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First Geothermal Electricity Production Project from Non-artesian Geothermal Wells in Turkey - Aydın-Buharkent Geothermal Field

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ABSTRACT

Aydin-Buharkent geothermal field is located at the Eastern part of Buyuk Menderes Graben and 4 km to the existing 95 MWe capacity Kizildere-Saraykoy geothermal power plant. Three reservoir levels, one at 500-900 m level composed of marbles and cavitations, second reservoir level at 1500-1700 m depth composed of schists and gneisses and the potential deeper reservoir level is expected at around 2200 – 2500 m depths composed of marbles and quartzite levels.

Three wells have been drilled already in Buharkent geothermal field and the depth of the wells are 600 m, 817 m, and 1975 m respectively. The geothermal field static water level is about 265-290 m depth, productivity index has been measured 200 tons/h/bar at first well drilled by MTA (2009). Production casing diameter has been designed and applied as 13 3/8" with depth of – 600 m It is designed to install the downhole submersible pump at 450 m depth, maximum temperatures of three wells at the well bottom are 147°C, 159°C and 153°C respectively.

Buharkent geothermal power plant will be the first application in Turkey for electricity generation from non artesianic geothermal wells. This is a kind of new approach for utilizing the non artesianic geothermal wells for electricity generation. Developer would be encouraged by this application. After this application many fields will be developed because of good, successful example.

1. INTRODUCTION

In Buharkent geothermal field, the flowrate has been (by air lift and estimations, calculations accordingly) tested as 100 L/sec. The first stage of the power plant capacity is planned as 15 MWe as air cooled binary cycle (Figure 1). The Buharkent geothermal brine can be classified as the diluted Kizildere geothermal brine. The CO_2 gas ratio is less than 0.2 percent in the reservoir and the H_2S is less than 1 ppm, this geothermal water is suitable for power generation because of the flowrate, temperature and very less non condensable gases content. The outlet temperature at the binary cyle unit is designed as 70°C.

Because of the temperature difference (density difference), non artesian and no pressure conditions at the reinjection well at well heads, the reinjection is going to be made by means of gravity flow without pumping. Downhole pump application is beneficial for the power generation because of the production of the geothermal brine, less corrosion, less scaling and we will save energy for reinjection pumping electricity consumption. For example at Germencik and Kizildere geothermal fields reinjection pressures are around 30-35 bar. At the Paris basin reinjection pressure is around 40 bars through the sandstone reservoir. Therefore energy free reinjection is about to compensate energy consumption for the production downhole pump. It could be as a small difference like about 3% more in house consumption.

2. TECHNICAL CONDITIONS

Geothermal field potential is calculated as 42 MWe by Stored Heat method, but at first stage of power plant will be 15 MWe binary plant. The static water levels of the geothermal area are - 260 m, -220 m and -275 m. According to the assumed productivity index of 100 ton/h/bar (average), the assumed production water flow rate could be 100 L/sec. We have two pump alternatives; line shaft pump and ESP submersible pump. Because of the existing 160°C brine water temperature both are possible but according to the 450 m. installed depth we have designed and decided on ESP pump (Figure 2).

Geothermal water contains very less CO_2 and H_2S. It is not corrosive. TDS value is 3822 mg/l at first well, chemical inhibitor for against scaling is neccessary but the dosing is expected less compared to Kızıldere geothermal brine. Therefore downhole pump could be operational without scaling, corrosion, gas, cavitation difficulties. Water-sand ratio is very little so it could be classified as a silt. Because of the pumping efficiency, friction loses, oil consumption, leakage, wells inclination, cost and other parameters are disadvantages for line shaft pump. Instead of line shaft pumps, ESP pumps would be more suitable in terms technical, economical and operating conditions.

Pumping pressure at wellhead is 8 bars g. Pressurized hot geothermal water is supplied to binary cycle power plant. Leaving temperature from the power plant is about 70 °C. The leaving geothermal water is transferred to the reinjection wells without additional pumping.

The power plants operational in Germencik, Kizildere and Salavatli geothermal fields have conditions like artesianic, high well head pressure wells, and reinjection pressure is about 30-35 bars g. Therefore the electricity consumption at the ESP pumps are a little bit more (increasing 3% in the house consumption) than the consumption of reinjection pumps. The main difference is, the cost of the down hole pumps are much more than the reinjection pumps. Because of the reasons that mentioned, down hole pump application for non-artesianic wells is economically and technically suitable and reliable.

