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A REVIEW ON SOLAR DEHYDRATION (DRYER) SYSTEM

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ABSTRACT

Drying, particular of grain (Crop, Fruits, and Vegetables), is an important human activity and the globally use of dry product is distributed. For preservation, quality improvement and processing purposes, moisture must be often removed from organic and inorganic materials. Sun drying and Mechanical dehydration using fossil fuel are the most common technologies used. Sun drying is the low cost drying method but the final quality is protean, while the Mechanical dehydration is energy intensive process and contributes substantially to energy used, and Mechanical dehydration process cost has high as comparative to Sun Drying process. In this paper to present the various types of solar dehydration (Dryer) system like direct solar dryer and indirect solar dryer used today. Also to give the technical parameter of that dryer and presents the related technologies that can help improve existing solar dryers.

Keyword: Solar Dryer, Direct Solar Dryer, Indirect Solar Dryer, Mixed Solar Dryer, Natural Convectional Dryer, Forced Convectional Solar Dryer.

I. INTRIDUCTION

In the present scenario,in India 80-90% people represent agriculture economy, of the working population is employed in agriculture sector. Also in developed and developing countries increasing the population that why they do not solve their food problems of the entire population. This increasing population has direct impact on food balance. The quality and quantity of food grains are recuperate because of poor processingtechniquesandshortageinstoragefacilities. To maintain the balance of food supply and increasing the population in entire country, reducing the food losses of that production time is compulsory. Above this problem to solve, in food production caused by grains failure and significant seasonal fluctuation in availability can be found out by food conservation, e. g. By Dehydration (Dryer).

Preserving food by drying is the oldest method of food conservation. Sun drying of grains, fruits and vegetables was practiced before scripturaltimes inHindus, Egyptians, Chinese, Greeks and Persians. Dried foods have the advantages of taking up very little space, not required refrigeration and provided variety to the diet. They are good for backpacking, lunches, camping, and snacks. Drying is a relatively simple process, requiring little outlay of equipment, time and money. Also drying is not hard to be understood, it take time, constant attention, skill, and understanding of the principles of food drying methods. For preservation of food the drying method is

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very effective. The used of solar dehydration system, the advantages to give by less time to dry, unprotected from rain, wind-borne dirt and dust, infestation by insects, rodents and other animal.

In India, sun drying is the most commonly used method to dry the agricultural materials grains, crops, fruits and vegetables. In sun drying, the gains arepropagate in a thin layer on the ground and exposed directly to solar radiation and ambient conditions. The rate of drying on various parameters such as solar radiation, ambient temperature, velocity wind, relative humidity, and moisture content, type of crops, crop absorptive and mass of product per unit exposed area.

Solar thermal technology is a technology which is rapidly gaining acceptance as an energy saving measure in agriculture application as rural area. It preferred to other alternative sources of energy such as wind and shale, because it is easy, infinite, and non-polluting. Solar air heaters are simple devices to heat air by utilizing solar energy and it is employed in many applications required lowsparing temperature, such as grains (Crops, Fruits, and Vegetables) are drying and space heating.

Today, all over to used the dryer all most every countries, provides economical and best quality of drying be dryer used. But this dryer are some advantages and some limitation by used of dryer efficiency, cost, power consumption, quality of drying. Today lots of dryer designed by used of dryer like natural air used to get natural conventional dryer, air pass to the chamber by some electrical utility that forced conventional dryer, similar as freeze drying, osmotic drying and vacuum drying.

II. TYPES OF DRYER

2.1 Open Solar Drying [1]

This method is oldest method in India and commonly used. In this method to give that the small thin layer of grain on mats or trays in open sun light, bring out the product to wind and sun. This drying method shows Fig 2.1

Fig. 2.1 Open Solar Drying in Ruler Area

The open drying is not suitable for large amount of product dry in firms, because intensity of open dryer to give larger area require. Also some disadvantage of that higher cost of labour, decreased quality of products, it also involves a labour intensive process before the products can be ready for storage. Open solar drying depends on environmental situation, such as solar radiation, wind, and ambient conditions. It usually leads to the impairment

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of the products because of many losses, damage, such as reduced amount of product due to the wind, wastage, and rainfall, birds, and animal and ethnologist impedance. As the drying process is relatively slow, considerable losses occur, including insect contagion, enzymatic response, growth of micro-organisms, and diminution of mycotoxin, which causes adeterminable reduction in product quality.

