USE OF GEOTHERMAL ENERGY FOR FOOD PROCESSING INDIAN STATUS

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PRESENT STATUS OF FOOD INDUSTRY

One of India's proudest accomplishments has been achieving self-sufficiency in food production and that the country produces a wide variety of agricultural products at prices that are at or below world values in most cases- states the office of the agricultural affairs of the United States Department of Agriculture (USDA). The country's food industry's sales turnover at the end of the year 2000 was at US$ 31 billion. India's food processing industry covers fruit and vegetables (onions, garlic, tomatoes, potatoes, peas; pineapples, bananas, apples, papaya, grapes and oranges); meat and poultry; milk and milk products, alcoholic beverages, fisheries (prawns, shrimps, tuna, cuttlefish), plantation, grain processing and other consumer product groups like confectionery, chocolates and cocoa products, soya-based products, mineral water, high protein foods and other products.

According to the official statistics of the Ministry of Food Processing (MFP,2001), India exported processed vegetables and fruits worth US$ 2 billion in 1999-2000. India's food exports is about US$ 6 billion whereas the world total is about US$ 440 billion. Thus, India is one of the world's major food producers but accounts for less than 1.5 percent of international food trade. Foreign investment, in food processing sector, after the economic liberalization stood at US$ 2 billion. In recent years, processed food demand has grown considerably--especially from the middle-east countries.

In the case of fisheries sector (prawns, shrimps, tuna, cuttlefish, squids, octopus, mackerels, lobsters and cat fish), there is a growing demand for canned and processed fish from India. India's 8,041 km of coastline, 28,000 km of rivers and millions of hectares of reservoirs and brackish water have large marine product base and variety of fish that can be processed. During the last few years, India invested to the tune of US$ 0.7 billion in this sector with a foreign investment of the order of US$ 0.2 billion. The fish production potential in the exclusive economic zone is 4 million tonnes while the actual production is 3 million tonnes. This excludes the inland production which is of the order of 3 million tonnes.

FUTURE OF FOOD PROCESSING INDUSTRY AND GEOTHERMAL PROJECTS

Realizing the potential of this industry, the government of India accorded top priority and announced several financial incentives to attract investors. They are: a) No industrial license is required for almost all of the food and agro processing industries, b) Use of foreign brand names is now freely permitted, c) Capital goods can now be freely imported, including the second hand machinery in the food-processing sector and d) Excise as well as import duty has been substantially reduced and export linked duty free imports is also allowed. Hence, there is large scope for U.S. companies to invest in food processing and packaging sector which is growing annually at 15 to 20 percent. Increased literacy, changing pattern of life-styles, mass media promotion has all contributed to a change in demand for processed food. India's total food market is estimated at US$ 70 billion and value added food products would be worth US$ 22 billion. To minimize the pre/post harvest wastage, the Indian government is encouraging investment in this sector and has approved several proposals for joint ventures/foreign collaborations. Foreign investment in this sector was about US$ 2.2 billion during the last decade and is expected to increase substantially in the future. India is keen on maximum utilization of agricultural products, which are demand through out the year, and restricting the wastage of vegetables like onions. These products become scarce only due to perishability and lack of storage and handling facilities. Investment opportunity worth US$ 30 billion will be available across the food chain to strengthen the procurement, processing and storage and distribution infrastructure. All these condition in processing and handling various food commodities offer excellent opportunities for U.S. firms in the food processing and packaging equipment sector. (MFP 2001; EoI, 2000; FAO, 1996; EoUS, 2000).

Thus with economic liberalization, India has become one of the prime countries for investment. The total local production in the food processing sector in the year 2000 is estimated at US$ 1,240 million. India's total imports is estimated at US$ 400 million of which US$ 120 million are the imports from the U.S. because the food processing sector is lucrative for investment. India's diverse agro climatic conditions and also wide-ranging and large raw material availability throughout the year are suitable factors for the growth of food processing industry.

If such is the situation, then why India is not able to cash it and be the world's best processed food exporter? The problem lies in inadequate infrastructure like cold storage, dehydration facility etc. About 75-80 percent of vegetables and fruits in India perish due to high water content. This industry requires about US$6 billion in investment in the next five years to create necessary infrastructure, expand production and storage facilities using state-of-art technology to match

international standards. Because of lack of such facilities products worth US$2.5 billion is wasted yearly out of which the farm products accounts for US$ 1.5 billion.

Using conventional energy to minimize wastage is expensive today and is going be the same or more expensive in future with ever increasing cost of conventional fuels. For example, 250 gm of dehydrated onions costs US$0.5 (processed in Gujarat) in the Indian market today while the price of 1 kg of raw onion from the producer is available at US$ 0.1/kg. Even if 100 percent profit margin is given, the cost of 1 kg of dehydrated onions costs US$ 0.26 which is expensive for 300 million middle class population. The cost of conventional fuel makes the finished product very expensive. To compete with international market and to promote the product in the local market, the amount spent in such process should be minimum. This can be accomplished by using the country's available geothermal energy resources. To give an example, the table below gives a comparative statement of cost involved in dehydrating fruits using conventional energy and geothermal energy.

