DESIGN AND FABRICATION OF SOLAR DEHYDRATOR FOR CROPS

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ABSTRACT

Agriculture represents the biggest part of the economy.80-90% of the working population is employed in agriculture. Despite these large numbers, national food production still does not meet the needs of the population. The lack of appropriate preservation and storage systems caused considerable losses, thus reducing the food supply. There are some drawbacks relating to the traditional method of drying, i.e., spreading the crop in thin layers on mats, trays or paved grounds and exposing the product to the sun and wind. These include poorer quality of food caused by contamination by dust, insect attack, enzymatic reactions and infection by micro-organisms. Also this system is labor- and time intensive, as crops have to be covered at night and during bad weather, and the crops continually have to be protected from attack by domestic animals. Our dryer is super sized about 6 feet tall and 7 feet, can dry large amounts of food quickly and is a must have for off-grid living. If you have a big garden or buy bulk produce, this solar dehydrator will help you keep up with food preservation all summer and into fall. If you live in a cloudy or humid region, you can add heat from light bulbs to improve its operation. Thus it was totally hygienic and dust free process.

CHAPTER 1

INTRODUCTION

1.1 SOLAR RADIATION – SOURCE FOR SOLAR DRYING

The sun is the central energy producer of our solar system. It has the form of a ball and nuclear fusion take place continuously in its centre. A small fraction of the energy produced in the sun hits the earth and makes life possible on our planet. Solar radiation drives all natural cycles and processes such as rain, wind, photosynthesis, ocean currents and several other which are important for life. The whole world energy need has been based from the very beginning on solar energy. All fossil fuels (oil, gas, coal) are converted solar energy. The radiation intensity is 6000°C solar surface corresponds to 70,000 to 80,000kW/m2. Our planet receives only a very small portion of this energy. In spite of this, the incoming solar radiation energy in a year is some 200,000,000 billion kWh. This is more than10, 000 times the yearly energy need of the whole world. The solar radiation intensity outside the atmosphere is in average 1,360 W/m2 (solar constant). When the solar radiation penetrates through the atmosphere some of the radiation is lost so that on a clear sky sunny day in summer between 800 to 1000 W/m2 (global radiation) can be obtained on the ground.

1.2 DEHYDRATOR DRYING.

Dehydrator drying is a possible replacement for sun drying or for standard dehydration processes .In terms of normal drying, dehydrator drying is competing with an approach that is deeply the way of life for most potential users. Normal drying is by no means a perfect process with problems arising due to potential contamination of the produce, variability in drying times, rain damage and so on.

- The higher temperature, movement of the air and lower humidity, increases the rate of drying.
- The dryers have often required big changes from traditional methods.
- The dryers are water proof and the food does not therefore need to be moved when it rains.
- Food is enclosed in the dryer and therefore protected from dust, insects, birds and animals.

1.3 TYPES OF DRYING

There are two types of drying systems; there are three main subtype categories that are based on how the contents are heated.

- Active Solar-energy systems- Airflow is forced.
- Passive solar-energy systems- Airflow is created by natural convection

1. Direct heating.
2. Indirect heating.
3. Mixed mode (both direct and indirect).

We specifically looked into each of these conceptual designs except for the mixed mode type of active dryer. We felt that between the consideration of the indirect active system, and the mixed mode passive system. We also did consider direct sun drying and oven drying as methods of fruit and vegetable dehydration, but quickly deemed these would not be viable solutions to the problem presented because they deplete the nutritional value if not done properly and did not spend time further analyzing them.

1.3.1 Direct passive method.

It has two different types of direct and passive solar dehydrators are shown. One is a cabinet style, and a tent style. These are two similar concepts that both utilize direct sunlight as the source of heat for the contents as the top is transparent. Passive airflow is created by convection, as each have either holes in cabinet or a vent in tent on the bottom, and small outlets at the top to allow the hot air to rise and then escape. Both are very simple, having only a single area where the food is held. They are a cheap method for dehydration that is not only simply to construct, but also very simple to operate, and also easy to see when the contents are dried. Direct heating can be efficient and produce fast drying when the sun is able to quickly heat the fruit. This type of design, however, does not promote abundant airflow, immediately cools down when the sun sets, and cannot performance in conditions with cloud coverage. The direct sunlight can also cause depletion of nutrients in the fruits and vegetable, along with discoloration that is not desirable. They also are limited in size, and therefore cannot generate a large amount of output.