In open solar dryer, solar radiation effect of heat and mass transfer influencing on grain they shows in Fig 2.2 and Fig 2.3.

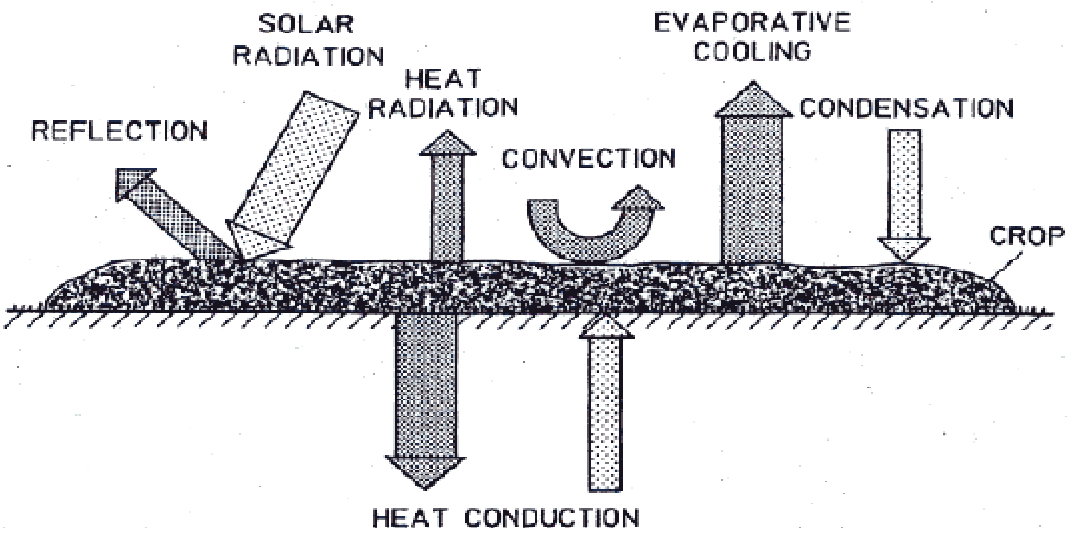

Fig. 2.2 Heat flow influence on open solar dryer

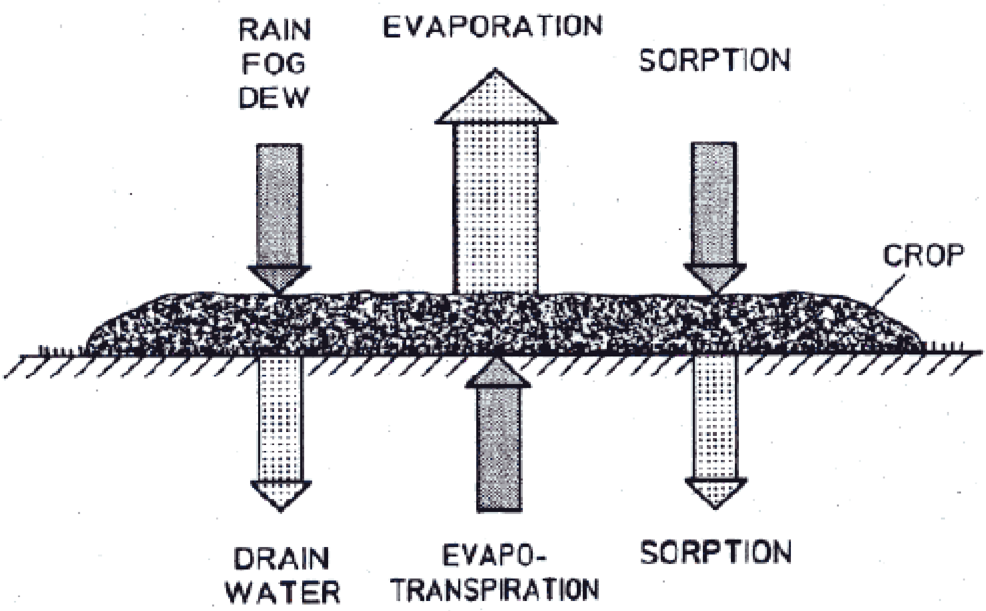

Fig. 2.3 Mass flow influence on open solar dryer

Jain and Tiwari studied the thermal behaviour of open sun drying and developed a mathematical model. They found that the rate of moisture transfer significantly high and the prediction of grain temperature, removal of

