PROBLEMS IN DIRECT UTILIZATION OF GEOTHERMAL ENERGY IN KAMOJANG GEOTHERMAL FIELD, INDONESIA

Untung Sumotarto

Direktorat TPSE, BPP Teknologi
Jl.MH.Thamrin No.8, Lt.19 (Gd.II), Jakarta 10340, Indonesia.
Telp.(021) 316-9737, Fax.(021) 316-9736, E-mail: tarto@bppt.go.id

Key Words: geothermal, Kamojang field, direct use, agriculture industry, mushroom cultivation

ABSTRACT

There is not much effort of direct utilization of geothermal energy in Indonesia. The most common and traditional but in a very small use of geothermal energy in Indonesia is for balneology and hot swimming pool purposes. Although other uses in other area such as in agricultural industry is widely potential, however, the work is still in infancy that is only in research and development (R&D) stage.

Recent R&D on direct utilization of geothermal energy in Indonesia is in helping mushroom cultivation i.e. for growing media sterilization in Kamojang geothermal field, West Java. Technologically, there is not much problem in the development and application of direct use of geothermal energy. Problems arise from the development of direct use in Kamojang geothermal field, Indonesia are mostly non-technical, among others, difficulties in acquiring land for expanding the prospect into commercial scale, distance of geothermal resource from product to be processed, measuring geothermal fluid used due to lack of apparatus, fuel subsidy policy causing expensive cost of geothermal energy, etc.

With the above problems, however, research and development on direct use has to continue considering recent government policy and attention in developing renewable energy including geothermal energy.

1. INTRODUCTION

In 1999 the Government of the Republic of Indonesia had announced the implementation of Constitutions No.22 and 25 that basically regulate the regional government autonomy. With these two constitutions, the regional governments are now continuously doing preparation and activities for the implementation of the constitutions. One of the development sectors that require responsibility and ready to be handled by regional government is the development and utilization of natural resources owned or under authorization of regional government.

Bandung regency and the surrounding areas has various natural resources potency. One of the natural resources found abundantly in Bandung regency and the surrounding is geothermal energy resources. During the past 20 years, i.e. before the implementation of those two constitutions, geothermal resources in Bandung regency has been developed mainly for electricity generation for examples the resource found in Kamojang geothermal field. Other utilizations are limited to tourism purposes, i.e. for hot water bathing and balneology, for example those found in Ciater area. Geothermal energy can also be utilized directly for various purposes including in the area of agriculture industry.

Directorate for Energy Resources Development (Dit.TPSE), BPPT is one of the non-departmental research institutes that has long been doing R&D of various energy resources. One of the energy resources they are working on is geothermal energy for example in the development and installation of geothermal power plant using binary cycle technology of 2.5 MW capacities in Lahendong (North Sulawesi). Recently, when the government emphasizes the development of "small holder" economy, the R&D is directed to activities that can be used by people in general particularly peasants.

This paper describes activities and problems in the utilization and development of geothermal energy in agriculture industry. There are several applications in this field. However in this first stage, the activity is intended specifically for utilization of geothermal energy to help mushroom cultivation. In the next stage it can be directed to other applications.

By introducing the technology for utilization of geothermal energy in agriculture industry i.e. for helping the mushroom cultivation process, the project will help peasants, increasing their income, supporting the "small holder" economic development, and thus assisting in the success of autonomy of Bandung regency and West Java in general considering the vast potential of geothermal energy in this area.

2. PROSPECT

Indonesia is a country having many volcanoes. There are at least 177 volcanic centers that are spread over volcanic belts of 7000 km long. From that many centers, there is at least 19,000 MWe equivalent from geothermal energy resources contained in the volcanic areas. By now, only about 769.5 MW of that much energy potency has been utilized for electricity power generation. The rest has not been utilized optimally.

