Energy Efficient Solar Milk Chiller

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Pakistan is the 4th largest milk producing country in the world (34 million tonnes annually) while the larger proportion of producers are small scale farmers (>80%). Unfortunately, only 5% of this milk is processed while other is handled by Milkman which is mostly unhygienic at high health risks especially for the infants. Moreover, the farming community do not get proper price for milk due to non-availability of processing facilities at farm level. The prices of Nestle packed milk is about Rs. 110 per litre which is not easily affordable because unpasteurized local milk is about Rs. 70 per litre and available easily. The pasteurized milk can be preserved for longer shelf life thus increasing its shelf life and marketability. The promotion of small-scale agro-based industries for value addition and income generation using innovative solar technologies can become a multiplier in rural development. An energy efficient solar milk chiller was developed as a part of research and demand of the livestock department of the Government of Punjab as well as the farming community who wish to process and store milk in the chilled form. The milk processing is a rapid growing business but high energy running cost is a serious problem. With solar based technology milk is chilled with cheapest source of energy which is solar energy available in Pakistan for more than 300 sunny days in a year. Solar energy is the medium of energy production for this technology and the milk is cooled down to 4°C in the chiller within 2 hours (standard time by WHO).

Development of Energy Efficient Solar Chiller

Solar milk chiller comprises 200 liters chiller (semicircular pug mill type, SS-304), a 2kWp PV system (8 PV modules each module with 250Wp), a hybrid inverter (3kVA) and two batteries (150Ah) as a backup sources to meet weather fluctuations. The design of milk chiller is 200 liters container in order to have maximum area to volume ratio. One ton of vapor compression refrigeration system is coupled with the chiller through coils at the bottom side of the vessel. An agitator installed with the lid of the tank and its fan inside the tank to stirr the milk continuously to make sure that each drop of milk receives equal amount of cooling and also to avoid freezing of ice in the bottom of chiller. The agitator is driven using electric motor which is powered by PV Panels. The actual view of the solar based milk chiller is shown in Figure 1.

Figure 1. Actual view of energy efficient solar based milk chiller unit

To build this energy efficient milk chiller more energy efficient invertor technology was introduced which helps to eliminate the torque load which is a big hurdle in using solar PV systems, while using a rotary type compressor with the inverter technology only an average load 950W was calculated. The system run with 1.2kW solar PV panels off-grid system or only with the two batteries in the backup. Efficiency of the unit was achieved up-to 69%. This research study is conducted to prolong the shelf life of the milk and results as the most excellent and economical way of preserving milk through this solar energy resource technique.

The system is equipped with pyranometer, thermocouples, volts crafts, amperemeter for real time data monitoring to assess the performance of the system employing a data logger as shown in Figure 2.

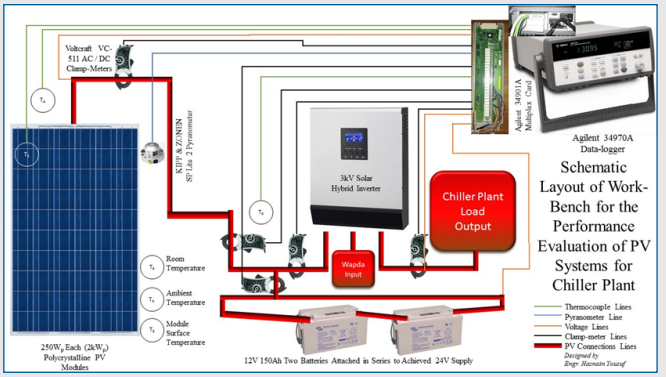

Figure 2. Sensor system and data acquisition for solar milk chiller

Impact and benefits of the technology

I. No running or operational cost of the system
ii. Environmental friendly source of energy supply which is free from harmful emissions
iii. Little repair and maintenance is required
iv. Opportunity for indigenization at cheaper rates
v. Possibilities of on-farm and commercial applications
vi. Income generation and employment opportunities for farming community