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moisture rate, and static condition of air temperature to ambientconditions.Opensundrying isveryslowprocessand leadtoconsiderablyhuge losses. [2]

2.2 Direct Solar Dryer [1]

In direct mode of solar dryer the crop is directly bring out to the solar radiation. For this occur, the structure containing the grains must be covered with the transparent material. The solar radiation passes through the glass over and is absorbed by the grains and its contiguous surroundings. Most of the solar radiation covered into heat, thus rising the temperature of the grains and surrounding. This dryer shows in Fig 2.4

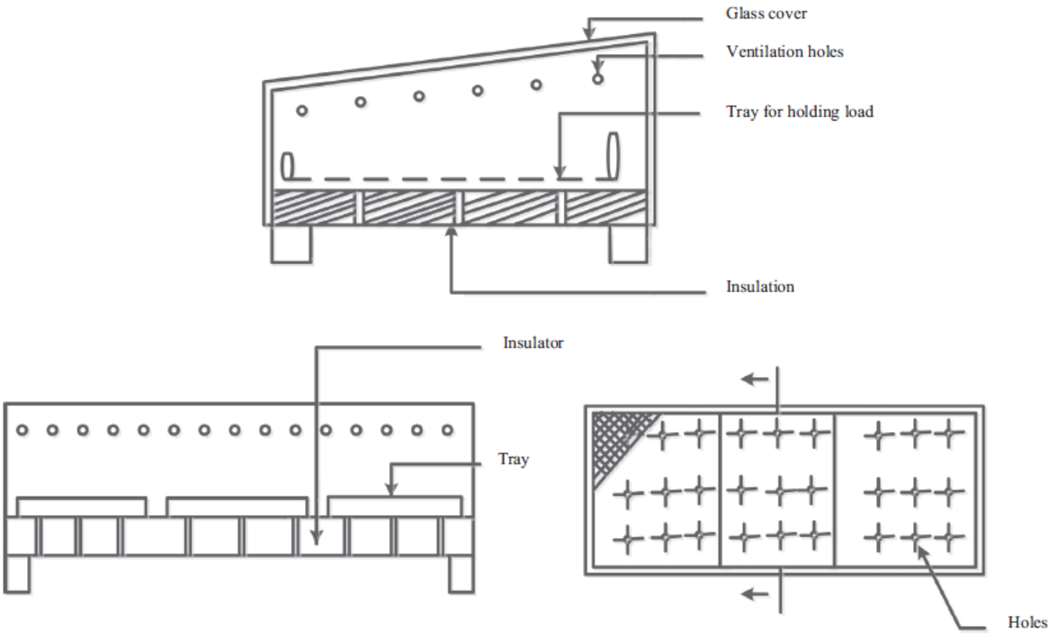

Fig 2.4 Direct Solar Dryer

The direct absorption of solar radiation by the grains is most effective way of converting solar radiation into useful heat for drying purpose. The final dry quality of some grains is also heightening by direct exposure to solar radiation.

In the direct mode of dryer, the grains are directly absorbed solar radiation, the grains temperature is difficult to control and this is main disadvantage of this type of dryer. Drying rates and final grains quality are dependent on grains temperature. However this simplicity and relative low cost of this type of dryer make it’s attractive for both small and large sale of production.

