DEVELOPMENT OF GEOTHERMAL ENERGY DIRECT USE IN INDONESIA

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ABSTRACT

As a country with vast potential of high enthalpy geothermal resources, Indonesia has been focusing the development of geothermal energy for electricity generation. On the other hand, Indonesia is also blessed with a huge low-to-medium geothermal resources such as hot springs, natural geothermal wells, etc., which can be applied for direct use applications. Besides the above geothermal resources, direct use applications also utilize energy from un-exploited brine and small capacity production wells. In general, the geothermal resources in Indonesia are located in mountainous areas with agricultural lands (including plantations), forestry, bathing and spa resorts, etc. which need heat for their processes or activities. This is a perfect situation for the geothermal energy direct use to be developed. However, unfortunately at present the direct use of geothermal energy in Indonesia is very low. Agency for the Assessment & Application of Technology (BPPT) has been developing direct use applications since 1999 by utilizing various geothermal resources such as steam from a small well, brine from a separator in an existing power plant, and hot water from natural as well as man-made shallow geothermal wells for mushroom cultivation, copra and cocoa drying, etc.

INTRODUCTION

Indonesia is a country with the largest hydrothermal type geothermal resources in the world, with a potential of more than 17,000 MW. The utilization of geothermal energy in Indonesia is 1,179 MW (4%), and limited to the power generation only (indirect use). The geothermal resources which are generally located in mountainous areas with agricultural lands (including plantations), forestry, bathing and spa resorts, etc. are very potential for various direct use applications. According to the Geothermal Law (Law No. 27 / 2003), geothermal energy must also be developed for direct use, but up to now its implementation in Indonesia is still very low.

The geothermal energy direct use applications can contribute significantly to the government's energy diversification program and fossil fuel substitution, as well as increase the life standard of the local communities. Many local governments have been starting the identification of the direct use potential in their administrative territories. For example, West Java, a province with the largest geothermal resources utilized for power generation, completed the study and reported it on the development plan of direct use in the West Java Province in 2003, and started the implementation in 2006 by adopting the existing mushroom cultivation direct use for the community development program.

PRESENT STATUS

Bathing and Swimming

The most common and traditional usage of geothermal energy in Indonesia is for balneology, bathing and heated swimming pools. Figure 1 shows traditional bathing in Darajat geothermal field, while figure 2 shows a heated swimming pool from a hot spring which is commercially exploited in Cipanas of West Java Province.

Figure 1: Traditional Bathing with Geothermal Hot Water in Darajat Geothermal Field

Figure 2: Hot Water Swimming Pool in Cipanas

At present, there are no accurate data on the total countrywide utilization and capacity because the number of traditional bathing is a lot along the country, so that they are very difficult to collect and quantify. Another example, since more than 10 years ago Pertamina Geothermal Energy has been utilizing the geothermal steam to heat up freshwater for the domestic and office use in Kamojang Geothermal Field, but there is no measurement for the capacity as well as the annual energy use. According to the

estimation by Lund et al. (2005), the use for bathing and swimming in Indonesia is 2.3MWt in capacity with an annual energy use of 42.6TJ/yr. However, it is believed that the real number is much more than the above estimation.

Agriculture

Mushroom in Kamojang Field

The utilization of geothermal energy for agriculture in Indonesia was initiated by a geothermal research group of BPPT (Agency for the Assessment and Application of Technology) in 1999. BPPT with the cooperation of Pertamina Geothermal Energy implemented a pilot plant of the geothermal energy direct use for mushroom cultivation in Kamojang Geothermal Field (West Jawa). The facility consists of a steam generator heat exchanger, an autoclave, a freshwater tank, an inoculation room, incubation rooms and production rooms. The schematic diagram of the facility is as shown in figure 3 below. Dry steam from a small capacity well with the temperature of 110-120ºC is directed to a steam generator to heat up freshwater. The heated fresh-steam is used to sterilize the mushroom growing media, or as so called "bag-log", and also for space heating to keep the incubation room warm. The geothermal steam is to substitute the use of fossil fuel (kerosene) which is getting very expensive every year. The mushroom cultivated in this direct use facility is shown in figure 4.