1.3.2 Direct active method.

In direct active solar dryer a transparent top allows the sun to radiate directly to the contents. Generally this type of system has a wide area, and a small height, allowing the sun to quickly heat it. Because of this set up, there is no natural convection, so fans are used to force airflow (hence: active system). Creation and operation is relatively simple, as it is a single chamber with the addition of fans. Airflow can effectively function in many conditions, but the heating element is completely weather dependent and it cools down very quickly at night. Direct sunlight can also cause depletion of nutrients in the fruits and vegetable, along with discoloration that is not desirable. A single layer limits the throughout to only be effective for very small operations.

1.3.3 Indirect active method.

In Indirect active solar dehydrator, a key component of this type of design is the fan, usually located near the bottom of the chamber, causing air to cycle through and aid in the drying of the fruit. Heat inside the chamber is achieved through insulated walls that are heated by the sun throughout the day. The size of this type of system is taller than any of the direct systems because it can be more than one layer deep inside the chamber, meaning a larger quantity of food can be dried. Nutrients of the food are also better preserved without the direct sunlight and the airflow is not dependent on the weather, and it is able to hold the heat slightly longer into the night.

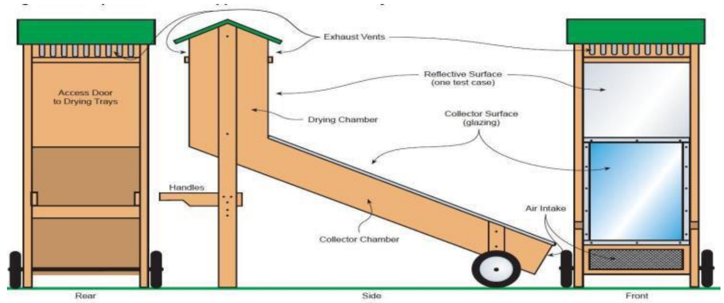

Figure 1:-Indirect/Active method

CHAPTER 2

LITERATURE REVIEW

AP Mnkeni, P Soundy and MO Brutsch., [1] (2008) For thousands of years people have sundried fruit and vegetables to preserve for leaner times. New technologies brought changed techniques, but at present the increasing demand for healthy, low- cost natural foods and the need for sustainable income, are bringing solar drying to the fore as a useful alternative for surplus products.

Werner Weiss Josef Buchinger., [2] (2011) the high temperature dryers used in industrialized countries are found to be economically viable in developing countries only on large plantations or big commercial establishments. Therefore the introduction of low cost and locally manufactured solar dryers offers a promising alternative to reduce the tremendous post harvest losses. The opportunity to produce high quality marketable products seems to be a chance to improve the economic situation of the farmers. However, taking into account the low income of the rural population in developing countries, the relatively high initial investment for solar dryers still remains a barrier to a wide application.

John Barrie monik Goforth Lori Hart.,[3] (2015)Children in their first 1000 days of life during these hungry months suffer from stunted development, and older children struggle in school due to lack of energy. At the Panyebar Childcare and Nutrition Center, they are trying to combat this problem. Other nutrition centers in Guatemala have had success with dehydrating fruit, and Panyebar would like the tools to practice this in their community.

Eben Fodor., [4] (2006) More and more people are recognizing the importance of food quality in their daily lives. The freshest, tastiest and most Nutritious food comes from our own gardens or local farmers. But because these high quality fruits and vegetables are seasonal, you have access to them for only a few weeks or months each year. What do you plan to eat the rest of the year Will you rely on industrial foods grown by strangers from all over the world and shipped thousands of miles .With increasing interest in healthy eating, sustainable local food supplies and self-reliance, many people are discovering the benefits of a solar food dehydrator.

Dr. Mohamed Mansour Mostafa., [5] this project presents the design, construction and performance of a mixed-mode solar dryer for food preservation. In the dryer, the heated air from a separate solar collector is passed through a grain bed, and at the same time, the drying cabinet absorbs solar energy directly through the transparent walls and roof. The results obtained during the test period revealed that the temperatures inside the dryer and solar collector were much higher than the ambient temperature during most hours of the day-light. The temperature rise inside the drying cabinet was up to 74% for about three hours immediately after 12.00 (noon). The dryer exhibited sufficient ability to dry food items reasonably rapidly to a safe moisture level and simultaneously it ensures a superior quality of the dried product.