This method the dryer is the advantage of above open solar drying method by the product assertive protection from rain and dust. This type of dryer called as box, tents or cabinet dryer and his low performance. [3]

Nitin Kumar et al., the low cost solar cabinet dryer gives more than three times heat in the chamber than the outside atmospheric temperature, and this high temperature get the drying purposed. Drying efficiency is high than open sun drying.[4]

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2.3 Indirect Solar Dryer [1]

In an indirect solar dryer, the grains are not directly exposed to solar radiation. The incident solar radiation is absorbed by some other surfaces, usually solar collector, where it is covered into heat. The air for drying flows over the absorber and heated the air. The warm air or heated air is then used to transfer the heat to the grains located within the cloudy structure.

For some grains, especially herbs and some spices, the final quality reducesif the product is exposed to directly to solar radiation. The spice cardamom is one such example. Exposed to direct sun light, the seedcase are inclined to splits and the chlorophyll destroyed.

High and controllable temperature can be achieved in this type of dryer if a fan is used to move the air through the collector. The main disadvantages of an indirect solar dryer are the additional cost and complexity involved in construction, but the capacity and quality of drying as high than the direct solar dryer. The indirect solar dryer shows in Fig 2.5

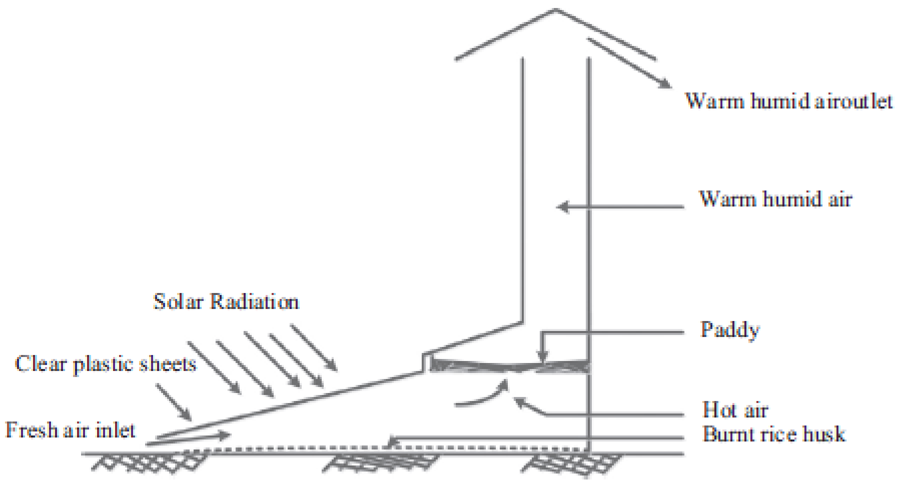

Fig. 2.5 Indirect Solar Dryer

C.V.Papade et al., to studied the design and constructed to the use of solar dryer is limited because of drying is not potential due to frequent occurrence clouds in the day or evening. If storage of solar energy can provide in solar dryer, then there is the potentially drying product in evening time. Hence the energy can be stored either in sensible or latent heat. Designing the indirect type solar dryer, some technical factors are taken into consideration. In explain to parameter of indirect type solar dryer are carried out like mass of water evaporate, energy required to removable water content, heat gain by air, drying time, velocity, drying rate, losses of heat and insulator thickness. [5]

2.4 Mixed Solar Dryer [1]

In mixed mode solar dryer are the contribution of direct and indirect solar dryer and no moving parts are required that called as passive dryer. This type of dryer gain the energy from the sun rays that insert through the collector. The inside surface of the collector is painted black, and the sun rays are accoutrement by embellishment the heat of the air that is collected inside the chamber. This mode of solar dryer show in Fig. 2.6

