Solar Water Heating- Potential use in Dairy Industry

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***Abstract*— Dairy industry is of crucial importance to India. The country is the world's largest milk producer, accounting for more than 13% of world's total milk production. Heating water accounts for more than 30% of the energy in Dairy Industry of India. Apart from that rising fuel prices have had a tremendous impact on milk processing industry now a days, the industry is constantly adopting various technologies to reduce operational costs the result of which various dairies have adopted low cost fuel as an option regardless the pollution & other unhygienic impacts. Today milk processing plants need to transform & divert their attention to cleaner production/processing & need to opt for renewable energy as a source of fuel. One of such source is concentrated solar thermal (CST) technologies. The use of an appropriate solar technology can have a positive impact on the energy and environmental scenario of Dairy industry at a large. The solar steam or pressurized hot water generated by solar boiler / solar thermal concentrator can be used for heat treatment process such as pasteurization/sterilization and washing of dairy appliances/process equipments.**

Key words: Solar water heating, dairy industry, solar energy

I. INTRODUCTION

India is the world's no. 1 milk producing country, with an output of 134 million tons in 2014 as reported by the National Dairy Development Board, and is second only to the European Union in production. Furthermore, milk production in India is growing at an annual rate of 5%, far ahead of the global average of 1.35%. Nearly 16% of the milk sold in the domestic market is processed into dairy products (baby foods, ice cream, whey powder, casein, and milk albumin) and that requires heat. There are some 700 milk processing plants in the formal dairy sector. While most of the hot water requirements are at the dairy processing plant, there is also a minimal need for hot water to clean containers at the collection and chilling centre. Thermal energy is used for various processes, such as pasteurization and washing. At the dairy processing plant, a central boiler produces steam which is then used to heat water. The common practice in the dairy industry is to use petroleum fuels for steam generation in boilers. Concentrating solar power typically saves between 1 and 5% on petroleum fuel consumption. Space for solar water heaters is less of a constraint for dairies than it is in other industries. Because treatment facilities already exist for supplying boiler feed water, water quality is also not an important issue. Rapid growth in the organized dairy industry offers a significant opportunity for solar thermal systems.

II. SOLAR WATER HEATING

Solar water heating industry constitutes the majority of solar thermal applications in both domestic and industrial sectors. They are considered as the most cost-effective alternatives among all the solar thermal technologies currently available. SWH systems are now in commercialized stage and very mature in many countries in the world. Since 1980, utilization of SWHs has been increased with 30% annual growth rate. SWHs are usually composed of solar collectors and a storage space. It works on the basis of the density inequality of hot and cold water or thermo-syphon. In colder countries, integrated collector/ storage SWHs is more common because of simple and compact structure. Batch solar collectors are more suitable for compensating sun radiation limitations in the evening and afternoon. Solar thermal can be applied in milk, cooked meats (sausage and salami) and brewery industries at medium temperature for washing, cleaning, sterilizing, pasteurizing, drying, cooking, hydrolyzing, distillation, evaporation, extraction and polymerization.

III. POSSIBILITY OF SOLAR ENERGY IN DAIRY INDUSTRY

Solar power is an emerging technology that has the potential to reshape the way we think about energy and where it comes from. By harnessing the free energy given off by the sun it is possible to lower or eliminate the cost of powering daily electrical needs. On the roof top of dairy farm and processing plant, solar photo-voltaic systems can be installed for generation of electrical energy. The power thus generated can be used for performing various operations such as heating, cooling, cleaning, lightening, ventilation etc. Solar thermal systems can greatly contribute to energy savings during the production processes in the dairy sector, which demand water

temperatures of <80^{0}C. The hot water produced by the solar collectors can also be used for pre-heating the water entering the installation's steam boiler. In this case, the energy contribution of the solar system is relatively small both in comparison with the total energy demand, as well as in absolute figures. There are some dairy processing operations which can be particularly completed very easily by solar energy.

A. Low temperature processes < 80^{0}C

Such processes are:

- Bottle washing 60^{0}C
- Pasteurization 70^{0}C
- Yogurt maturation 40-45^{0}C
- CIP (Cleaning-in-Place) 70-80^{0}C

B. High temperature processes >100^{0}C

Such processes demand hot water of very high temperatures. More precisely:

- Bottles sterilization
- UHT treatment (milk sterilization)
- Multiple stage evaporation
- Spray drying

IV. SOLAR HEATING FOR STEAM GENERATION IN DAIRY PLANT

Low temperature steam is extensively used in sterilization processes and desalination evaporator supplies. Parabolic trough collectors (PTCs) are high efficient collectors commonly used in high temperature applications to generate steam. PTCs use three concepts to generate steam the steam-flash, direct or in situ and the unfired-boiler. In the steam-flash method, pressurized hot water is flashed in a separate vessel to generate steam. Oil fired Boiler is feed with normal water for the routine operation. On installation of solar water heater, the feed water of the boiler raised to 67^{0}C from 27^{0}C. On inspection and verification it is found that an average 3000 l of feed water being utilized per day. Due to this the thermal load saving to the extent of 120000 kcal/day saved which amounts to 4774.20 l of Furnace oil saved per annum.

V. SOLAR DRYING IN DAIRY OPERATION

Solar drying and dehydration systems use solar irradiance either as the solely power supply to heat the air or as a supplementary energy source. Conventional drying systems burn fossil fuels for their performance while the solar dryers take advantage of sun irradiation for drying and dehydration processes in industries such as bricks, plants, fruits, coffee, wood, textiles, leather, green malt and sewage sludge. They are categorized into 2 main groups: high and low temperature dryers. Almost all high temperature dryers are currently heated by fossil fuels or electricity but low temperature dryers can use either fossil fuels or solar energy. Low temperature solar thermal energy is ideal for use in preheating processes as well. Drying of milk powder, due to the high constant energy demand, is another important consumer. In the production, milk and whey are spray-dried in huge towers with air, which is heated from 120- 180^{0}C. The drying process can have a running time up to about 8000 h per annum. Solar energy is used mainly for the preheating of air which supplied to the air heater. It increases temperature of air 35^{0}C to 80^{0}C by use of solar energy. It reduces the load of air heater, cost saving, less pollution of air.

VI. CONCLUSION

India has huge availability of green energy and limited resources of fossil fuels forces us toward solar energy. India has sufficient amount of sunshine that favors solar energy investments. Investment in solar energy technology should be encouraged as the merits include: pollution free environment, free renewable and energy source, high reliability and low maintenance costs. The use of solar energy in the dairy is generally found for hot water supply to boiler, hot water generator for processing of milk or for CIP cleaning. We can use solar energy at chilling centre for cooling/refrigeration purpose, for solar drying, for pumping dairy fluid, for room conditioning, for cold storage of milk & milk products, for lighting and for electric fencing. All these processes are operated on grid electric supply. To overcome problem of peak load penalty, the part load can be shared by solar based system for such operations.

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