CHAPTER 3
BASICS OF SOLAR DEHYDRATOR

3.1 CONCEPTS.

Drying or dehydration of material means removal of moisture from the interior of the material to the surface and then to remove this moisture from the surface of the drying material.

3.1.1 Nature of component.

The drying of product is a complex heat and mass transfer process which depends on external parameters such as temperature, humidity and velocity of the air stream; drying material properties like surface characteristics (rough or smooth surface), chemical composition (sugar, starches, etc) physical structure (porosity, density, etc.) size and shape of the product.

3.1.2 Moisture of the product.

The rate of moisture movement from the product inside to the air outside differs from one product to another and very much depends on whether the material is hygroscopic or non-hygroscopic. Non-hygroscopic material can be dried to zero moisture level while the hygroscopic materials like most of the food products will always have residual moisture content. This moisture in hygroscopic material may be bound moisture in the material due to closed capillaries or due to surface forces or unbound moisture which remains in the material due to surface tension of water. When the hygroscopic material is exposed to air, it will either absorb moisture or desorbs moisture depending on the relative humidity of air.

3.2 PROPERTIES.

The Eight thermodynamic properties of moist air, generally used in drying are.

- Vapor pressure.
- Relative humidity.
- Humidity ratio.
- Dry bulb temperature.
- Dew point temperature.
- Web bulb temperature.
- enthalpy, and
- Specific volume. These parameters are correlated and the effect of one on another can be seen.

3.2.1 Vapor pressure.

Vapor pressure or equilibrium vapor pressure is defined as the pressure exerted by a vapor in thermodynamic equilibrium with its condensed phases at a given temperature in a closed system.

3.2.2 Relative humidity.

Relative humidity is the ratio of the partial pressure of water vapor to the equilibrium vapor pressure of water at a given temperature. Relative humidity depends on temperature and the pressure of the system of interest.

RH = Actual vapor density/Saturated vapor density

3.2.3 Humidity ratio.

The humidity ratio is sometimes referred to as moisture content or the mixing ratio. It is the mass of water vapor per unit mass of dry air. The humidity ratio (W) can be calculated if the % moisture by volume (%MV) is known.

3.3 FUEL METHOD COMPARISON.

Conventionally fueled dryers are the primary alternative to solar dryers. In conventional dryers, a fuel is burned to heat the food-drying air. In some cases, the gaseous products of combustion are mixed with the air to achieve the desired temperature. Although these drying systems are used around the world with no apparent problems, there is the possibility of a mechanical malfunction, which might allow too much gas into the drying stream. If this occurs, the food in the dryer can become contaminated. The great advantage that conventional dryers have over solar dryers is that drying can be carried out in any kind of weather. Unlike solar dryers, conventional dryers are not subject to daily and seasonal variations and other climatological factors. On the other hand, the fuels burned in conventional dryers may present other problems Use of wood may contribute to problems of deforestation coal may cause pollution. Fossil fuels are becoming increasingly expensive and are not always available.

3.4 FLOW DIAGRAM OF FACTORS TO CONSIDER IN SELECTING A SOLAR DEHYDRATOR.

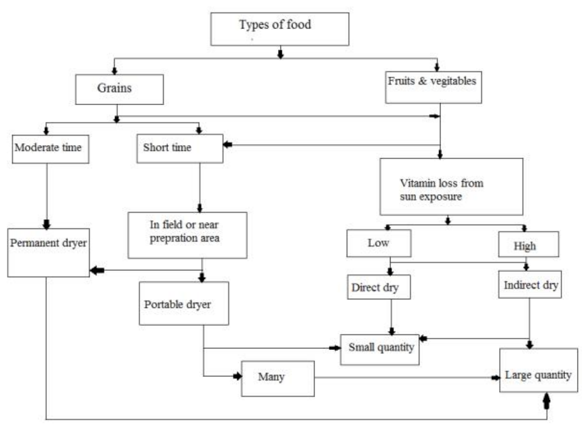

Figure 2:- Flow chart

- What food will the dryer be used for? Also, what quantities of food will be dried?

