Application of Geothermal Water forFood and Crop Drying

Anirbid Sircar, Kriti Yadav, Namrata Bist
Centre of Excellence for Geothermal Energy
Pandit Deendayal Petroleum University, Gandhinahar-382007, Gujarat, India

Abstract- **Around 155 million tons of food products are produced in India but suffers from wastage losses due toincapable storage technologies. In India, around 60-80% of farmers use sun drying method which leads to loss of needful minerals or vitamins for the human body and hence is inappropriate. To overcome the grain losses due to storing and harvesting a food drying system can be made for the preservation of crops. This paper reviews various geothermal food drying systems used in the various food industry as well as in research and development sectors for reducing food loss with several engineering storage methods. In this paper three types of food drying processes are described namely standalone geothermal food dryer, geothermal dehydrator and hybrid solar- geothermal food dryer. This paper review the working principal and features of the food dryers, which are driven by the renewable energies like solar and geothermal.**

Index Terms- **Geothermal, Food Dryer, Storage, Heat Exchanger.**

I. INTRODUCTION

India has established its expertise in agriculture and the high crop yield is a proof for that. About million tons of grains, fruits, and many other products like cotton, tobacco, and tea are some of the agriculture produce from India. But unfortunately, the annual losses of this yield areabout 10 to 11% in India. The utilisation of conventional methods of drying such as Sun drying method and improper storage facilities degrade the food grains and other affects the quality of the agriculture. It also affects the nutritious value of food(Shukla and Patil, 2010). India needs to focus on the emerging technologies and utilization of renewable energy for storage and drying of agriculture crops, food drying, and fish drying(Andritsos et al., 2003). Drying out of natural products or vegetables is one of the oldest forms of nourishment conservation strategies known to man. The method includes moderate expulsion of the majority of water contained within the natural product or vegetable so that the moisture contents of the dried item is underneath 20%. The conventional method of vegetable and fruit drying (like tomatoes) is by utilizing the sun, a procedure that has remained generally unaltered(Van Nguyen et al., 2015). Geothermal food drying is a slow drying process because higher temperature can completely or partially destroys the nutritious values and can damage physically and chemically the food grains(Popovska-Vasilevska, 2003). There aremany low enthalpy geothermal resources temperature ranging from 40°C to 100°C which can be utilisedin the application for drying of crops. As geothermal food dryer would not only enhance the quality of grains and food items but also shall reduce the time for drying as compared conventional method of drying. In Dang and Unai area of Gujarat, geothermal hotspots are identified with temperature up to80°C.These areas are also good producer of rice.In the same way in the Himachal area,drying tea and apple products can be achieved by the geothermal food dryer(Lund, 1986). The geothermal food dryer requires dehumidified air at different temperature ranges from 30°C to 60°C according to crops or food. The utilization of renewable energy and direct application of low geothermal enthalpy canbenefit the agriculture sector to remove the use of electricity in drying,would have low carbon emission footprint and also would be cost-effective for farmers in long term use as the extra cost of electricity is eliminated(Wiset et al., 2001). This paper discusses about two standalone geothermal dryer systems and one hybrid solar geothermal dryer system which might be useful for drying the food and agriculture products.This paper gives a glimpse about how green energy (geothermal and solar) driven food dryers can secure the wastage of food and grains.

II. METHODOLOGY AND SYSTEM DESIGNS

In India, crop drying has been carried out under direct sunlight for decades. Seasonal and climate changes can impact crops by fast degradation and the presence of moisture contents leads to imperfect drying due to the discontinuous process. Constant drying involving continuous heat flow is required to enhance the operation outputs. This can be done by the constant flow of hot drying energy supplies, like a geothermal working fluid.There are generally three types of crop drying systems namely:

- Standalone Geothermal Food Dryer
- Geothermal Food Dehydrator
- Solar-Geothermal Food Dryer

2.1. Standalone Geothermal Food Dryer

In Standalone geothermal food dryer a heat exchanger is generally designed in such a way the tot elevates the temperature of air for grain drying. Fig. 1 describes the design apparatus, for the drying process, the air is blown on the heat exchanger for extracting heat from geothermal water. The following food drying system uses geothermal energy indirect form. The grains are deposited on the stainless steel trays in the drying area. The blower is generally constructed according to the pressure created by geothermal water. The air blower is positioned right behind the heat exchanger for drying the grains on the other side. By performing a number of experimental runs, exact timings can be noted for the product quality. If the design meets the requirements then the system can be commercialized (Sumotarto, 2007).