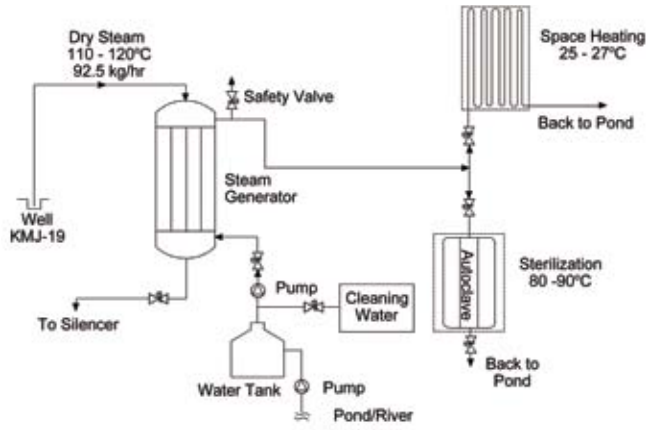

Figure 3: Schematic Diagram of Mushroom Cultivation by Utilizing Steam from Small Production Well

Starting from 2006, the local government of the West Java Province has been adopting this facility as a model for community development program, and expanding the capacity of the facility to 25,000 bag-logs per month. The provincial government provides production houses for the local community, and they are involved in the production process. They can buy the sterilized bag-logs at a lower price, and are allowed to deliver the mushroom directly to the market.

Palm Sugar in Lahendong Field

Lahendong geothermal field is surrounded with a palm sugar plantation which is managed by about 3,500 farmers. A non-governmental organization called Yayasan Masarang with the cooperation of Pertamina Geothermal Energy built a large scale geothermal energy direct use facility for palm sugar production (figure 5) with the capacity of 12 tons/day by utilizing flashed steam from the separated hot water (brine). At present, the facility is running with capacity of 1 ton/day only.

Figure 4: Mushroom Cultivated from Geothermal Direct Use in Kamojang Field

Figure 5: Direct Use for Palm Sugar Production in Lahendong Field

The schematic diagram of the facility is as shown in figure 6. Brine from the separator is directed to a flasher to produce flashed steam of about 4 tons/hour, and it is utilized for the palm sugar processes. Some of the products are exported to the Netherland.

Copra and Cocoa in Way Ratai Field

In 2003 and 2008 BPPT implemented pilot plants of geothermal energy direct use in Way Ratai Geothermal Field (Lampung Province) for coconut meat (copra) and cocoa dryings by utilizing a shallow natural geothermal well and a man-made shallow geothermal well, respectively.

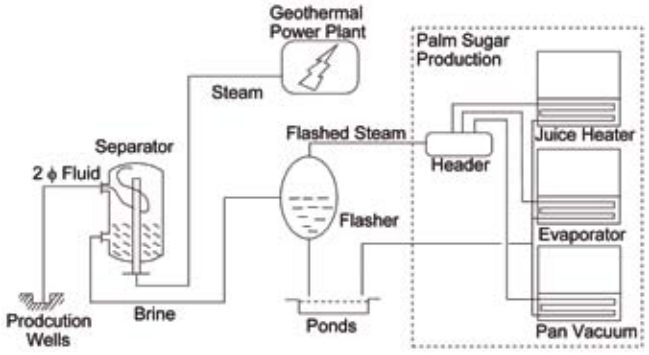

Figure 6: Schematic Diagram of Palm Sugar Production by Utilizing Brine

Way Ratai is an undeveloped geothermal field in Lampung Province, located in a coconut plantation area. There are many natural shallow wells in it with temperature range between 80 – 98ºC. BPPT (Agency for the Assessment and Application of Technology) implemented a pilot plant of the utilization of natural geothermal well for coconut meat drying (copra) in this field in 2003 – 2004, with the capacity of 200 kg coconut meat per batch. The facility consists of a downhole heat exchanger, a drying room, a pump, and a freshwater tank. The schematic diagram of the facility is as shown in figure 7. The downhole heat exchanger is put into a natural geothermal well with the depth of 2m and the temperature of 80 - 95ºC (figure 8), and the freshwater is flowed into it. The freshwater is heated up and directed to the drying room which is kept at the temperature of 50ºC to dry up the coconut meat by natural draft conductive heat exchange. The quality of the copra produced in this facility is much better compared to the conventional one because there is no smoke contamination on it.