Meanwhile, in the geothermal fields that have been developed and utilized such as Kamojang, Dieng, Darajat, Gunung Salak, etc, there have been production geothermal wells that have reduced pressure, temperature, and production rate thus unable to supply the existing electric power plant. Such wells have been modified to re-injection or monitoring wells. There are also waste geothermal fluids from electric power plants that are usually re-injected into the reservoir to maintain the live of the geothermal reservoir. The heat contained in the fluids can still be extracted to supply equipment or engines for producing fresh

water steam, or to supply heating equipment for sterilization of growing media, agricultural, and husbandry products and other direct utilizations.

The existence of geothermal energy resources that is commonly found in mountainous and inland regions has its own benefit. In Indonesian mountainous and inland regions there are found agricultural, plantation, forestry areas in which their products require processes such as drying, preservation, heating, sterilization, pasteurization, etc. The agricultural and plantation products requiring such process are for examples: potato seeding, mushroom cultivation, milk pasteurization, etc.

As an agricultural country in which its economy had used to depend on natural resources (*natural resources based country*), Indonesia also relies the foreign exchange on agricultural products particularly at the economic crises time. At the time when non-agricultural industry undergoing stagnancy, the agriculture industry has just proved to be survived. Hence, it has to gain support in order to be able to help assist the whole economic relieve process.

Agriculture, plantation, and forestry commodities that need processes as sterilization, pasteurization, and drying such as potato, mushroom, tea, and milk are found in mountainous regions where several geothermal fields have been developed and utilized. In such regions, the application of sterilization and pasteurization technology using geothermal energy would be helpful to the farmers, plant growers, and agriculture entrepreneurs in the cultivation, preservation, and growing the plants and agricultural products.

With simple heat exchanging principle, the heat from geothermal fluids can be utilized for sterilization equipment of agricultural and plantation growing media.

3. KAMOJANG GEOTHERMAL FIELD

Kamojang geothermal field is located at 40 km south east of Bandung, the capital city of West Java, Indonesia. The field size has been determined using CSAMT method to be 21 km^2, and its potential is about 300 MWe (Sudarman et al, 1995).

By 1996, more than 70 wells have been drilled since the first well drilled by the Dutch before the Indonesian government era with an average depth of 600 – 2100 m. The field is a vapor dominated, having average temperature of 235^0C – 240^0C, pressure of 30 - 33 Bar, permeability of 5 –120 Darcy meter, non-condensable gas of less than 1% weight, and enthalpy of 2800 Kj/Kg of steam produced from the wells (Pertamina, 1993, 2000).

Of those more than 70 wells, only about 30 wells are being used to supply the 140-MW power plant. The rest are either turned into re-injection wells or monitoring wells. At the monitoring wells, steam is bleed to the atmosphere, thus wasting it without being used for any purposes. There is a monitoring well with the steam currently being used for domestic water heating (KMJ-23). After a long negotiation, the steam from the same well was then decided to be used for direct utilization R&D activity conducted by BPPT.

The field is located in a protected forest, with agricultural lands outside the forest and newly converted forestland into agricultural lands in the surrounding. The agricultural lands are cultivated with vegetables such as potato, carrot, tomato, cabbage, corn, peanuts, etc. Some people are also doing mushroom cultivation.

4. ENVIRONMENTAL, SOCIAL, AND ECONOMIC REASONS

Kamojang geothermal field, West Java, Indonesia is located in a mountainous and forested restricted area. Recently there have been social, economical, and environmental problems due to the activities of peasants and community surrounding the field. Since the economic crisis hit Indonesia in mid 1997, people are desperate to seek jobs. In such area, agriculture is one of the best choices, not only that this area is the most survived in the crisis, but also most people in the area are peasant by profession.

When the crisis started hitting Indonesia, people starts altering forest areas surrounding Kamojang geothermal field into agricultural land. The change has caused soil erosion problem, which further reduce infiltration of run-off (surface) water into ground water. The reduction of ground water supply in turn caused reduction of water supply to geothermal reservoir. When this happened, many wells decrease steam production, which caused reduction to supply to the power plant. This is the time when steam is flashed into the air. There are more than 10 wells in Kamojang geothermal fields that are no longer used to supply the power plant.

