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EXPERIMENTAL INVESTIGATION OF EFFECT OF SOLAR-BIOMASS HYBRID DRYING SYSTEM ON DRYING RATE OF MAIZE

Er.T.B.Shaikh
M.Tech Scholar, Department of energy technology, Department of Technology, Maharashtra, India
Er.A.B.Kolekar
Asst. Prof. Department of energy technology, Department of Technology, Maharashtra, India
Er.N.N.Shinde
Asst. Prof. Department of energy technology, Department of Technology, Maharashtra, India

Abstract:

Globally it is estimated that 84% of produced grains are wasted. In India 20-40% of food grains are spoiled, due to conventional preservation technique. The preservation tech like canning, freezing, drying etc are used in order to avoid the food wastage. Renewable hybrid drying system may be optimum for food preservations at low cost and will exploit at large in the present scenario.

Proposed system of hybrid drying system is an integration of solar thermal air heating system coupled with air heating using suitable heating system based on biomass burning to maintain continuous drying process. Experiments are carried out for sun drying, oven drying, solar drying using air heaters and solar- biomass thermal drying.

It is observed that solar hybrid system using biomass as a fuel for heating has reduced time of drying maize. For only solar system hot air drying time reduced from 72 to 33 hours and for solar hybrid drying time reduced from 72 to 15 hours.
KEY WORDS: Drying, Hybrid Drying System, Biomass.

I. Introduction:

Till date hardly any research work carried out on hybrid renewable energy maize dryer. Therefore renewable energy drying system aimed at reducing the weather dependency and improving the temperature and flow rate stability with a biomass back-up heater is to be designed. The efficiency of solar dryers could be increased through the use of a combination of solar and biomass heating sources, compared to conventional dryers with only solar or only biomass heating sources. Using combined solar and biomass dryers have the potential to increase the productivity and resultant economic viability of developing countries. The overall objective of this work is to design, develop, a prototype renewable energy-based (solar-biomass) hybrid drying system.

II. Methodology:

The research work is proposed based on the test set up for drying maize as shown in fig below and is divided in to 4 stages.

a. TEST METHODS:

1. Sun drying
2. Oven drying
3. Solar air drying
4. Solar biomass hybrid drying

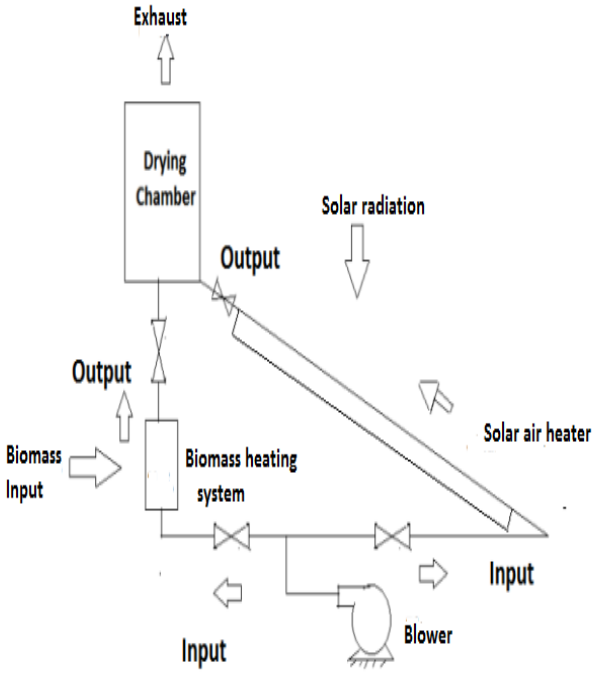

Fig.1 Proposed test set up

III. TESTING:

The testing is carried out for maize local variety in India generally cultivated and available. Various tests carried out for open sun drying, controlled oven drying to ascertain the rate of moisture removal with respect to time. The same data is used for designing batch type solar air heater and a cross flow heating system using biomass as fuel for thermal air heating. Test set up for prototype maize dryer is shown in fig.2.

Fig.2 Test set up for solar hybrid maize drying

The overall results are represented as under.