Grains, fruits, and vegetables require different drying techniques. The flow diagram that may be helpful in defining the type of design. The safe storage of the harvest is of prime concern to all. As soon as fresh fruits and vegetables have been prepared, they must be dried immediately. Grains, too, have only a limited time in which they must be dried to ensure their storage. Rice in the husk, for example, will begin to germinate within 48 hours if its moisture content is about24 percent.

- What are the climatic conditions during the harvest (and drying) season?

Climatic conditions (solar radiation, rainfall, temperature, humidity, wind, etc.) Should be considered in determining what kind of dryer is best suited for a particular application, will help you to visualize the factors that must be considered here. If the occurrence of sunshine is low-say, 50 percent or less then it may be wise to add an auxiliary heat source to enable drying to continue on cloudy days or even through the night. Dry climates with hot or moderate temperatures are well suited for solar food dryers.

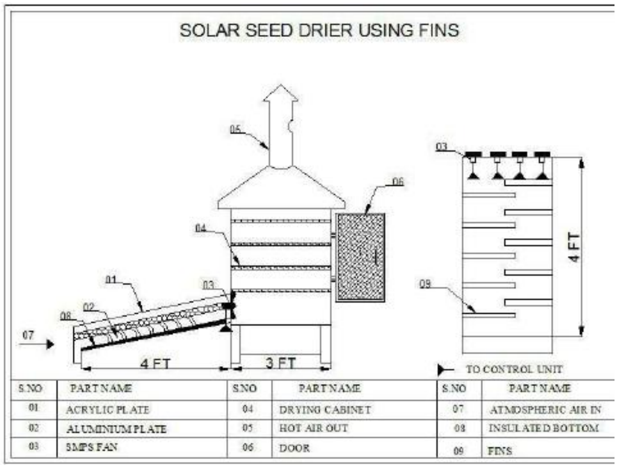

Figure3:- Block Diagram of Solar Dehydrator

CHAPTER 4
DESIGN APPROACH AND METHODOLOGY

Solar drying refers to a technique that utilizes incident solar radiation to convert it into thermal energy required for drying purposes. Most solar dryers use solar air heaters and the heated air is then passed through the drying chamber (containing material) to be dried. The air transfers its energy to the material causing evaporation of moisture of the material

4.1 DESIGN APPROACH.
4.1.1 Drying Mechanism.

In the process of drying, heat is necessary to evaporate moisture from the material and a flow of air helps in carrying away the evaporated moisture. There are two basic mechanisms involved in the drying process the migration of moisture from the interior of an individual material to the surface, and the evaporation of moisture from the surface to the surrounding air.

The drying of a product is a complex heat and mass transfer process which depends on external variables such as temperature, humidity and velocity of the air stream and internal variables which depend on parameters like surface characteristics (rough or smooth surface), chemical composition (sugars, starches, etc.), physical structure(porosity, density, etc.), and size and shape of products. The rate of moisture movement from the product inside to the air outside differs from one product to another and depends very much on whether the material is hygroscopic or non-hygroscopic. Non-hygroscopic materials can be dried to zero moisture level while the hygroscopic materials like most of the food products will always have residual moisture content. This moisture, in hygroscopic material, may be bound moisture which remained in the material due to closed capillaries or due to surface forces and unbound moisture which remained in the material due to the surface tension of water.

Drying is done either in thin layer drying or deep layer drying. In thin layer drying; which is done in case of most of fruits and vegetables, the product is spread in thin layers with entire surface exposed to the air moving through the product and the Newton‘s law of cooling is applicable in the falling rate region. Most of the grains are dried in deep layer which can be considered as a series of thin layers and the temperature and the humidity varies from layer to layer.

4.1.2 Air Properties.

The properties of the air flowing around the product are major factors in determining the rate of removal of moisture. The capacity of air to remove moisture is principally dependent upon its initial temperature and humidity; the greater the temperature and lower the humidity the greater the moisture removal capacity of the air. The relationship between temperature, humidity and other thermodynamic properties is represented by the psychometric chart. It is important to appreciate the difference between the absolute humidity and relative humidity of air. The absolute humidity is the moisture content of the air (mass of water per unit mass of air) whereas the relative humidity is the ratio, expressed as a percentage, of the moisture content of the air at a specified temperature to the moisture content of air if it were saturated at that temperature.

