed solar dryer.

- Many types of drying systems utilize both direct and indirect solar radiation. In these types of systems, radiant energy from the sun falls directly onto the product being dried; however, in addition, a preheater also is used to raise the air temperature, which in turn, accelerates the drying rate.
- Acceleration of drying rate can occur in two ways: hot air can transfer some of its heat to the product being dried, thus raising its vapour pressure causing a faster moisture loss; or as temperature of air mass increases, the water-holding capacity also increases

Thank you