Introduction of new technology in the agricultural industry process will increase people's earning, economic performance as a whole, and improve the learning capacity and curiosity of the people. The simple technique will be easily digested and enabling people to operate the plant without much learning and training process.

Therefore, the implementation of direct utilization R&D will be expected to:

a. Reduce environmental problems because of the reduction of oil fuel consumption, reduction of deforestation problem due to concentrated activity in the mushroom industry, renovation of geothermal reservoir with the decrease of erosion and increase of ground water supply.
b. Alleviate economic and social problems by providing jobs and new activities of higher economic and export value (compared to traditional non-mushroom agricultural activities).
c. Improve technological awareness and competence of the people in the surrounding geothermal field. The technology is not a complicated one, making people capable to operate the industry on their own.

5. DIRECT UTILIZATION

Although ideas of geothermal direct utilization has been initiated since more than ten years ago, however, there is no field implementation whatsoever. Until two years ago, a group of researchers in BPPT began to implement the idea of using geothermal energy directly in the agricultural industry area, particularly in mushroom cultivation. The work is still in research stage. Specifically, in this research project geothermal energy is utilized for helping sterilization of mushroom growing media.

Among the objectives of the research and development (R&D) are:

a. Saving the environment by changing the use of fossil fuel to renewable and environmentally friendly energy (geothermal energy).
b. Substituting oil fuel by renewable energy (geothermal energy), which can save the use of oil fuel in particular.
c. Creating jobs to surrounding community, which can help alleviate economic crisis currently hit Indonesia.
d. Saving geothermal reservoir from groundwater shortage problem due to forest alteration into agricultural land (deforestation) in the area surrounding geothermal field.

The research has proven that it is technically feasible to use geothermal energy for helping growing media sterilization process in the mushroom cultivation industry. For specific geothermal fields and fluid types, it could also be economically feasible. In this case, Kamojang geothermal field is a field having aging wells that are no longer being used to supply power plant. Geothermal fluids from the aging wells that are flashed into the air can be utilized for direct-use (non-electricity) purposes.

Mushroom growing media sterilization requires supply of fresh water steam. The media is steamed in a chamber or space from below. Traditionally and current practices use boiler to produce steam by burning oil fuel (IDO or kerosene). Geothermal heat is used to replace the oil fuel; in this case only heat from geothermal fluids is extracted. By using heat-exchanging principle, heat from the geothermal fluids is conducted through metal pipe in the heat exchanger and passed to fresh water in a tank. Continuous heat supply will increase fresh water temperature until reaching boiling temperature. The heat exchanger has to be designed such that heat transferred is enough to boil the fresh water. Fresh water steam is than flown to sterilization chamber full of growing media. The chamber is constructed such that the steam is distributed well in the chamber. **Figure-1, Figure-2** and **Figure-3** show facilities and results of geothermal utilization for mushroom cultivation in Kamojang geothermal field, West Java, Indonesia.

The next process is seeding and growing the media to produce mushroom. This is common practice that has no change from what has been done by mushroom growers so far. Experiments of cultivating various species of mushroom such as *Agaricus bisporus*, *Pleurotus spp*., and *Auricularia spp*. showed successful results. These have initiated negotiation among business parties to develop such project into commercial scale. The most current activity in the R&D is the use of geothermal energy to help potato growing media sterilization. The work has shown successful results and has also interested investors.

6. PROBLEMS IN DIRECT USE

After two full years of research and development, there appeared problems related to the direct utilization of geothermal energy at Kamojang geothermal field. Among the problems are:

1. Difficulty in acquiring land if the project is expected to develop to commercial scale. Referring to an existing mushroom industry at Pangalengan region, the nearby agricultural area, a commercial and concentrated mushroom industry should meet a land requirement of at least 10 hectares. Because the land surrounding Kamojang field is a protected forest under the jurisdiction of Perhutani and Department of Forestry and Plantation, it is difficult to acquire land to be used for commercial purposes. This problem may be solved by a concept of peasant-land-based cultivation industry. In this case, cultivation mushroom houses may be built on peasant individual land near the field. Once the mushroom growing media has been sterilized and seeded, it can then be placed in peasant-land mushroom houses.