Product	Capacity (kg)	Time (hr)	Geothermal	Conventional
Pineapple	817	18	90	4950
Apple (slices)	771	16	810	4500
Apple (cubes)	907	16	810	4500
Banana	817	24	1350	5625

Courtesy: M/s Eco-Fruit Agro Industry, Guatemala, Central America: cost in Rs.(48 Rupee - 1 US$)

Most food-processing and greenhouse operators over the world estimate that using geothermal resources instead of traditional energy sources saves about 80% of fuel costs– about 5% to 8% of total operating costs. Worldwide, the installed capacity of direct geothermal utilization is about 9000 MW and the energy used is about 31,200 GWh/yr distributed among 38 countries (Lund, 1999).

Geothermal reservoirs of low-to-moderate temperature water (20 to 150ºC) provide direct heat for industrial and commercial uses. This resource is large and widespread in India and can be used to support food-processing industry to minimize the cost of finished product and wastage. Directly using geothermal energy in commercial operations is much less expensive than using traditional fuels. It is also very clean, producing only a small percentage (and in many cases none) of the air pollutants emitted by burning fossil fuels. A majority of the thermal manifestation are in rural areas and utilizing this resource will benefit the rural India and improve the socio-economic status of the rural population.

WHERE IS "GEOTHERMAL" IN INDIA?

Low–medium temperature geothermal resources exist at seven geothermal provinces in India in the form of 400 thermal springs with surface temperatures varying from 47 - 98ºC. These provinces are, at present, the centers of pilgrimage (Chandrasekharam, 1999). Considering the geographic location and climate and agricultural activity and fishing, two provinces are most suitable for initiating food-processing industries in India. They are the west coast and the Himalaya geothermal provinces.

The West Coast Geothermal Province

The west coast geothermal province extends over a length of about 800 km and includes more than 25 thermal manifestations (Figure 1). The surface temperature varies from 47ºC (North of Bombay) to 90ºC (Tuwa, Gujarat) (Chandrasekharam, 2000; Minissale et al., 2000) with flow rate of 48 L/min (surface)(Ravi Shanker 1987) to 1000 L/min (borehole flow)(Muthuraman, 1986). The heat flow value and geothermal gradient in this province varies from 93-129 mW/m^2 and 59-70ºC/km respectively (Ravi Shanker 1988). The estimated minimum reservoir temperature is 120ºC (Minissale et al., 2000). All the springs are located in rural India well connected by road and railways and many are close to areas with agricultural activity.

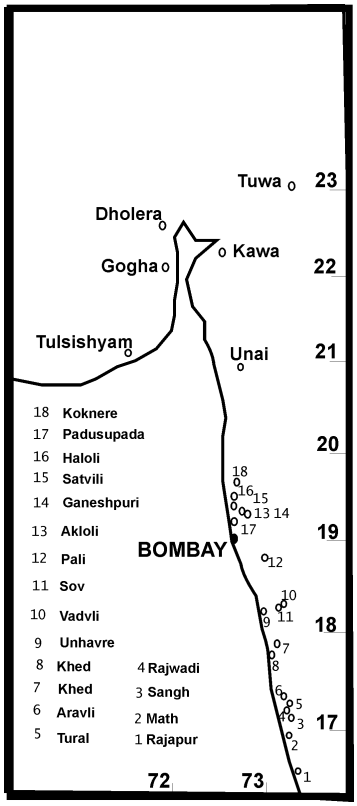

Figure 1. West Coast thermal springs.

The Himalaya Geothermal Province

This province, spreading over an area of greater than 1500 sq.km, includes about 100 thermal springs. This province is bounded by the main central thrust (MCT) on the south and the Indo-Tibet suture zone (ITSZ) on the north (Figure 2). The surface temperature of the thermal springs varies from 57 - 98ºC. The estimated reservoir temperature is more than 260ºC (GSI, 1991). This province record the highest heat flow value and geothermal gradient (>100 mW/m^2 and 100ºC/km, respectively (Ravi Shanker, 1988). The flow rate measured from the bore wells vary from 200 L/min to more than 1000 L/min (GSI, 1991). The presence of younger granite intrusives (22-5 Ma)(Schneider, et al., 1999) and ongoing shallow magmatic processes makes this region an excellent site for any geothermal related activity.

