

# A REVIEW OVER DIFFERENT TYPE OF SOLAR AIR DRYER AND ITS APPLICATIONS IN INDIA

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**Abstract.** In India the people are drying the agricultural products are dry under the open environment. However, we have drying the agricultural produce in the open air the quality of product is degrades due to an external dust particles and uneven rate of drying. Solar radiation are absorbed by mainly three type device which is used as undeviating type solar dryer, miscellaneous mode air dryer and indirect solar dryer. We study different type of solar dryer and different design modification applied to them in order to increase their effectiveness. The several solar exposures to air applications are classified into two major categories, with the purpose of agricultural and industrial. Much remuneration could be exploited since solar energy for drying applications. The study is based on the diverse types of solar air dryers utilize in India and their applications like agriculture products including fruits, vegetables, crops, grains etc. Also the some Indian government policies have been discussed which are used to promote solar products in India.

**Keywords:** Solar Energy, Thermal Application, Utilization .

## 1. INTRODUCTION

Energy has developed into a significant and one of the essential for infrastructures any economic improvement of any nation. The renewable energy resource such as wind, sun, biomass and geothermal heat are non-conventional energy resource. Solar energy absorbed by the plants is estimated to be trillion. Solar energy is also used by many methods and appears in nature in some other forms of energy. Solar energy is called as mother of all the form of energy [1].

Sun radiation warming the body during winter is perhaps the earliest method to use of direct solar heat that man has made. Drying of clothes, timber, fodder, salt water and agricultural produce remain the most extensive use of direct solar energy in history. All other devices for harnessing direct solar energy are fairly recent origin [2]. A traditional and wide spread used of the sun radiation for drying the specific agricultural produce. This method substantial effect in economic. We have used the sun rays to dry the many products like as grains, maize, paddy, cash crops such as ginger, cashew, pepper etc. There are two noticeable obstacles to harnessing solar energy. First of all it is not continually available on earth. Hence, a little form of storage is required to maintain a solar power system through the night and during periods while local climate conditions

unclear the sun. Secondly the solar radiation is gentle. Although the entire sum of power is massive, the gather and maintenance of solar energy into constructive forms must be carried out over a large area which entails a large resources speculation for the conversion apparatus. Solar energy has numerous tremendous returns in evaluation to the other source of energy. Solar energy does not infect surroundings or put in danger biological equilibrium. It avoids main setback like investigation and transportation. [3] Energy conservation involves all the sectors of the economy. Although the importance of energy conservation has been discussed for quite some time, the efforts generated had been fragmented and half hearted. There has also been a lack of adequate focus on the institutional arrangement, which would devise suitable incentives appropriate to each sector, backed by adequate statutory power enforcement. During the ninth year plan, they require for a power preservation act be realized. Consider the huge potential of energy saving and remuneration of energy effectiveness, the Government of India enacted the Energy Conservation Act, 2001[4]. India is second most populated nation in worlds. So it is huge amount of energy and it's also produce large amount of energy. In present time our nation rank third in the world wide in energy production. India produces 8% energy of the world in total production, and fifth rank in consumption of energy in the worlds. India consumes 4.4% of total energy generation in the worlds.

The Prime Minister Shree Narendra Modi is initiated the International Solar Alliance. In this alliance 121 countries are members. It is a greatest grouping of state world-wide. Basically the purpose of International Solar Alliance is working with the clean energy, sustainable environment, public transport and climate. This is focus on the utilization of solar energy. [5].

## 2. LITERATURE REVIEW

**Suherman, Hadiyanto, Evan Eduard Susanto, Shesar Anis Rahmatullah, Adity Rofi Pratama**

In a recent research paper we have study about the experimental data of hybrid solar dryer. This is consisted of the supplementary heater and a solar dryer and liquefied gasoline. When the fan speed of a dryer is 1690 rpm the efficiency of hybrid solar dryer device has been obtained maximum. The drying rate of the system more, because the temperature of the chamber increase about 60-70 C. under a this modeling we have concluded the quality of the

agricultural produce. When the lime are dry in high temperature the quality of products decrease [6].

**Jelena R. Tasic, Milan Gojak, Nenad Lj. Cupric, Milan R.Bozovic**

Another paper study we have concluded that is the construction and the modeling design of direct type solar dryer. This model is moveable and small in size. Active solar dryer utilized the sun radiation throughout the day. Active solar are drying the non timber products of the forest as well as drying medicinal and aromatic material [7].