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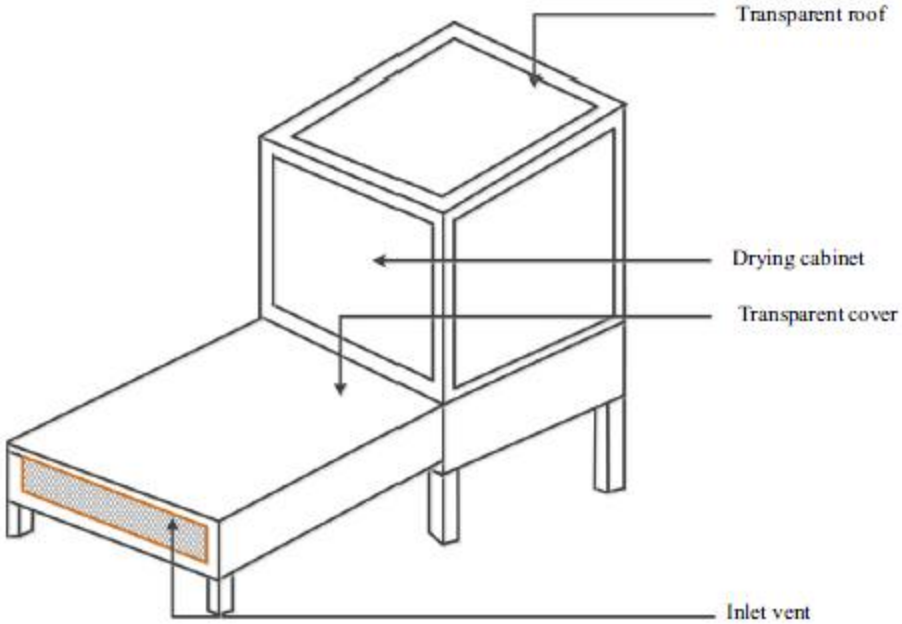

Fig. 2.6 Mixed Mode Solar Dryer

A simple mixed-mode solar dryer has been design and develop in some other work. This system is driven by the principle of thermal test procedure. This mode get effectively work than other and quality and quantity of drying product are good than other dryer. Time is less required for drying.

Ahmed Abed Gatea et al, Mixed mode of Solar dryer consists of three parts; 1) solar collector for air heating, 2) fins and 3) the drying cabin section with four trays. The drying test conducted after maintained the air speed at 1.5 m/s at the drying cabin. The drying process continued until the total beans weight (100 kg). The collector efficiencies are the highest and the lowest be61.82 and 45.40% respectively. Higher moisture evaporating from the beans was perform in the first tray, as content of moisture was reduced from 60 to 8% during the 6 h compared with the other three trays. [6]

Bukola O. Bolaji et al, evaluated the mixed solar dryer, the heated air from a separate solar collector and passed through a grain bed, and then the drying cabinet absorbs solar energy directly through the transparent walls and roof. The results obtained the test period revealed that the temperatures inside the dryer and solar collector, higher than the ambient temperature during hours of the day-light. The temperature rise inside the drying cabinet was up to 74% for about three hoursproximately after 12.00h. The drying rate and system efficiency are 0.62 kg/h and 57.5% respectively. The drying rate in the dryer reveals its ability to dry food items reasonably rapidly to a safe moisture level. [7]

2.5 Natural Convection Solar Dryer [1]

A natural convection solar dryer needs minimum disbursement for controlling the drying temperature. Its drying rate is limited. This kind of solar dryer plays essential role in the drying sector because its low cost. It’s popular because of its simple maintenance and operation. It consists of a collector, a transpicuous open sheet, and a unit for drying; it is covered by a shade on top. These parts are connected in a series, comprising a system that can

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obtain very satisfactory drying rates. The simplest of solar cabinet dryer, it was very simple, and consists essentially of a small wooden hot box. The sides and bottom can be portable and can be made by wood or metal sheet. A transpicuous open polyethylene sheet was used as cover at upper surface. Air holes opening are located on the side edge of the drier for circulation.They show in Fig. 2.7. This dryer is also called as Passive Mode Solar Dryer. However, the natural convection solar drying system has a limited capacity.