IV. RESULTS AND DISCUSSION:

a. SUN DRYING:

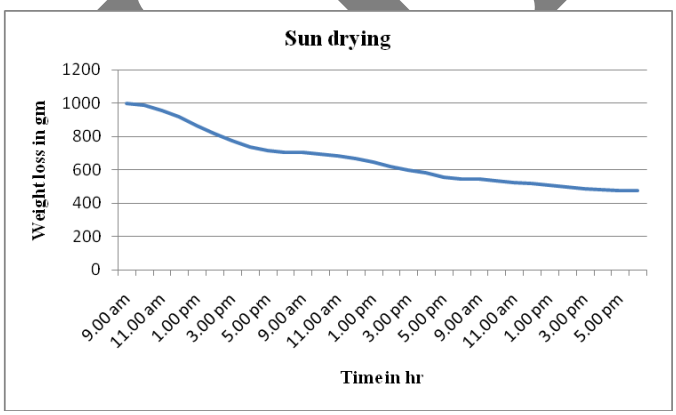

Chart 1-a Weightloss Vs time

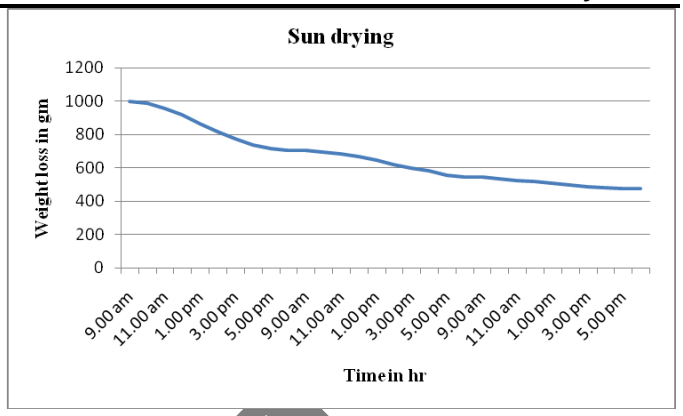

Chart 1-b Cumulative Weightloss Vs time

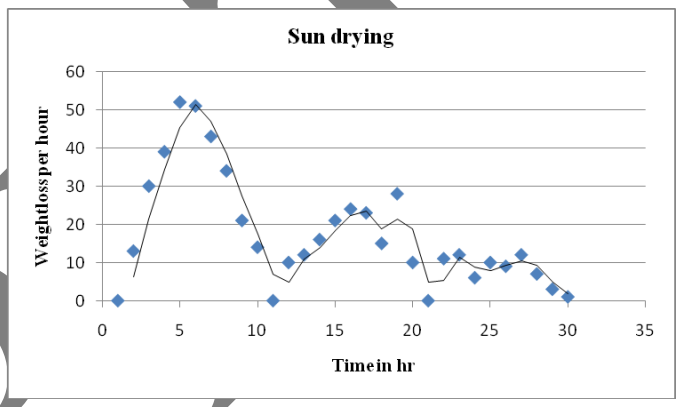

Chart 1-c Weightloss per gram Vs time

Chart-1a, b, c: Drying characteristics for open sun drying Tavg = 29.9^0 C

It is observed that the weightloss per hour reached to its peak on each day and then decreased. The rate of drying is increased due to increase in temperature between 11.00 am to 3.00 pm but decreased there after which shows the earlier and faster removal moisture from the dried maize. The total drying time required to reduce 70% moisture to 13% is 72 hours.

b. OVEN DRYING:

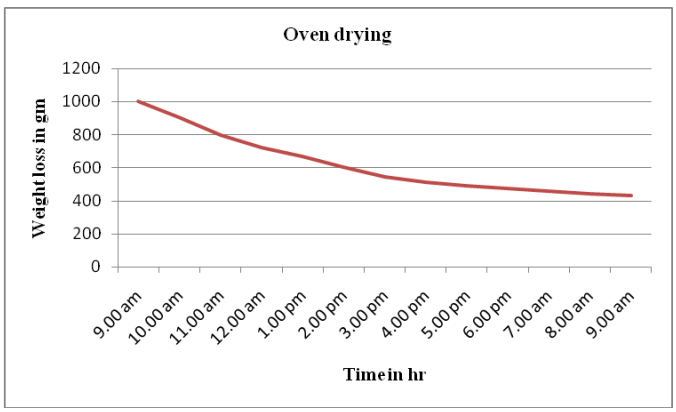

Chart 2-a Weightloss Vs time

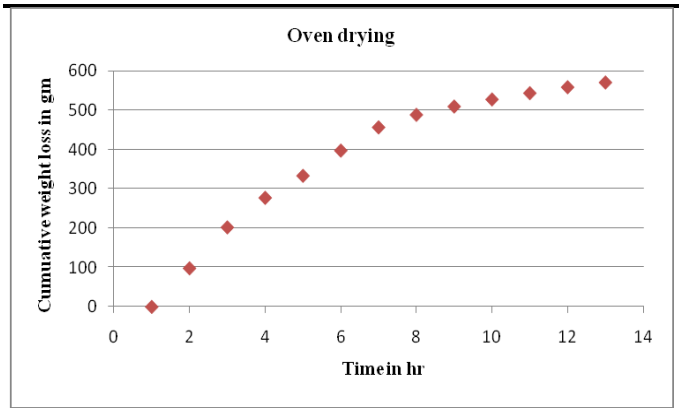

Chart 2-b Cumulative Weightloss Vs time

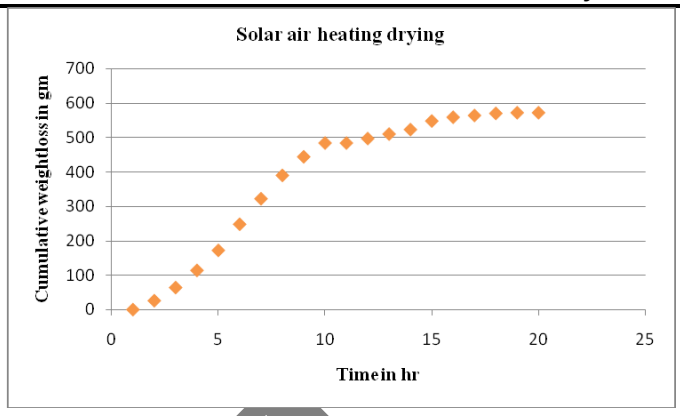

Chart 3-b Cumulative Weightloss Vs time

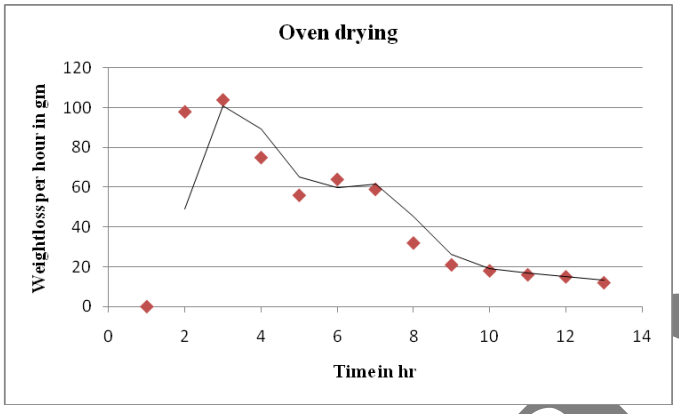

Chart 2-c Weightloss per gram Vs time

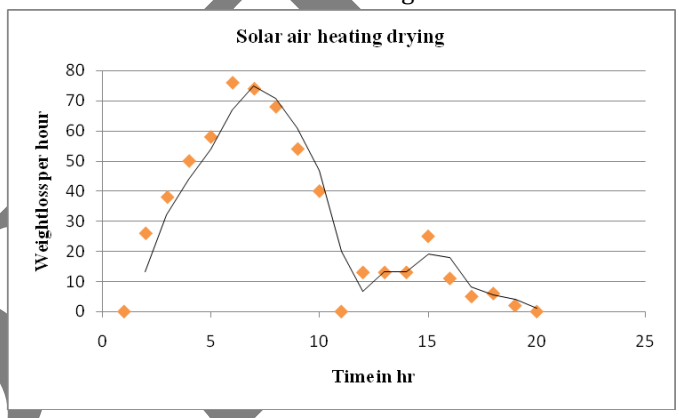

Chart 3-c Weightloss per gram Vs time

Chart-2 a, b, c: Drying characteristics for oven drying

It is observed that weight loss per hour reached to its peak within 4 hours of drying as at start skin of maize was soft and it is easy for evaporation to take place. As maize dries, the skin become harder and rate of drying reduced. Total drying time required to reduce 70% moisture to 13% is 12 hours.