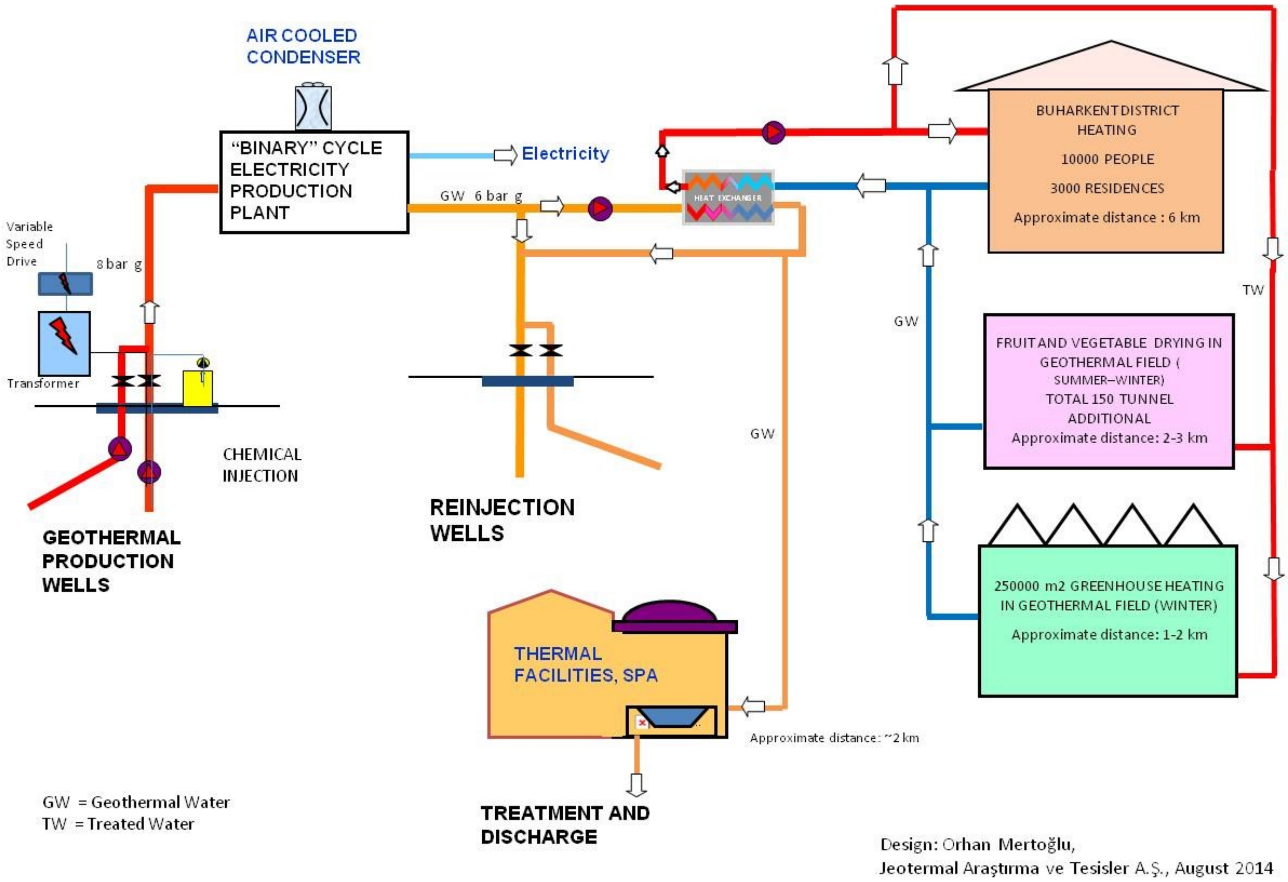

Figure 1: Buharkent Binary Geothermal Electricity Production System and Integrated Use Flow Diagramme

Total cost of each well ESP pump system is 900.000 US dollars including frequency converter (variable speed drive), special transformer for high voltage (~ 4000 V), chemical inhibitor system against scaling, measuring monitoring system, controlling sytem and column pipes as a production casing

At the geothermal field, the depth of the wells are 600 m., 820 m. and 1975 m. respectively. Second and third geothermal wells has been drilled in 2014. Totally 3 wells now exists. Three wells had been pre tested by air lift method. The picture taken from third well, diameter of discharging pipe is 7" (Photo 1). Tested, calculated and estimated dynamic level will be 300 – 350 m. depth. Each ESP pump electricty consumption will be about 400-500 kWh.

Photo 1: Testing of Third Well

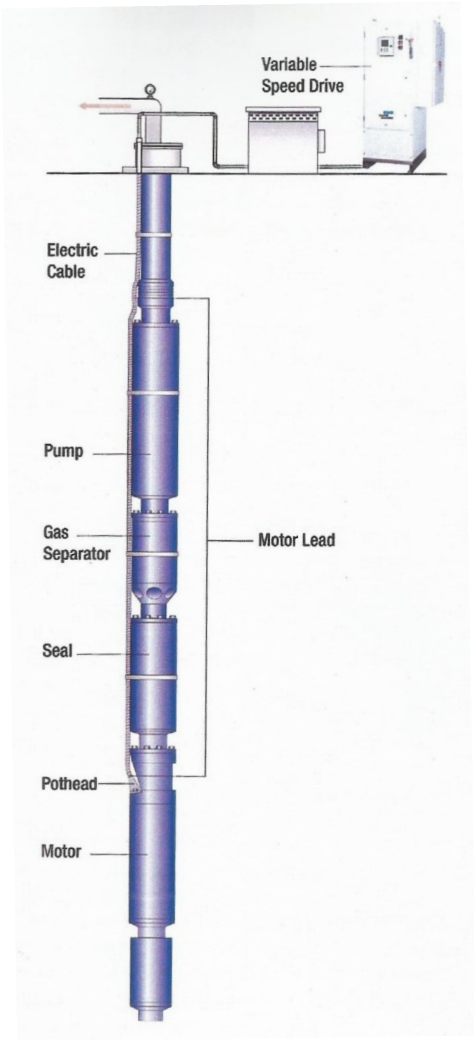

Figure 2: ESP Submersible Pump

3. CONCLUSIONS

Buharkent geothermal power plant will be the first application in Turkey for electricity generation from non artesianic geothermal wells. This is a kind of new approach for utilizing the non artesianic geothermal wells for electricity generation. Developer would be encouraged by this application. After this application many fields will be developed because of good, successful example..

Due to the non artesianic condition of the geothermal field, it has not seen as favorable during the MTA (General Directorate of Mineral Research and Exploration) bidding procedure and the purchase fee was 1/3 – 1/6 low compared to the artesianic fields. This is an important advantage in terms of the investment.

Geothermal field exploration study, basic system design and general consultancy service has been realized by Jeotermal Arastirma ve Tesisler A.Ş. (sister company of ORME Jeotermal A.Ş.) involvement in Ankara.

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