The changes in condition of air when it is heated using the solar energy and then passed through a bed of moist product .The heating of air from temperature is raised. Air moves through the material to be dried, it absorbs moisture. Under (hypothetical) adiabatic drying; sensible heat in the air is converted to latent heat and the change in the condition of air is represented along a line of constant enthalpy. Both absolute humidity and relative humidity increase respectively, but air temperature decreases. The absorption of moisture by the air would be the difference between the absolute humilities if unheated air is passed through the bed. Assuming that the air to be at the same relative humidity, then the absorbed moisture would be considerably less than that absorbed by the heated air.

4.2 DESIGN METHODOLOGY

4.2.1 Types of solar dryers

Solar-energy drying systems are classified primarily according to their heating modes and the manner in which the solar heat is utilized. In broad terms; they can be classified into two major groups, namely

- Active solar-energy drying systems (most types of which are often termed hybrid solar dryers).
- Passive solar-energy drying systems (conventionally termed natural-circulation solar drying systems).

The distinct sub-classes of either the active or passive solar drying systems can be identified which vary mainly in the design arrangement of system components and the mode of utilization of the solar heat, namely

- Direct (integral) type solar dryers.
- Indirect (distributed) type solar dryers.

Direct solar dryers have the material to be dried placed in an enclosure, with a transparent cover on it. Heat is generated by absorption of solar radiation on the product itself as well as on the internal surfaces of the drying chamber. In indirect solar dryers, solar radiation is not directly incident on the material to be dried. Air is heated in a solar collector and then ducted to the drying chamber to dry the product. Specialized dryers are normally designed with a specific product in mind and may include hybrid systems where other forms of energy are also used.

Although indirect dryers are less compact when compared to direct solar dryers, they are generally more efficient. Hybrid solar systems allow for faster rate of drying by using other sources of heat energy to supplement solar heat. The three modes of drying are

(i) Open sun,

(ii) Direct and

(iii) Indirect in the presence of solar energy.

The working principle of these modes mainly depends upon the method of solar-energy collection and its conversion to useful thermal energy.

4.2.2 Open sun drying (OSD).

The working principle of open sun drying by using solar energy. The short wave length solar energy falls on the uneven product surface. A part of this energy is reflected back and the remaining part is absorbed by the surface. The absorbed radiation is converted into thermal energy and the temperature of product stars increasing. This results in long wavelength radiation loss from the surface of product to ambient air through moist air. In addition to long wave length radiation loss there is convective heat loss too due to the blowing wind through moist air over the material surface. Evaporation of moisture takes place in the form of evaporative losses and so the material is dried. Further apart of absorbed thermal energy is conducted into the interior of the product. This causes a rise in temperature and formation of water vapor inside the material and then diffuses towards the surface of the and finally losses thermal energy in the end then diffuses towards the surface of the and finally losses the thermal energy in the form of evaporation. In the initial stages, the moisture removal is rapid since the excess moisture on the surface of the product presents a wet surface to the drying air. Subsequently, drying depends upon the rate at which the moisture within the product moves to the surface by a diffusion process depending upon the type of the product.

4.2.3 Direct type solar drying (DSD).

Direct solar drying is also called natural convection cabinet dryer. Direct solar dryers use only the natural movement of heated air. A part of incidence solar radiation on the glass cover is reflected back to atmosphere and remaining is transmitted inside cabin dryer. Further, a part of transmitted radiation is reflected back from the surface of the product. The remaining part is absorbed by the surface of the material. Due to the absorption of solar radiation, product temperature increase and the material starts emitting long wave length radiation which is not allowed to escape to atmosphere due to presence of glass cover unlike open sun drying.

Thus the temperature above the product inside chamber becomes higher. The glass cover server one more purpose of reducing direct convective losses to the ambient which further become beneficial for rise in product and chamber temperature respectively . However, convective and evaporative losses occur inside the chamber from the heated material. The moisture is taken away by the air entering into the chamber from below and escaping through another opening provide at the top. A direct solar dryer is one in which the material is directly exposed to the sun‘s rays. This dryer comprises of a drying chamber that is covered by a transparent cover made of glass or plastic.