Chart-3a, b, c: Drying characteristics for solar air heating drying

It is observed that weightloss per hour reached to its peak on each day and then decreased. The drying rate increased due to increase in temperature between 11.00 am to 3.00 pm but decreased after due to decreasing solar radiation and dryer outlet air temperatures. The moisture is also gained during the night.Tolal drying time required to reduce 70% moisture to 13% is 33 hours.

c. SOLAR AIR HEATING DRYING:

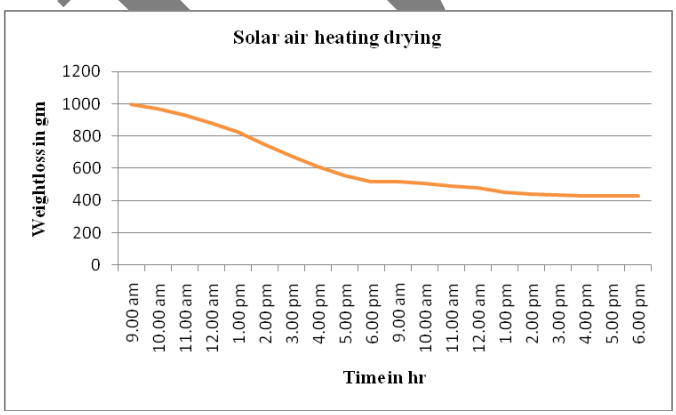

Chart 3-a Weightloss Vs time

d. SOLAR-BIOMASS HYBRID DRYING:

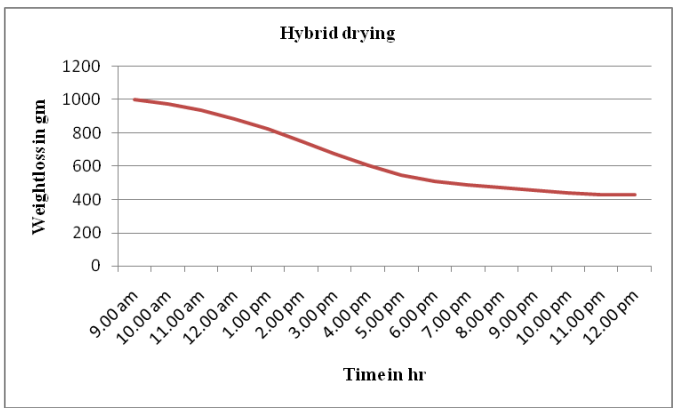

Chart 4-a Weightloss Vs time

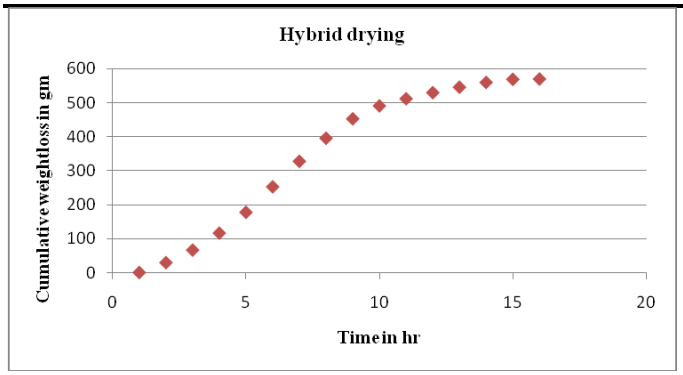

Chart 4-b Cumulative weightloss Vs time

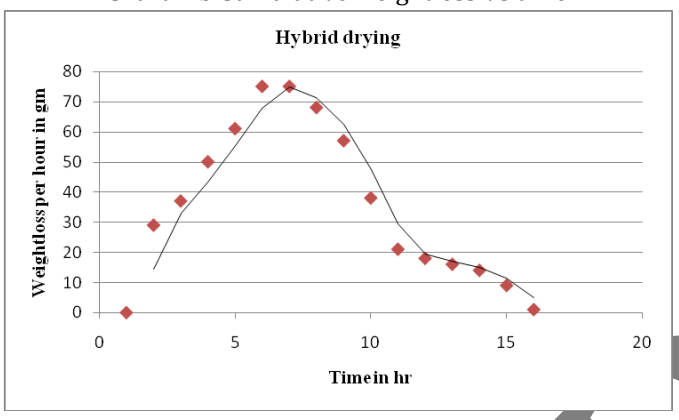

Chart 4-c Weightloss per gram Vs time

Chart-4 a,b,c: Drying characteristics for hybrid drying T_{avg}=55 ^{0}C

It is observed that at start drying rate is faster and it reached to its peak and then decreasing upto sunset at an average hot air temperature of 42.3^{0}C.After sunset when biomass heat exchanger is started with hot air temperature of 45^{0}C.The drying rate attains the peak and then reduces to final moisture in maize. The rate of moisture removal is more in solar drying as maize is fresh. The drying time to reduce moisture from 70% to 13% is 15 hours.