**Mehmat Das, Ebru Kavak Akpinar**

In present time there are many scientific studies to increase the thermal performance of solar dryer system. Mehmet Das study about the performance of a solar dryer with solar tracking system had been investigated. In research paper compare the solar air collector dryer with moving solar air collector dryer. This type of dryer is used to drying the apple product. The collectors are also studied in double pass mode to investigate to extent of improvement in efficiency that can be achieved without increasing the size of collector and cost [8].

**P. A. Potdukhe, B. S. Thombre**

Solar energy storage is a serious problem in last decades. But in recently many scientists are working with sun energy to store in thermal form. P.A Potdukhe study solar dryer system to tied with a novel intend of absorber having integral thermal storage capabilities was designed, made-up, replicated and also tested at Rajiv Gandhi College of Engineering Research & Technology, Chandrapur India. Thermic oil was used as a storage material. This dryer system is used to store the energy in the form thermal energy and reduce the drying time of agricultural products. It is a mathematical design and experimental evaluation of solar dryer. They are used thermic oil to store sun energy in form thermal energy. The stored energy sued to dried the product and also increase the performance of the solar dryer. The main objective this model to reduce the drying time and to maintain the better quality of product mainly fenugreek leaves and chilies. They are also study about humidity factor and temperature has performed on the solar dryer [9].

**A. Borah \*, K. Hazarika, S.M. Khayer**

In india many products are dried through the sun radiation just like as chilies, grains, grapes and turmeric etc. A.Borach studies about turmeric and dry with using solar conduction device. In this solar system the temperature have been obtained about 39 to 52 C .Recently the review paper on process to how to dry the turmeric by using the solar conduction dryer. This is good to drying the turmeric power. The moisture contain in turmeric is 76.65%. It is reduce to 6.36% in a day time. The model of turmeric dryer is efficient

to dry the products by using solar air dryer system. The overall thermal efficiency of the solar air dryer has been founded to 55%. We have cut the turmeric as slice curve, because they are more than the drying rate is also increases [10].

### 3. Material Used

The subsequent resources be used for the manufacture of the inactive type solar dryer: [11]

1. Timber – timber are used to make whole base this dryer. Because wood are cheap and easily available in market. It is cheaper than other material.
2. Acrylic Sheets: This sheet is used to make the upper part of solar dryer, for absorbing the sun radiation. It is long durable material with respect to time.
3. Aluminium sheet: Aluminium is good conductor of heat and its available sheet form in the market .Aluminium sheet are used for making trays in solar dryer to keep the material. When they are painted by black with tar to absorb the sun rays.
4. The construction of the trays for placed the products in the dryer chamber nets are used.
5. The silicon glue is used for adhesive and fasteners and also used nail glue.
6. The nets are used for the restrict to inlet and exit the insect in the dryer system.
7. We have taken the handles, hinges and reflector and dryer door.
8. 8. We have coated the black and brown Paint.

### 4. METHODS OF SOLAR DRYING TECHNOLOGIES

**4.1. Direct Solar Dryer:** Direct solar dryers to dry the product or material by the direct contact of sun radiation. Inside dryer the temperature is higher when basinthere are some solar dryer are explained in below that are used to drying products. The air inters the chamber it's also heated by inside temperature that removes the saturated air from the drying product kept in the solar dryer. In recently tents type of solar dryer are constructed [12].

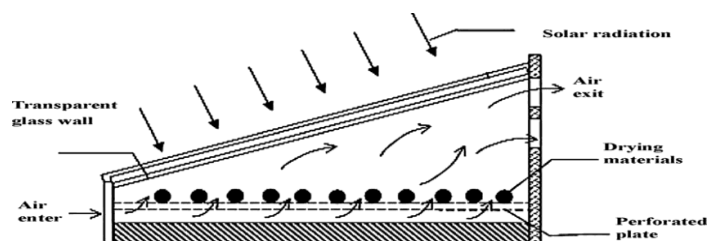


Fig.2 direct type solar dryer

#### 4.1. The Indirect Type Solar Drier

This type of solar dryer was constructed for used t dry higher humidity agricultural produce. Such as paddy, coffee bean etc. they are magnifying the solar radiation indirect form to dry the products. When we have use the storage device to store the solar radiation in the form of thermal energy. The store energy has used to drying the products and also reducing the drying time. It's a closed system so it prevents from the external effects such as wind, insect, birds and dust particles to spoilage. The solar drier constructed of air heater, blower drying chamber, air supplier device and thermal storage system. The heated air is blown to drying chamber by blower of the centrifugal type to handle large quantity of air. Batch type or regular flow drying chamber manually created the necessary radiation to reduce moisture [12].