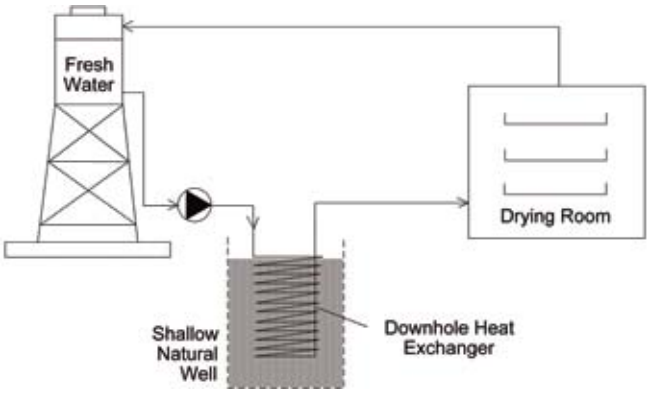

Figure 7: Schematic Diagram of Copra Drying by Utilizing Shallow Natural Well

Close to the location of the above copra drying direct use, BPPT implemented a pilot plant of the utilization of a man-made shallow geothermal well for cocoa drying in the same field in 2008. The well is made artificially from an existing hot water seepage on the ground (figure 9). It has a temperature in a range of 85 - 95 ºC. The schematic diagram of this cocoa dryer facility is the same as the one shown in figure 7, but different in the size of the downhole heat exchanger.

Figure 8: Downhole Heat Exchanger in Natural Geothermal Well

Aquaculture

At present, there is only one place identified as an aquaculture facility that utilizes geothermal fluid in Indonesia. It is a traditional freshwater fishery in Lampung Province, mixing natural geothermal hot water (outflow) with freshwater from a river to grow large catfishes. The farmer reported that the fishes grow better in the geothermal fluid and freshwater mixture.

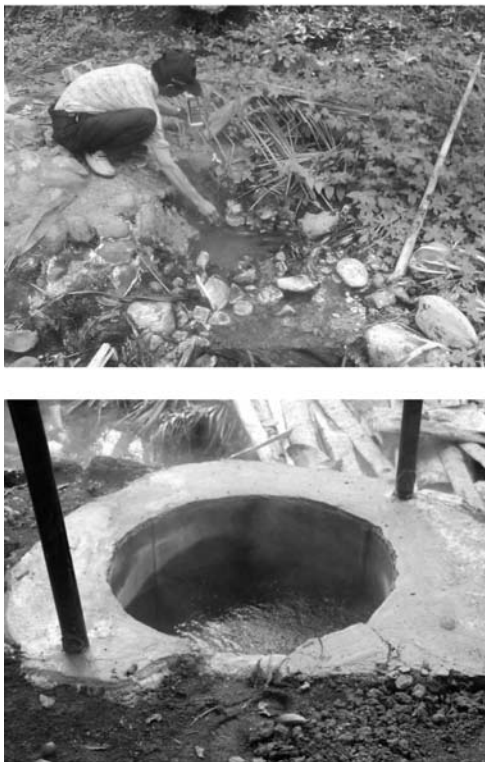

Figure 9: Artificial Shallow Geothermal Well Hot Water Seepage Before improvement (top) and after improvement (bottom)

Figure 10: Geothermal Direct Use for Large Catfishes Growing in Lampung

Space Heating

As a tropical country, the need of space heating in Indonesia is extremely limited. A small space heating facility was applied in Patuha Geothermal Field, but the detailed information about the exact size and capacity is not available.

Figure 11: Geothermal Direct Use for Space Heating in Patuha Field

FUTURE PROSPECTS

As stated before, the regulation of geothermal energy utilization for direct use is stipulated in the Geothermal Law. The Government of Indonesia cq. the Department of Energy and Mineral Resources is preparing an implementation regulation on the direct use activity in Indonesia. It is predicted that in the near future the development of direct use businesses will grow rapidly, provided that the regulations on it can be settled and come into effect soon.

BPPT has been identifying some geothermal fields which are very prospective for the direct use applications.