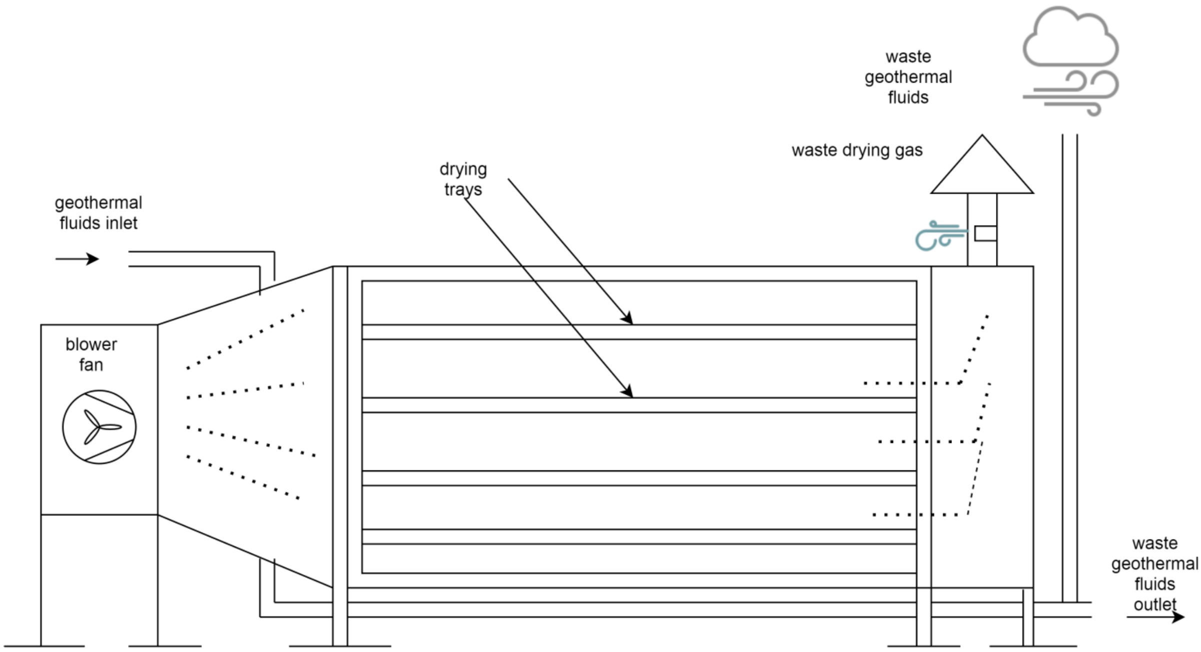

Figure 1. Standalone geothermal food dryer (Sumotarto, 2007)

2.2. Geothermal Food Dehydrator

In case of geothermal food dehydrator the moisture content of food is reduced. Fig. 2 shows an example of such dehydrator process where the geothermal water is taken from the extraction well at 80ºC.The water is then passed through a plate type heat exchanger and then reinjected to the injection well. The water at 65 ºC is circulated to the finned tube heat exchanger, positioned at the drying chamber, where the heat gets transferred to the air. Air gets sucked into the drying chamber utilizing a fan and raises the temperature to 55ºC. Based upon the humidity factor within each food, humidity elimination process in food stretches to 15 hours. When the moisture level reaches 12%, the drying phase gets over. At last, the humidity air is passed out through the chimney from the drying chamber. All kinds of fruits and vegetables are dehydrated by GFD. Around three to four sensors were placed in the dryer for tracking the process, measuring temperature as well as humidity. Fresh vegetables, fruits, or grains are deposited in the trays and then the trays are loaded in the dehydrator for the process (Javad Khazaei *et al.,* 2008). With 70% humidity, the air gets into the heating chamber at 21ºC; when the following air is passed through the heat exchanger, the temperature level rose to 48ºC, and the humidity level declines to 19%.

