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Direct Utilization of Geothermal Energy Resources
NW Himalayas, India

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Keywords
Himalaya Geothermal Province, Himachal Pradesh, hot dry rock, geothermal power, geothermal energy, food processing

ABSTRACT

India’s share in the global market of processed food is minimal due to high cost of finished products. Though a large amount of geothermal energy is available, the Indian food processing industry still uses conventional energy. Himachal Pradesh Geothermal sub-provinces (HPG), in northwest Himalaya, form a part of the large Himalaya Geothermal Province (HGP), which covers an area of over 1500 sq km enclosing more than 150 thermal manifestations, with surface temperatures varying between 57 and 97 °C. Direct utilization of geothermal energy resources is already in practice in this State. If its use is extended to food processing and other agricultural based industries, this State can capture the entire world market in agricultural based industries.

Introduction

The installed capacity of fruit and vegetable processing industries in India has jumped from 2.08 million tones in 1998 to over 2.1 million tones in 1999. Consequently the production of processed fruits and vegetables has also seen a substantial growth, within a year, from 0.94 million tones in 1998 to over 0.98 million tones in 1999. Indian major processed food includes fruit pulps, juices, canned fruits and vegetables and dehydrated vegetables (MFP, 2001). Due to ever increasing demand for such item, the Government of India liberalized issuing license and issued 5198 licenses in 1999 compared to 5112 issued in 1998. Due to decentralization of these industries, a large number of them have become small-scale industries with an annual turnover of about 250 tones. With recent liberalization and removal of excise duty, multinational companies have entered this market and are able to produce processed food of the order of 30 tones per hour.

The Central Food and Technology Research Institute (CFTRI), at Mysore, Karnataka State, standardized the methods and cost for establishing various food processing industries. Table 1 lists a few of them.

<table>
<thead>
<tr>
<th>Item</th>
<th>Production (kg/year)</th>
<th>Working Capital/year (US$)</th>
<th>Power/year (kW)</th>
<th>Fuel/year* (kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dehydrated vegetables</td>
<td>18,000</td>
<td>12,500</td>
<td>2900</td>
<td>18,000</td>
</tr>
<tr>
<td>Fruit bar</td>
<td>18,000</td>
<td>12,500</td>
<td>2900</td>
<td>1,800</td>
</tr>
<tr>
<td>Raisins</td>
<td>36,000</td>
<td>18,000</td>
<td>3600</td>
<td>18,000</td>
</tr>
<tr>
<td>Mushroom</td>
<td>9000</td>
<td>1,200</td>
<td>720</td>
<td>1,800</td>
</tr>
</tbody>
</table>

*(coal/LPG; MFP, 2001)

From the Table 1 it is apparent that these industries use either coal or liquid petroleum gas (LPG). Because of this the cost of the finished product is very high although the cost of raw products at the production site is low. Perhaps this is the reason India is not able to compete with world market and the country’s share in the world trade of processed fruits and vegetables is still less than one percent (Chandrasekhararam, 2001a).

One of the States in India, which is putting large thrust in food processing industry, is Himachal Pradesh. This State made licensing procedures simple and is giving major incentives to private investors. Viewed in terms of power supply, good governance, and attractive physical environment, this region in future may capture the entire food processing market of the country. However, these factors may attract foreign investors to certain extent but may not be able to compete in the world market if conventional fuel continues to provide energy to the industry. Cost of the finished product is always linked to the price of the fuel and hence this industry cannot maintain cost stability. With ever increasing fuel cost there is remote chance of reducing the cost of finished products. The only viable alternate method for sustained growth of the industry is to utilize its large geothermal resources.
If the available geothermal energy sources are utilized India can compete in the world market and can become one of the leaders in this industry.

**Geothermal Manifestations and Heat Source in HPG**

Himachal Pradesh (HP), in northwest Himalayas, forms a part of the large Himalaya Geothermal Province (HGP), which extends from northwestern part of India (Ladakh) to its northeastern part (Assam) covering an area greater than 1500 sq km and encloses over 150 thermal manifestations. They fall between the Main Boundary Thrust (MBT) and Indo-Tsangpo Suture Zone (ITSZ), which are parallel to the Indo-Asia collision zone (Fig.1). Himachal Pradesh geothermal sub-provinces (HPG) form a part of this large Himalaya Geothermal Province (HGP). Thermal manifestations around Puga (north of HP), Parbati and Kullu valleys are known for their high temperatures. Preliminary investigations on these areas were carried out by several workers (Sehgal 1963; Jangi et al., 1976; Gupta et al., 1976; Giggenbach et al., 1983; GSI, 1991; Alam, 2002). Recently, as a part of Indo-Italian collaborative research programme, detailed investigation on the thermal waters and thermal gases from thermal manifestation along Parbati and Kullu valleys have been carried out to understand the geochemical evolution of the thermal waters and gases and assess the geothermal potential of these sub-provinces.