2. Distance of geothermal resource from product to be processed. Kamojang geothermal field is located in a protected forest area, while agricultural lands are on distance from the geothermal field. If the project has to develop for various applications such as geothermal energy for agricultural product drying purposes, then there should be means of transportation for the products from the harvesting location to the drying plant site. This will need extra cost of production. Piping geothermal fluids available for direct uses to the agricultural lands and peasant living area may solve this problem.

3. National fuel subsidy policy causing expensive cost of geothermal energy. Oil fuel has been subsidized for quite long time. This has caused geothermal energy uncompetitive to oil fuel. If the project has to develop into commercial scale then there should be compromise on steam price. Unit price for geothermal energy (steam) to be used in the direct use project should be charged at affordable lower price and less than standard price for other utilization such as for electricity generation. This is because in the case of Kamojang geothermal field the direct utilization requires only geothermal fluids from aging wells that are no longer used for power plant supply. Instead of bleeding and wasting the steam into the atmosphere, it can still be utilized for non-electricity purposes.

4. Post-harvest handling and market of the product (in the case of mushroom). Mushroom is an agricultural product that needs extra careful handling and limited marketing time. Once a fresh mushroom harvest has been done, it should be marketed within only maximum of six hours. Above that period, the mushroom quality will quickly degrade. Thus, a commercial mushroom cultivation industry should also provide a preservation plant or at least there should be guarantee that the harvested mushroom will be preserved soon although by different company. In other words, there is an agricultural preserving and packing company that would accept the mushroom produced to be preserved such as canned products ready to sell.

5. Measuring geothermal fluid used due to lack of apparatus. The mushroom cultivation project with assistance of geothermal energy uses heat exchanger to produce fresh water steam using a 2”-coiled-tubing geothermal pipeline. Such size caused difficulties in measuring the geothermal steam being consumed. Converting the flow rate at wellhead to smaller pipe diameter may solve this problem, because flow rate is dependent on pipe diameter. Knowing the flow rate at wellhead could be used to refer to calculating the rate at smaller diameter pipe. The project has also found solution by installing small diameter pipe flow meter with the one usually used in chemical industry. Although the apparatus may not quite stand to corrosion problem, however, this is enough to measure the flow rate temporarily.

7. COMPATIBILITY TO THE NATIONAL POLICY

The geothermal direct use R&D project is definitely compatible with the government development strategy particularly in the energy policy. With the decrease of oil reserve and in accordance with the environmental policy and regulation, the new and renewable energy including geothermal energy will play a more important role in the near future. The use of geothermal energy will reduce oil consumption in the agricultural industry that is not only reducing the use of oil fuel, but also reducing the potential of environmental damage. The project will environmentally save not only the air and the forest above the ground, but also the geothermal reservoir underground.

The geothermal R&D project is also supportive to the current government economic policy that encourages small and medium enterprises to develop. If the project could be developed into commercial scale, the management can be handled by small or medium enterprises recommended by the government such as cooperation (koperasi) or purely private sector as long as it involves local labors, thus confirming the objective of the project. The project is in-line with the temporary trend of national current economic base that is going to agricultural and natural resources base. The mushroom cultivation industry does not only belong to agricultural industry but it is also developed and based on production of natural resources.

8. CONCLUSIONS

Indonesia is a country rich in geothermal energy. Although utilization of geothermal energy for electricity purpose has been growing, however, utilization for non-electricity purposes (direct use) is still in infancy. R&D performed in Kamojang geothermal field in the last two years revealed lessons for the future development. Problems in the direct utilization in Indonesia's geothermal field could be solved with some requirements.

Although direct utilization of geothermal energy in Indonesia still has problems, however, development activity should be continuously done considering the direct utilization prospect. The total prediction of geothermal potency of 19,000 MW is not all technically feasible for electricity generation. Direct utilization may use waste geothermal fluids and fluids belong to medium and low enthalpy geothermal fields.