When the air is blown to the drying chamber output its humidity level is around 29% and temperature 41ºC. Air humidity entering to drying chamber should be equivalent to air humidity at the outlet, then only the operation is considered to be completed (Jiménez *et al.*, 2016).

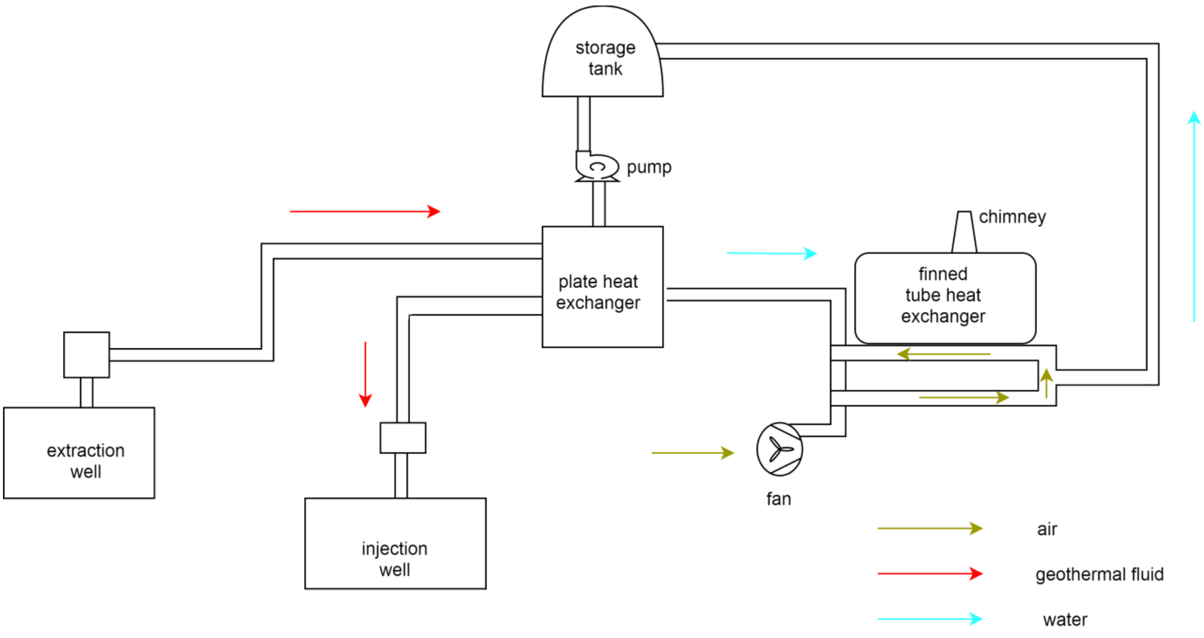

Figure 2. Geothermal Food Dehydrator (GFD)(Jiménez et al., 2016)

2.3. Solar-Geothermal Food Dryer

The dryer had been evaluated for service just after the planning and designing of the conceptual model. The analytical experiments were carried out under controlled conditions in a research lab with simulated irradiations created by halogen lamps positioned at various distances from the drying region at steady ambient temperatures. The main aim of this experiment was to investigate the variables that affect the prototype model including homogeneity of the system, consumption of energy, chamber temperature, and many more. This must be stated that the following methodology was repeated under climatic conditions, where solar irradiations, dampness, and atmospheric temperatures are adjustable. The measuring technique was conducted as a systematic method, established during the numerous laboratory experiments for a persistent gathering of data (Delgado-Plaza et al., 2019). The principal factors that were assessed in the system are as follows:

- Air temperature.
- Velocity of air.
- Flow of hot or drying air circulating through the tray assembly.
- Humidity at the inlet and outlet of hot air
- Solar irradiation.
- Energy consumption.