V. COMPARISON OF VARIOUS DRYING SYSTEM:

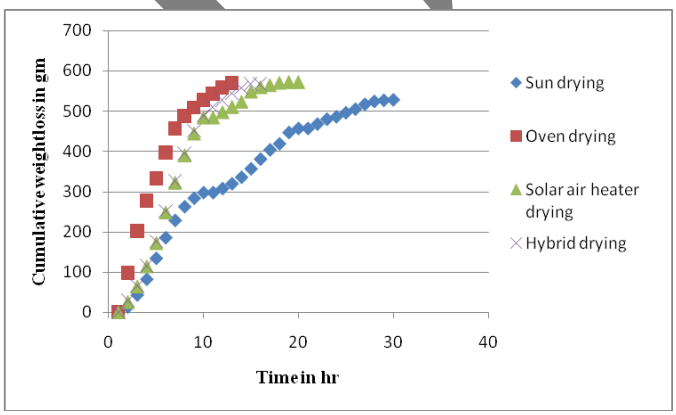

Chart 5-a Cumulative weightloss Vs time

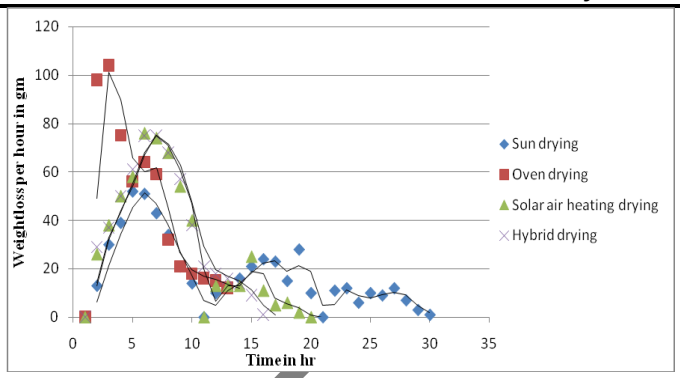

Chart 5-b Weightloss per gram Vs time

Chart-5a, b, c: Comparison of various drying system and moisture removal rate of maize.

It is observed that, drying rate of maize is maximum in oven drying and minimum in sun drying.

VI. CONCLUSION:

The solar-biomass drying system has able to dry fresh maize within 15 hours. Maximum drying temperature of 47^{0}C was obtained with solar and biomass heating source even though ambient temperature for the test period was between 24^{0}C to 30^{0}C.This study proves that the efficiency of agricultural dryers can be increased through the use of a combination of solar biomass heating system. It implies that improvements in design and construction of the various components of the system would lead to more efficient drying system for sustainable development of developing countries. Using combined solar biomass drying system has the potential to reduce wastage of grains and increases the efficiency of drying system.

REFERENCES:

[1] Mohanraj, M., and Chandrasekhar, P., 2009 *"Performance of a forced convection solar dryer integrated with gravel as heat storage material for chili".*

[2] Joshua, F., 2008 *"Design, Construction and Testing of Simple Solar Maize Dryer",* Leonardo Electronic Journal of Practices and Technologies, (13), pp. 122-130.

[3] Cengiz Y., and Çakmak, G., 2009, *"Design of a new solar dryer system with swirling flow for drying seeded grape",* International Communications in Heat and Mass Transfer, 36, pp. 984–990.

[4] Farid, M. M., Khudhair, M. A., Razack, S. K., and Hallaj, S. A., 2004 *"A review on phase change energy storage: materials and applications",* Energy Conversion and Management, 45, pp. 1597–1615.

[5] S. Boughali , H. Benmoussa , B. Bouchekima , D. Mennouche ,H. Bouguettaia, D. Bechki *"Crop drying by indirect active hybrid solar – Electrical dryer in the eastern*

Algerian Septentrional Sahara" Laboratory of New and Renewable Energy in Aride Zones, University Kasdi Merbah, BP511 Ouargla, Algeria,Faculty of Science, Department of Mechanics, University Hadj Lakhdar, Batna, Algeria , S. Boughali et al. / Solar Energy 83 (2009) 2223–2232

[6] Istvan *Farkas "Integrated Use Of Solar Energy For Crop Drying"* Department of Physics and Process Control, Szent Istvan University, European Drying Conference - EuroDrying'2011 Palma. Balearic Island, Spain, p.26-28 October 2011

[7] P. Barnwal, G.N. Tiwari *"Grape drying by using hybrid photovoltaic-thermal (PV/T) greenhouse dryer: An experimental study"* Solar Energy 82 (2008) p1131–1144