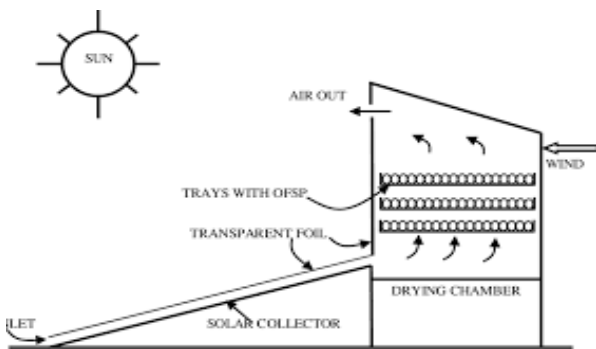


Fig.3 Indirect solar drier

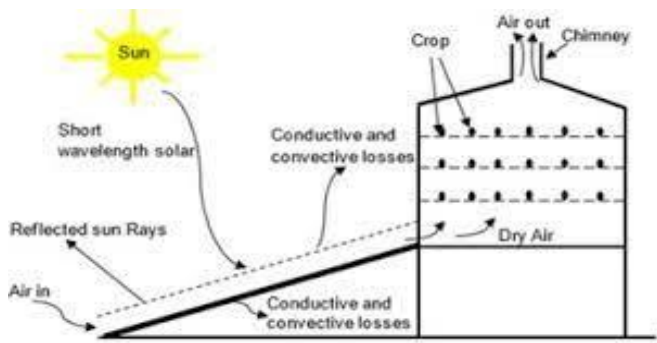


Fig.4 Indirect solar dryer

#### 4.3. Forced Convection and Natural Convection Solar Dryer-

**4.3.1 Forced convection-** Forced convection is a process in which we have used an external source to transport the air present in surroundings by using the fan. In this system natural convection, thermal conduction and thermal radiation occurs to transfer heat by a very good rate in this system. The heat transfer coefficients associated with forced convection are much greater than those associated with free convection [14].



Fig .5 forced convection

**4.3.2. Natural Convection-**This type of convection the circulation of air is take place in natural way. The flow of heated air has transfer by temperature gradient. When flow of fluid is due to buoyancy forces created by density differences are caused by temperature gradient in the fluid, the heat transfer in this action is called free or natural convection [15].



Fig.6 Natural Convection

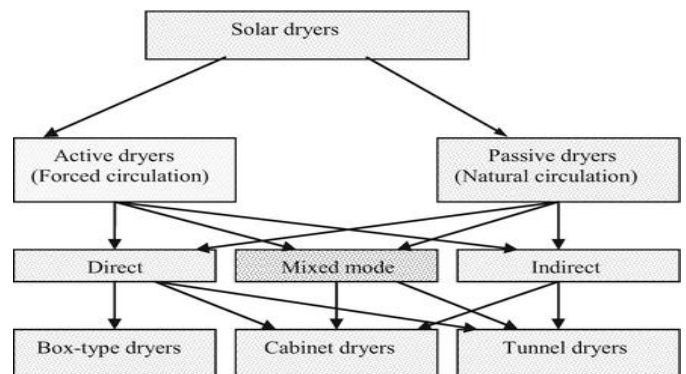


Fig.7 Classification of solar dryers and their drying modes

#### 5. Different Types of Solar Dryers Installed In India

Solar energy can be basic need of human being that have used in various form .In recent years the Indian government focused on the renewable energy. The government of India is working in various project of the solar energy. Because the consumption of energy increases day by day.

##### 5.1. Fish and Vegetables type of Solar dryer

This is system consists of many chamber to dry the vegetables products as well as fishes. This method of drying taken more time as compare to others drying method .Because we have used the sun radiation to convert into heat form .This type of solar dryer system are depends upon the climate changes. That type of solar dryer the sun rays fall on



the surface of solar dryer the air inside the system are heated and circulated the hot air in drying chamber. When the dry air heat passes all over the drying chamber. In this case it is a single unit box which is traps all the sun rays or heat .It is easily installed in any location in Asian country. In India maximum time the temperature are higher than 27 C [17].



Fig.7 Solar dryer for fish and vegetables

**5.2. Solar Copra Dryer:** Solar copra dryer is based on the solar green house dryer that have to used for drying the copra .This is a tunnel type system that have used in India because they are maintain the temperature inside the system. The government of India also provided the subsidy to install the solar dryer. Tamilnadu state government also provided the subsidy for the farmers to install the copra dryer. The maximum subsidy given by state government is 50 to 60% of the total investment amount. In Tamilnadu the area covered by solar copra dryer installation approx 85,100 sq.fit. [18].