4.2.4 Indirect type solar drying (ISD)

This type is not directly exposed to solar radiation to minimize discolorations and cracking. It has proposed and analyzed reverse absorber cabinet dryer (RACD). The drying chamber is used for keeping the in wire mesh tray. A downward facing absorber is fixed below the drying chamber at a sufficient distance from the bottom of the drying chamber. A cylindrical reflector is placed under the absorber fitted with the glass cover on its aperture to minimize convective heat losses from the absorber. The absorber can be selectively coated. The inclination of the glass cover is taken as 45degree from horizontal to receive maximum radiation. The area of absorber and glass cover are taken equal to the area of bottom of drying chamber. Solar radiation after passing through the glass cover is reflected by cylindrical reflector toward an absorber. After absorber, a part of this is lost to ambient through a glass cover and remaining is transferred to the flowing air above it by convection. The flowing air is thus heated and passes through the placed in the drying chamber. The exhaust air and moisture is removed through a vent provided at the top of drying chamber.

CHAPTER 5

IMPORTANCE OF SOLAR DEHYDRATOR

5.1 IMPORTANCE OF SOLAR DRYER.

The world population is more than 6 billion and about 800-900 million people do not have enough food to eat.

- There are three methods to solve hunger problem

1. Increase food production.
2. Reduce population growth
3. Reduce loss of food during and after harvesting.

- It has been estimated that world as a whole more than 20-30 percent food grains and 30-50 percent vegetables, fruits/fish etc. are lost before it reaches to the consumers.
- Drying is a traditional method for preserving food. Solar drying is an effective method to preserve food.
- Solar energy is diffuse in nature and thus suitable for crop drying, locally available and thus saves transportation, solar dryers can be made locally of any size and capacity and solar dryers are economical if cash crops are dried.
- Experience over the past four decades has shown that in spite of high potential of solar drying it has not taken off.
- Systematic work on solar dryer has been done only in few countries.
- In industrialized countries, there is great interest towards solar drying. However, neither the temperature nor the heat requirement can be achieved with solar collector.

CHAPTER 6

MATERIALS REQUIRED

6.1 SHEET METAL

It is the main component of our project, thus the sheet metal covers the whole body of the kit which is used to get heated when the solar rays fall over the sheet, in side we using the perforated netted sheet metal plates for tray, thus the tray is used to place the components which is going to be dried.

Thus the sheet metal is cut as required for designing the body of the dehydrators, the body of the system consist of the lot of metals and the door at the back of the dehydrator is also made of sheet metal, the lower body consist only at bottom and in sides, because the upper surface of the lower body had an acrylic sheet.

Figure 4:- Sheet Metal

6.2 L ANGLE

The L angle rod act as a skeleton of the body solar dehydrator, the full body frame is made by the L angle thus the sheet metal covers over the frame to make a body.

Figure 5:- L Angle Rod

6.3 ACRYLIC SHEET

The acrylic sheet or glazing sheet which is placed over the bottom box of the solar dehydrator, it was used to collect the solar rays which is fall over the surface of the sheet, the black painted surface under the sheet is used to absorb more heat, because the black material attracts more heat.

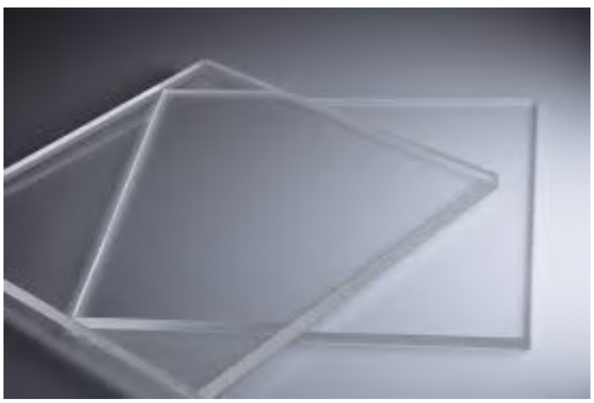

Figure 6:- Acrylic Sheet

6.4 ELECTRIC (SMPS) FAN

The fan is used in the system for absorbing the atmospheric air in to the solar dehydrator, the fan is fitted at the bottom of the system or else it was placed inside the system to absorb or suck it the air into the dehydrator, the air passes through the glazing sheet it got several fins for flowing the air, while travelling at the space due to the solar rays and the black surface the air got heated, thus the temperature of the air inside and outside the system is varied. The temperature of the air inside the medium is 50-70 degree Celsius. Due to this heat the moisture content of the product which is placed inside the system got removed and we got a moisture free dried product as outcome.