HPG experiences high geothermal gradient, reaching values as high as 260 °C/km and high heat flow values of 70 to more than 180 mW/m² (Ravi Shanker, 1988). The surface temperature of the thermal springs varies from 57 to 96 °C (GSI, 1991; Alam, 2002) and at some places (e.g. Manikaran) steam emergence is commonly seen. Recent investigation on thermal waters from Manikaran in Parbati Valley (Alam, 2002) shows that the thermal waters issuing here can be considered as a mixture of two end members, one represented by paleo-brine rich in Na-Cl and the other represented by calcium carbonate rich water produced by the interaction of meteoric water with calcite veins traversing the lithological formations. The estimated reservoir temperatures (Na-K geothermometry) vary from 260 °C (GSI, 1991) and 310 °C (Alam, 2002). Thermal water flow rates measured from the shallow exploration bore-wells, drilled by the Geological Survey of India, varies from 200 l/m to more than 1000 l/m (GSI, 1991). Direct utilization of geothermal energy is already in practice in some places in this region. For example at Manikaran, which is one of the pilgrimage centers in Himachal Pradesh, rice is cooked in pots using geothermal water (Figure 2). Further, pilot greenhouse cultivation experiments conducted by the Geological Survey of India in 1986 (Ravi Shanker, 1986) proved the potential for direct application of Puga-Chhumathang (north of HP) geothermal area.

Besides subduction tectonic regime, high heat flow and geothermal gradients in this region is due to younger shallow magmatic activity within MBT and ITSZ. Shallow, younger magmatic activity in this region is represented by a large number of granite intrusive, whose age varies from 60 to 5.3 Ma (Schneider et al., 1999a,b; Searle, 1999a,b; Le Fort and Rai, 1999; Haris et
al., 2000; Harrison et al., 1998, 1999; Chandrasekhar, 2001b; 2002). These granites occurring as lopoliths, sheets and dykes (leuco-granites), with thickness varying from a few meters to several meters, are either exposed on the surface or covered by a layer of sedimentary formation. Permian granite of 268 Ma also occurs in the western Zanskar (Noble et al., 2001).

International Deep Profiling of Tibet and the Himalayas (INDEPTH) project located 'seismic bright spots' in Tibet region (east of HPG), which are attributed to the presence of magmatic melts and or saline fluids within the crust (Makovský and Klemperer, 1999). Highly saline fluids are also found in Ladakh granite (~60 Ma) as inclusions, which are attributed to the high volatile content in the granitic melts (Sachan, 1996). Though INDEPTH investigation has not been carried out, considering the proximity of INDEPTH site in Tibet, probability of encountering such "seismic bright spots" within the HPG is high. This inference gains strength from the 1 Ma anatectic process reported in Nanga Parbat (Figure 1; Chichi Granite Massive) in Pakistan Himalayas (Schneider et al., 1999c). Similar processes must be in operation on the eastern side of Nanga Parbat also. These evidences confirm that the present day observed high heat flow value (>100 mW/m²) and geothermal gradient is related to subduction tectonic related crustal melting process at shallow depth.

Geothermal Energy Utilization in HP

HP, being a region with high altitudes and rugged mountain topography, it is not possible to transmit power to remote villages by conventional coal or hydropower grid. Though local government has installed transmission cables to remote villages, power supply has not been commissioned even after several years and the rural population are still using conventional lanterns to meet their power requirement. With the existing geothermal resources and available technology, it should be possible to generate power, which can provide at least one electric bulb in every home in these villages! In regions like Puga (north of HP), which is covered by snow and ice throughout the year, geothermal heat will benefit to a large extent to the army personnel. At present diesel is being used to support energy needs by security forces in remote regions of NW Himalayas. Thus besides power, direct utilization of geothermal energy (e.g. space-heating and greenhouse; Lund, 2002) will be more beneficial and economical in these regions if utilized, besides food processing industry, for space heating of houses, community centres, schools, dispensaries and other security establishments, sheep breading (animal husbandry), wool processing, carpet and shawl industries. All such industries are well within the realm of the local government and can drastically reduce dependence on conventional fuel and protect the fragile eco-system.

HPG have varied agro-climatic conditions suitable for growing different varieties of fruits. This region is successfully growing apple, pear, peach, plum, almond, walnut, citrus, mango, raisin grapes etc. The total area under fruit cultivation in Himachal Pradesh alone is about 2000 km² with a production of about 5000 MT of all kinds of fruits annually. Apple is the major fruit accounting for more than 40% of total area under fruit cultivation amounting to about 88% of total fruit production in HP. The present two fruit processing plants in HP has a combined capacity to process about 20,000 MT of fruit every year. But, then the region has to import other food products 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 (Chandrasekhar, 2001a; 2002).

Greenhouses, dehydration of fruits and vegetables and aquaculture (fish farming) are the three primary uses of geothermal energy in the agribusiness industry (Lund, 2002), 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, clean environment, clean water, a stable workforce, and low taxes. The HGP is best suited to initiate state-of art technology in food processing (dehydration and greenhouse cultivation) using geothermal energy. Although initial investment with geothermal based industries is high, over a long period of time, due to minimum maintenance cost, the cost of the finished products can be brought down by a factor of 4 or even more (Chandrasekhar, 2001a).

Conclusions

The existing data on the geothermal resources on HPG indicates that both power and direct applications are possible over the entire area of the Himalaya Geothermal Province. Considering the local agricultural products, incentives extended by the local government for small-scale food processing industries, this State is quite attractive to foreign investors. The practice of cooking rice using geothermal waters clearly demonstrates the awareness "geothermal" gained by the local population. Using locally available geothermal resources enable to adopt Clean Development Mechanism (CDM) and reduce dependency on conventional power sources and also mitigate global climate change. When Yangbajing Geothermal Field in China, located north of ITSZ and east of HPG is able to produce 25MW of power (Chandrasekhar, 2000), considering similar tectonic setting, the HPG undoubtedly is in a position to support geothermal based food processing industry at several sites within this province. This will drastically reduce the cost of the finished products and will improve the socio-economic status of the local hill population by promoting self-sustaining mechanism.

References


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