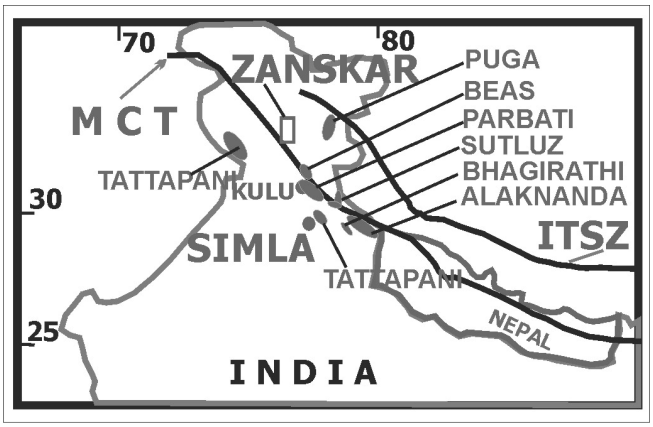

Figure 2. Northwest India.

Himachal Pradesh, where all the geothermal areas of the Himalaya province are located, has varied agro-climatic conditions suitable for growing different varieties of fruits. The state is successfully growing apple, pear, peach plum, almond, walnut, citrus, mango, raisin grapes, etc. The total area under fruit cultivation in Himachal Pradesh is about 2000 km^2 with a production of about 5000 tonnes of all kinds of fruits. Apple is the major fruit accounting for more than 40% of total area under fruits and about 88% of total fruit production in the state. The present two fruit processing plants has a combined capacity to process about 20,000 tonnes of fruit every year. But, then the region has to depend on other farm food from other parts of the country. If local geothermal resources are put to use, this region can be one of the major food producing and processing regions in the country.

Greenhouses, dehydration of fruits and vegetables and aquaculture (fish farming) are the three primary uses of geothermal energy in the agribusiness industry which are most suited under the existing Indian conditions. The relatively rural location of most geothermal resources in India also offers advantages, including clean air, few disease problems, clean water, a stable workforce, and low taxes. The Himalaya geothermal province is best suited to initiate state-of-art technology in food processing (dehydration and greenhouse cultivation) using geothermal energy. Beside the agro-based industry, large cold storage facilities can be commissioned along the west coast geothermal province where fishing is a major business.

HOW TO TAP THE RESOURCE?

Direct–use systems are typically composed of three components:

a. A production facility – usually a well – to bring the hot water to the surface;
b. A mechanical system – piping, heat exchanger, controls – to deliver the heat to the space or process; and
c. A disposal system – injection well or storage pond – to receive the cooled geothermal fluid.

These systems can be bought off-the-shelf and can further be modified to suit specific sites. Geothermal projects require one time capital investment and the annual operational cost is minimum. While in the case of conventional projects, the capital cost includes the cost of the boiler and distribution lines and a large annual operational cost which is continuous and fluctuates depending on the cost of (ever increasing cost of oil, gas and low ash coal) fuel. Depending on the available resources, direct-use projects can operate for over 20 years with low down-time period.

At present, nearly 70% of India's power production is based on coal due to the availability of huge coal reserves in the country. Excessive use of this source, without the use of strategies to mitigate its effects, will have deteriorating effect on the quality of human life. In another decade, emission of CO_2, SO_2 and NOx will exceed 1500 million tonnes, 1900 kilo tonnes and 1200 kilo tonnes respectively (World Bank Report 1999). This means CO_2 emissions will be 775 million metric tonnes per year as compared to 1000 million metric tonnes per year produced in the entire European Union! No doubt the cost of electricity produced from coal is far less expensive compared with other fuels. The present day cost of one kWh of power is less than a rupee in the case of coal based power while liquid fuel based power costs about Rs. 2 per kWh (Mehta, 1999) and hydro power costs about Rs. 1.50 (World Bank Report, 1999)(approx. US$0.04 and $0.03, respectively). But the expenditure spent to meet the consequences (like disposal of fly ash; treating the coal with high ash content, etc.) is high which automatically increases one rupee per kWh to several rupees. Now a time has come to look into those alternate energy sources which were not viable a decade ago due to non-availabilities of advanced technical know how. At present, 1.5 percent of total power generation capacity come from non-conventional energy sources like wind, solar and bio-mass. In the next fifteen years, according to the World Bank Report (World Bank report, 1999), this energy supply could increase by seven times and above.

CONCLUSION

The Ministry of Non-Conventional Energy Source and the Ministry of Food processing, Govt. India encourage use of non-conventional energy resources and provides funds for industries to initiate such projects with attractive financial incentives mentioned above. At present, the Himachal Pradesh depends on hydroelectric power; while, the rest of the country depends on coal based power. Considering the problems created by the coals based power projects and environmental degradation caused by the hydro-electric power projects, the future for geothermal energy resources is quite attractive and bright. India is the only country in the world which has not serious at utilizing its huge geothermal resources. With the present economic globalization process and attractive incentives given to foreign investors in food processing industry, geothermal energy resource utilization in food-processing industry should make a mark in India economy.

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