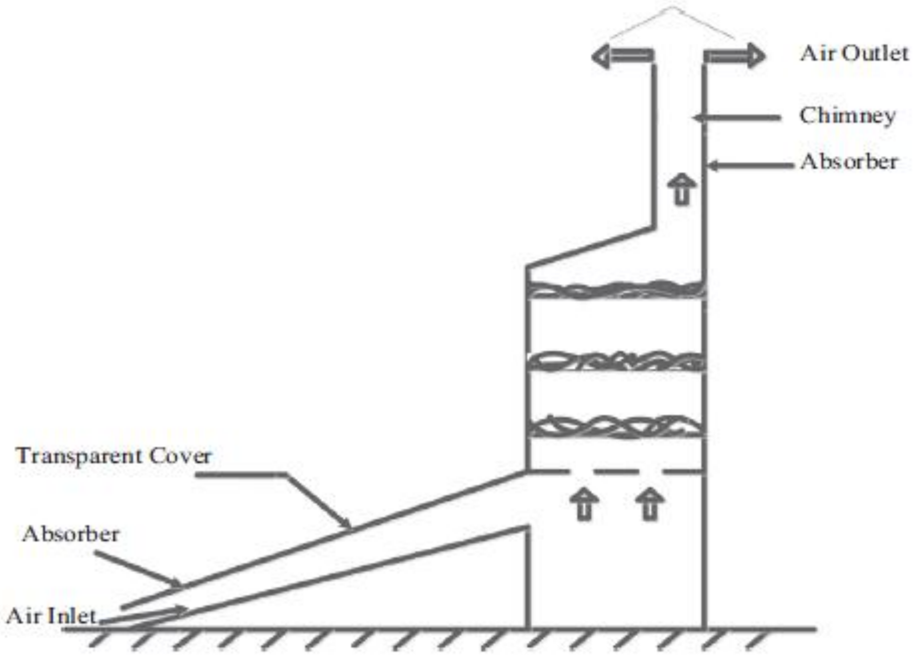

Fig 2.7 Natural Conviction Solar Dryer

Sharma et al. found that the predicted plate temperature for no load reaches a maximum of 80–85 8C during the peak hours, with load of 20 kg of wheat, the maximum temperature is about 45–50 8C.[8]

Gbaha et al designed the natural convection solar dryer and then tested experimentally by drying cassava, bananas and mango slices. This drying was simple design and made by farmers from local materials. It has a relatively moderate cost and easy to use. They reported the thermal performance of the newly developed dryer in terms of heat and mass transfers control by solar incident radiation were found to be higher compared to open sub drying for the selected food materials. [9]

2.6 Forced Convection Solar Dryer [1]

This dryer to need the electricity operated the fan or blower for force to get air pass through the cabin. In many rural areas either has no electricity or high costs to generate the electricity used to run this type of dryer. In developed country mostly widely use forced natural convection solar dryer. This dryer is also called as Active Mode Solar Dryer and they show in Fig. 2.8. The disadvantage of natural convection solar dryer overcome of this dryer be used. Its advantages include low energy cost, ideal shrinkage in the drying period, better drying capability, minimization mass losses, and better quality of the dried products.

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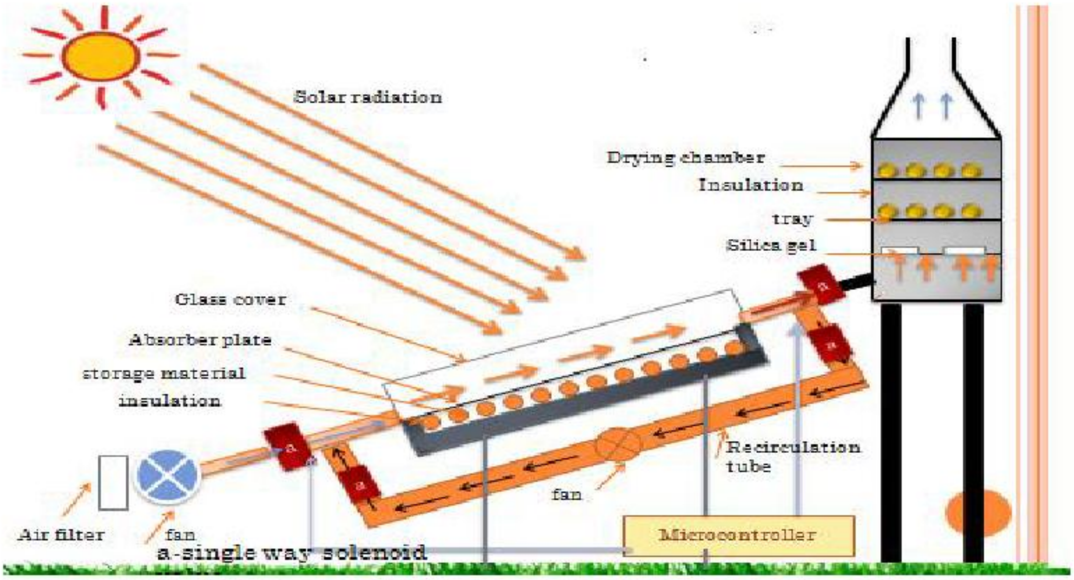