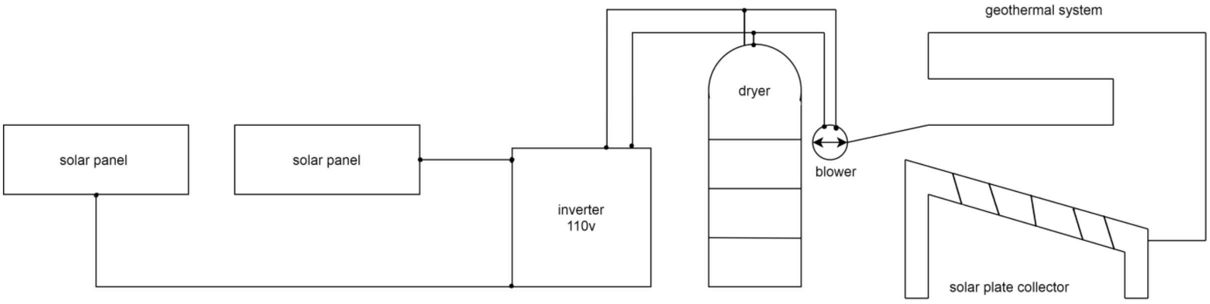

Figure 3. Solar-Geothermal food dryer (Delgado-Plaza et al., 2019)

III. CONCLUSION

The processing time for food drying can be reduced drastically by utilising geothermal dryers. The geothermal food drying system is efficient with a low amount of carbon emission. The power consumption is less compared to the electric food drying system. Nutrition losses from the food product can be controlled by temperature settings in the system as well as flow valves will be useful to maintain airflow velocity from the blower. However, solar collectors will be beneficial for food drying purposes during solar hours only which is about 8-10 hours. The geothermal food drying system will be economical in agriculture sector as the system as the system includes stainless steel body, heat exchanger, piping, dehumidifier, blower, and trays. From the following review, the geothermal food dryer system can be implemented in Unai, India as the geothermal water over there is of medium enthalpy (60-65ºC).

REFERENCES

Andritsos, N., Dalampakis, P., &Kolios, N. (2003). Use of geothermal energy for tomato drying. GHC bulletin, 24(1).

Delgado-Plaza, E., Peralta-Jaramillo, J., Quilambaqui, M., Gonzalez, O., Reinoso-Tigre, J., Arevalo, A., Arancibia, M., Paucar, M., & Velázquez-Martí, B. (2019). Thermal Evaluation of a Hybrid Dryer with Solar and Geothermal Energy for Agroindustry Application. Applied Sciences, 9(19), 4079.

JavadKhazaei, Chegini G., &Bakhshiani M. (2008). A novel Alternative Method for Modeling the Effects of Air Temperature and Slice Thickness on Quality and Drying Kinetics of Tomato Slices: Superposition Technique" Drying Technology: An International Journal, v. 26, 759-775

Jiménez, H.M.A., Pérez, P.S., Madrazo, O.V., González, E.P., & Rivera, A.J. (2016). Low-Enthalpy Geothermal Food Dehydrator. Peach, 85, 18.

Lund, J.W. (1986). Agriculture and aquaculture applications of geothermal energy. Geothermics, 15(4), 415-420.

Popovska-Vasilevska, S. (2003). Drying of agricultural products with geothermal energy. International Summer School on Direct Application of Geothermal Energy, Doganbey (Izmir), Turkey, 2-15.

Shukla, B.O., & Patil, R.T. (2010). Overview of grain drying and storage problems in India (No. Folleto 13661).

Sumotarto, U. (2007). Design of a geothermal energy drier for beans and grains drying in Kamojang Geothermal Field, Indonesia. GHC Bulletin, 28, 13-18.

Van Nguyen, M., Arason, S., Gissurarson, M., &Pálsson, P.G. (2015). Uses of geothermal energy in food and agriculture. Opportunities for developing countries.

Wiset, L., Srzednicki, G., Driscoll, R.H., Nimmuntavin, C., &Siwapornrak, P. (2001). Effects of high temperature drying on rice quality. Agricultural Engineering International: CIGR Journal.