

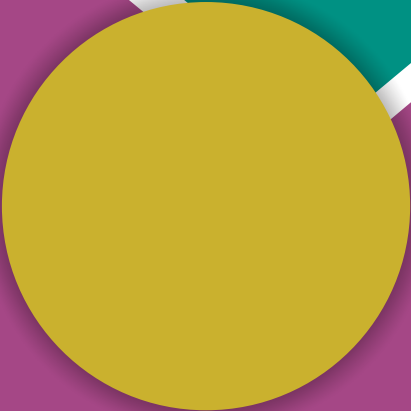
Solar Continuous Roaster (SCR)



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Most of the industrial processes require heat below 180°C and this temperature range can easily be achieved by using different vacuum tube collectors and solar concentrators. The common processes demanding medium temperature are as: sterilization, extraction, pasteurization, air conditioning and solar cooling, drying, distillation and evaporation, washing and cleaning, hydrolyzing, and polymerization. All the mentioned processes lie in the temperature range of 60 – 280°C. In order to reduce the post-harvest losses, various food storage and processing technologies like drying and roasting are

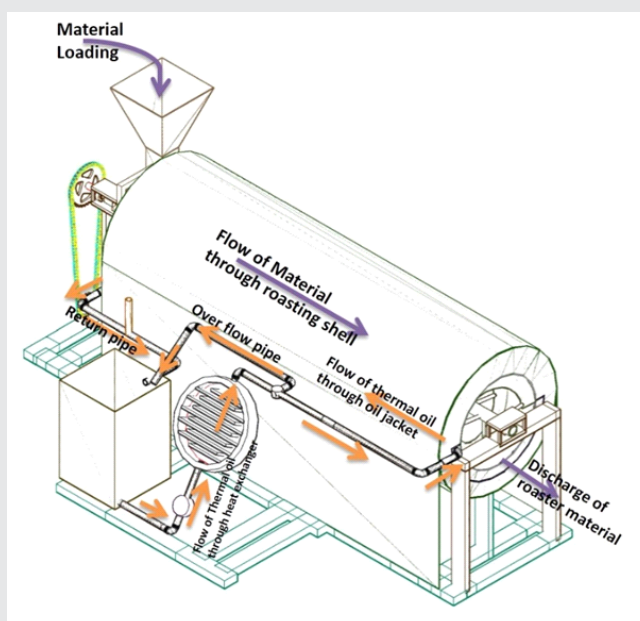
performed which cause numerous physical, chemical and nutritional changes in food, adversely affecting the quality attributes, nutritional value, anti-oxidative activity and microstructures. Several technical problems are associated with conventional methods of roasting to preserve fruits and make them edible, for example:

- a) Difficult to maintain controlled roasting conditions
- b) Contamination by dirt, garbage and environmental pollution
- c) Un-hygienic process conditions during conventional roasting
- d) Transportation losses due to unavailability of on-farm processing facility
- e) Value losses due to delay in processing after harvesting

To overcome above mentioned problems no solar based technology was developed to provide on-farm processing facility for roasting of agricultural products by keeping out dirt and by reducing the time of heating via controlled process under hygienic conditions. Dehydration and roasting of agricultural products is a new research area in the field of solar energy applications in medium ranged temperature (roasting temperature for different agricultural products lies between 80°C to 200°C). Keeping in view and understanding of all such facts, a decentralized solar roasting system for roasting of agricultural products (peanuts, coffee, pine nut etc.) has been designed and developed in order to provide on-farm processing facility for value addition and income generation for the small entrepreneur.

Operational principle

The solar roasting system is installed at Agricultural Engineering Workshop, University of Agriculture Faisalabad (Latitude, $31^{\circ} 26' 48.28''$). The system includes a Scheffler fixed focus concentrator (10 m^2 surface area), a dehydration system which comprises a feeding hopper, discharge chute and a separator for separating of roasted material and heating medium. The receiver is faced towards the primary heating system to heat up the thermal oil. Thermal oil conveying mechanism (a gear pump powered by $\frac{1}{4}$ hp motor) is equipped with heat exchanger having dimensions of diameter 350 mm and wall thickness of 16 mm with casted ribs in zigzag manner to increase the retention time for the thermal oil to absorb maximum heat energy transferred from Scheffler reflector (oil temperature ranged from $0\text{-}200^{\circ}\text{C}$). The backside of the receiver is closed by an aluminum sheet by providing high temperature gasket between them to eliminate any chance of leakage. Then the feeding into the roasting drum (2000 mm length, 450 mm inner diameter and 6 mm wall thickness) is done with a triangular shape hopper. The roasting drum is made of food grade stainless steel material in a very accurate, precise and well finished inner surface so that material can flow over it smoothly. A ribbon type screw conveyor is designed inside the chamber to convey the material from feeding side to discharge side. Small strips have also been welded with the ribbon of the conveyor on the outer edge to act as stirring device in order to mix the material gently for uniform heat distribution and protect the product surface from overheating or burning. A simple discharge chute is fabricated for easy discharge of roasted material guided towards collecting tank. A control unit is also designed and developed in such a way that it can be connected to both conventional electricity source and solar PV system. The main function of this box is to control the conveyor speed and gear pump speed for thermal oil circulation according to the required conditions for the specific agricultural product to be processed.



Technology impact

- Various agricultural commodities can be processed timely at farm level like roasting of ground nuts/peanuts, coffee and drying of seeds/grains to preserve them from spoilage.
- This technology can facilitate farming community by on-farm processing for the value addition of agricultural products.
- It is a sustainable technology with a payback period of 10500 working hours (4 years and 7 months) beyond which the roasting process will be much less than the conventional roasting system.

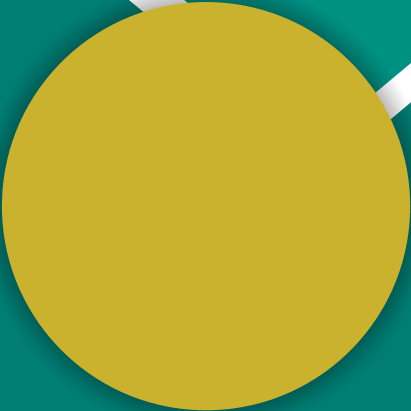
Glass Glazed Solar Tunnel Dryer (STD)



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Drying is a complex and energy intensive process used for the preservation of food material. Due to the increasing cost of electricity and fossil fuels, application of solar energy for drying of various agricultural products has become the need of the time. It is not only economical but also ceases the gas emissions. By solar drying, huge amount of national revenue can be saved by avoiding the spoilage of agricultural products due to non-availability of conventional processing facilities. Open sun drying is the most commonly used method in tropical and subtropical regions which deteriorate the quality of the product due to variation in ambient humidity, dust, attacks from insects, rodents and other animals. On the other side, for the controlled drying Hi-tech. food dryers are powered by fossil fuels and are expensive so remain unavailable for the small farmers to process their product at farm where electricity is not available. Therefore, a low cost sustainable energy technology to process agricultural produce at farm should be developed. Keeping in view the energy crises and small farming community a new solar tunnel dryer (STD) has been designed and developed at University of Agriculture Faisalabad to meet the drying needs of small farmers and small co-operatives. Instead of forcing the air through the depth of product, it is just directed over the product spread in a thin layer. The distinct feature of this dryer is the use of glass windows instead of plastic material (polythene dryer) which become fade due to dust and temperature creating hurdle for the transmitting of sun rays into the collector and drying chamber. The glass can easily be washed in case of dust problems.