Figure 7:- SMPS Fan

A **switched-mode power supply** (SMPS) is an electronic circuit that converts power using switching devices that are turned on and off at high frequencies, and storage components such as inductors or capacitors to supply power when the switching device is in its non-conduction state.

CHAPTER 7
CONSTRUCTION AND WORKING PRINCIPLE

7.1 CONSTRUCTION

The solar dehydrator is developed from the mentioned materials, the frame of the whole setup is made by the steel rod L angle, which was cut and welded for the shape as we required, and the bottom body requires limited number of rods for the making of base which is covered by the sheet metal. Then the upper body requites the lot of rods thus it was made as small house shaped look, thus the interior portion requires the rod for the trays which is going to be placed on the surface.

Then the sheet metal is covered over the surface of the L angle which made as the skeleton of the hydrator, thus the whole setup and the back door is also covered by the sheet metal which is planed as in the model.

7.2WORKINGPRINCIPLE

This is the system mainly used to dry the food products by absorbing the moisture which is present in the food, it is like an eco friendly oven there is no microwaves used in the system we are using only the normal air get it from the atmosphere, when the enter into the system it passes through the fins due to the sunlight it got heated and it was send it to the storage chamber where we placed the food in the trays, the heat air passes and absorb the moisture which is present inside the system and it got out through the ventilator at the top. Lot of food material can be dried in this system like nuts, fruits, vegetables, fish, meat, leafs and etc. These dried foods can be used in industries for making packed foods, and it also used in houses for storing (preserving) the food for a time for an easy usage.

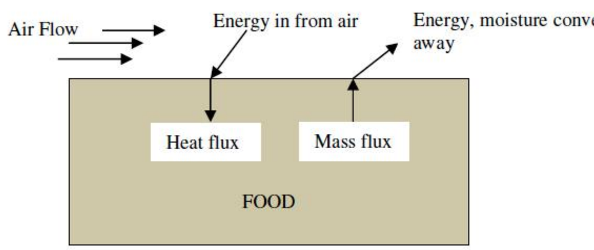

Figure 8:- Working

CHAPTER 8

APPLICATIONS AND ADVANTAGES

8.1 APPLICATIONS OF SOLAR DEHYDRATOR

- Agriculture crop drying food processing industries for dehydration of fruits, potatoes, onions and other vegetables,
- Dairy industries for production of milk powder, casein etc.
- Seasoning of wood and timber.
- Textile industries for drying of textile materials.
- Used to preserve the food materials for local use.
- Highly hygienic food drying dust free insect free bacteria free.

8.2 ADVANTAGES OF SOLAR DEHYDRATOR

- The higher temperature, movement of the air and lower humidity increases the rate of drying.
- Food is enclosed in the dryer and therefore protected from dust, insects, birds and animals.
- The higher temperature deters insects and the faster drying rate reduces the risk of spoilage by microorganisms.

- Dried products improve family nutrition because fruit and vegetables contain high quantities of vitamins, minerals and fiber.
- For diabetics dried fruit prepared without adding sugar is a healthy choice instead of desserts.
- People are encouraged to establish their own gardens.

CHAPTER 9

CONCLUSION

From the test carried out, the following conclusions were made. The solar dryer can raise the ambient air temperature to a considerable high value for increasing the drying rate of agricultural crops. The product inside the dryer requires less attentions, like attack of the product by rain or pest (both human and animals), compared with those in the open sun drying. Although the dryer was used to dry Potato, it can be used to dry other crops like yams, cassava, maize and plantain etc.

There is ease in monitoring when compared to the natural sun drying technique. The capital cost involved in the construction of a solar dryer is much lower to that of a mechanical dryer. Also from the test carried out, the simple and inexpensive mixed-mode solar dryer was designed and constructed using locally sourced materials. The hourly variation of the temperatures inside the cabinet and air-heater are much higher than the ambient temperature during the most hours of the day-light. The temperature rise inside the drying cabinet was up to 24 degree Celsius to 40 degree Celsius (74%) for about three hours immediately after 12.00h (noon). The dryer exhibited sufficient ability to dry food items reasonably rapidly to a safe moisture level and simultaneously it ensures a superior quality of the dried product.

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