Fig.2.8. Forced Convection Solar Dryer

Al Juamily et al.constructed and tested an indirect-mode forced dryer for drying fruit and vegetable in Iraq. The solar drying contain by a solar collector, a blower, and a solar cabinet. Two identical air solar collectors having V-groove plates of two air passes, a single glass cover was used. The total area of the collectors is 2.4 m^2. The dimensions of the drying cabinet are 1m×0.33m×2m (width, depth, and height). The cabinet has divided into six divisions separate by five shelves. The distance between the shelves is 0.3m except the upper one, which is 0.5m from the roof. Each shelf is 0.95m×0.3m and is made of metallic mesh. The drying chamber walls are made of plate except the southern side, which was fixed with glass plate and the dimensions 1m×2m×0.002m. They work on dry grain are grapes, apricots, and beans. The moisture content of apricot has been reduced 80% to 13% influence of one day and a half of drying. The moisture content of grapes has been reduced from 80% to 18% in two and a half days of drying. Also, the beans have been reduced from 65% to 18% in 1 day only. They concluded that air temperature was most adequate factor on drying rate. The effect variation of speed of air inside the drying cabinet be small and be neglected. His also concluded that the relative humidity of air exit from the cabinet was small (25 and 30%) and there is no need for high velocity air inside the cabinet. [10]

Karim and Hawlader determined that the V-groove collector was the most efficient collector and the flat-plate collector the smallest efficient. It results showed the V-groove collector has 7–12% higher efficiency than flat-plate collectors. Optimum situation of three collectors by cited to observe up to approximately 70% thermally efficient at 0.031 kg/m^2s could be gating with the V-groove. The double pass performance of the collector improved the efficiency of all tree collectors. The air collector's efficiency is a strong function of airflow rate. As flow rate of about 0.035 kg/m^2s is considered optimal for solar drying of agricultural produce. [11]

C. Velmurugan et alused indirect forced convection solar drier integrated with recirculation of air and its performance is tested for drying grapes under the metrological conditions of Coimbatore, India. The system gets a flat plate solar air heater with lens and recirculation tube, a drying chamber and micro controller. Drying experiments been performed at an air flow rate of 3.197kg/s. Drying of grapes in a forced convection solar drier

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removed the moisture content from around 80% (wet basis) to the final moisture content about 10.6% in 22.6h. Average drier efficiency is about 20.92%. The specific moisture extraction rate is 0.87 kg/kWh. [12]

III. APPLICATION

It is an applicable process in the preservation of agricultural crops and in industries, like as textile industry production, dairy product processing, cement industry production, clay brick production, tile production, wood and timber processing, wastewater treatment, and bio-mass treatment. The energy requirement for drying can be supplied from various sources, namely, wood, electricity, natural gas, fossil fuel, natural gas, bark forest residual, and solar. Although the use of solar radiation for drying has withdrawal since antiquity, it has not yet been widely commercialized, particularly in the industrial sector. Considering the fast drain of natural fuel resources and because of the rising fossil fuel cost, solar drying is expected to become indispensable in the future.

IV. CONCLUTION

The solar drying for agricultural and industry products are more potential the technical and energy saving point of view. Numerous types of solar dryers have been designed and developed in different parts of the world, flexible varying degrees oftechnical performance.

It concludes thatthe technical directions of the development of solar-assisted drying systems for agricultural produce are compact collector design, more efficiency, integrated storage, and long-life drying system. Air-based solar collectors are not the only available systems. The hot air for drying in agricultural produce hasbeen forced to flow in the water to air heat. The hot water tank acts as heat storage of the solar drying system.

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