Wayang Windu Geothermal Field

Wayang Windu geothermal field operated by Magma Nusantara Limited (MNL) is located in a tea plantation area owned by a state owned company called PTPN8, and surrounded by a national forest. The geothermal fluid produced in the southern field of Wayang Windu is of two-phase, so that a separator is installed to separate the steam from the hot water. The steam is directed to a turbine to generate electricity with the capacity of 110 MWe, while the separated hot water (or so called brine) which still has a high energy content with the temperature of 175 – 180ºC is reinjected into the earth through a brine pipeline. This pipeline is laid down about 500m from the PTPN8's tea drying plant. BPPT with the cooperation of MNL and PTPN8 has finished studying the feasibility of utilizing the brine for tea withering and drying processes in commercial base business, in order to substitute the use of Industrial Diesel Oil (IDO). PTPN8 spends more than 1 million litres of IDO annually. The application of the geothermal direct use is expected to reduce not only a huge fuel cost, but also the CO_2 gas emission.

Figure 12: Wayang Windu Geothermal Power Plant Located in the Area of Tea Plantation

Kamojang Geothermal Field

Learning from the experience of the existing direct use application for mushroom cultivation in Kamojang, the facility is technically and economically feasible to be expanded for commercial based mushroom cultivation business. However, it is necessary to establish a sustainable community based business model before the implementation.

Garut Regency, where Kamojang geothermal field is located, has a product with a globally competitive advantage called grass with fragrant root or java vetiver oil. It is an expensive raw material of perfumes and cosmetics, and exported to European countries with the global share of about 10 – 15%. Recently, the production of the java vetiver oil drops significantly due to a drastic increase in the fuel (kerosene) cost.

An experimental result by a non-governmental organization in Garut concluded that geothermal energy can substitute kerosene for the distillation process with even better quality of vetiver oil product. This shows that geothermal

energy direct use for vertiver oil production has a very good prospect to be developed in Kamojang. In order to implement it commercially, it is very important to have a cooperation with Pertamina Geothermal Energy as the owner of geothermal fluids in Kamojang geothermal field.

Figure 13: Grass with Fragrant Root located near Kamojang Geothermal Field

Lahendong Geothermal Field

Tomohon, where Lahendong geothermal field located, is a city in the North Sulawesi Province with a large potential of coconut plantation. The productive plantation area is 767.5 ha and the total coconut production in 2004 was 729.1 tons. Pertamina Geothermal Energy had a plan to utilize the excess steam or brine from the separator in Lahendong for copra production commercially. A pilot plant for coconut meat drying (copra) was built by Pertamina, and its operational experiment gave a good result.

Ulubelu Geothermal Field

Ulubelu is a geothermal field located in Lampung Province. At present, production well drilling activities by Pertamina Geothermal Energy are in progress to develop 220 MW power generation in total. Ulubelu geothermal field is surrounded by a coffee plantation with the productive area of 7680 ha, and coffee production in 2007 was 5200 tons. This indicates that direct use for coffee processing is a very prospective in this field.

Ulumbu and Mataloko Geothermal Fields

Ulumbu and Mataloko geothermal fields are located in East Nusa Tenggara Province. These fields are being developed by PLN, a state owned electricity company. There are many agricultural products yielded from these areas, for example, maize, cassava, onion, etc. These products need heat for their processing treatment, and geothermal fluids (steam or brine) can be prospectively utilized for direct use applications.

CONCLUSIONS

Geothermal resources in Indonesia are generally located in mountainous areas with agricultural lands, forestry, bathing and spa resorts, so that they are very potential for various direct use applications. At present the application of direct uses is mainly for balneology, bathing and swimming pool. Some agricultural applications such as mushroom cultivation, palm sugar production, copra and cocoa drying are also being implemented, but the numbers are very limited compared to the potentials around the country. The future prospect for commercial applications is very bright.

RECOMMENDATIONS

In order to accelerate the development of direct use in Indonesia, it is recommended to implement some actions such as the followings:

- Government regulations on geothermal direct use development must be issued soon. Some aspects which should be included in the regulations are as follows:
- Conditions and requirements to develop direct use in geothermal working areas where geothermal power plants exist.
- Pricing criteria or policy for direct use applications.
- Engineering standard for various applications, basically by grouping into edible and non-edible products, in order to prevent geothermal fluid contamination (for safety reason).
- Establishment of sustainable business model for community based as well as commercial development program.
- Geothermal developers should calculate and decide geothermal fluid potential in their working areas which can be utilized for direct use applications without disturbing the steam production to supply the power plants.
- Identify the direct use potential in Indonesia and prepare an action plan to develop it.
- Study and research to remove barriers, to enhance technology and economics, and to standardize equipment.

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