Fig .8 Solar Copra Dryer

**5.3. Fruits Dryer**

Fruit drying is a process to dry the fruits. In this method, we have used the sun radiation to dry the fruits and its products by using the solar fruits dryer .In many countries the wastage of fruits are increases due to lake of dryer system. These systems usually protect the product of fruits by the wind as well as dust particles. In solar drying method the dryer conserves the taste as well as flavor for extension in some time off period. This systems the cost of transportation, storage and handing has lowered as compare to other drying system. Dried fruits are in longer used under the proper storage of these products [19].



Fig.9 Solar fruits dryer

**5.4. Moringa Leaves drying:** Solar Dryer For Moringa Leaf Drying could be used to dry Moringa leaf from 70% moisture content to less than 5% moisture content with good colour and uniform drying. Temperature and Humidity could be controlled [20] .



Fig .10 Moringa Leaves drying

**5.5. Solar Spice Dryer**

In present time solar spice dryer used in Asian country because the sun radiation are obtained 6-8 months in a year. In India Kerala is spice capital .So solar spice dryer are installed in Kerala state. This type of solar dryer is low cost for drying the spice. In solar spice dryer we have obtain the good quality of the spice and it is also reduce the losses of material. This type of dryer was portable for making the Spice powder. In India the demands of solar dryer are continuous increasing, because it is portable and easy to install. The state government also promotes to manufacture solar device. It is change working process of drying of chilies. In Tamilnadu middle class families use this type of solar dryer, because it is cheaper than other drying system [21].



Fig. 11 Solar Spice Dryer

## 5. APPLICATION OF SOLAR DRYER

In present time solar dryer had been used in large area of the world. There will be some application given below [22]

- 1) Heating Building: For space heating such as room, the direct absorption of solar rays with the thermo plane window is done. Heat of fusion type thermal storage material, which has acted as a thermal buffer in the room used.
- 2) Air conditioning building utilizing desiccant beds or an absorption refrigeration process:

Dunkle(1965) had suggested solar air conditioning by using desiccant beds. Another approached to obtain cooling was by using heat of solar air heater, in the generator of an absorption air conditioner.

3) Drying agricultural product and lumber: The advantages of solar drying over open sun exposure of agriculture produce have been accepted. Solar drier are expected to be used by farmer with limited technical skills and shall, capital; therefore, those proposed devices should be simple, inexpensive and use least land area.

4) Heating green house: Direct assimilation of the solar energy is employed in the green house which acts as a solar air heater with no air circulation. The term "green house effect" usually refers to solar air or liquid heaters, employing transparent glazings.

5) Using air heaters as the heat source for a heat engine such as a Brayton or Stirling cycle: Application of air heater source for a heat engine, however, require temperature in the order of hundred of degrees which is beyond the practical range of operation of the collectors described here.

## 6. Government Policies Of Solar Dryer In India

- 1) The Ministry of New and Renewable energy are working for to setup the Ultra Mega solar power project and solar park in India. The target of Indian government in 5 years to installed 25 solar power project and solar park to increase 20,000 mega watts of solar power project and by installation of solar park.
- 2) The policy of Ministry of New and Renewable energy to enhanced the 20,000 mega watts to 40,000 mega watts. This Ministry's order dated 21-03-2017. Those parks have been installed to set up by 2021-22.
- 3) The Ministry of New and Renewable energy department provided the central fiscal support to Rs. 250, 0000 per solar projects in the India. Under this scheme, its obtained very good milestones in India.

- 4) The government of India also passes the schemes to make the infrastructure for the solar parks and solar power projects in the ratio of 60:40. Under this policy further provide financial assistance for external development of transmission system. This schemes applicable for all state sand union territories to benefitted for this policy.

## 7. Conclusion

First time in the world's scientific studies on solar energy are held in 1940. In last decades the energy utilization in India increases, but the generation of energy is quit less. It is way to solving the energy consumption problem to produce the more energy by using the renewable energy. Solar energy is cleanest form of energy and it can be easily too utilized. We have studies the utilization of solar energy to drying the agricultural products in India. However we shall be increase the solar energy to in various forms to dry the many products as a domestic and commercial purpose. The Ministry of New and Renewable energy are focused to how the solar energy utilized in large amount in India. The Ministry of New and Renewable Energy setup major plants to maximize the solar energy.

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