9. REFERENCES

Sudarman, S., Boediardi, M., Pudyastuti, K., and Bardan (1995) *Kamojang Geothermal Field: 10-Year Operation Experience. Proc. Of The World Geothermal Congress (Florence) Vol.2, pp.1773-1777*.

Pertamina (1993) *Panasbumi, Energi Masa Depan. Kamojang, Lapangan Pertama di Indonesia Yang Memanfaatkan Energi Panasbumi*, Brosur lepas.

Pertamina Area Panasbumi EP Kamojang (2000) *Panasbumi, Sumber Energi Andalan Masa Depan. Bersih, Efisien, Terbarukan*, Brosur lepas.

Sumotarto, U., Surana, T., and Lasman, F., (2000) *Pemanfaatan Energi Panas Bumi Untuk Budidaya Jamur, Presented at the 4th INAGA Annual Conference, Jakarta, 25-26 January 2000*.

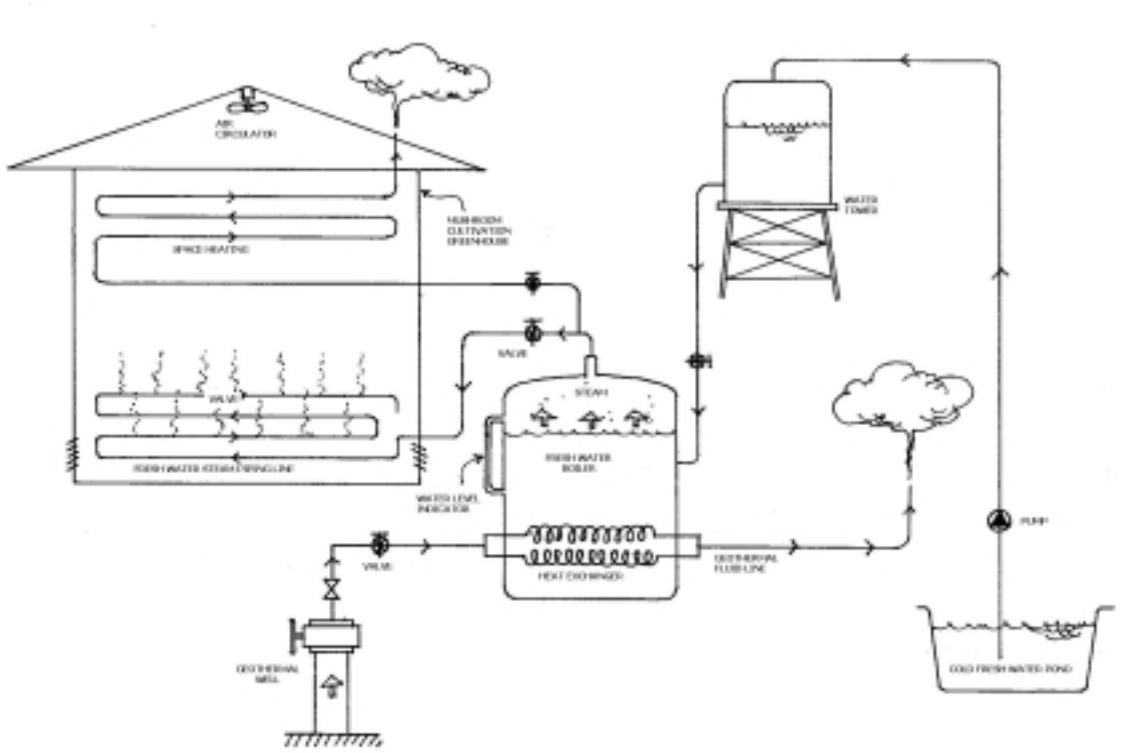

Figure 1: Scheme of geothermal energy direct utilization at Kamojang field, Indonesia.

Figure 2: Facilities in geothermal direct utilization for mushroom cultivation in Kamojang geothermal field.

Figure 3: Champignon mushroom (*Agaricus bisporus*) grows well with help of geothermal energy.