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Application and Design of Regional Geothermal Heating System Design for Citgol Municipality

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Abstract **– In this study; the project design and application of regional heating system with geothermal energy in Citgol Municipality which has population around 4000-people were performed. It was accentuated on project management and geothermal regional heating project with a modern equal way system was developed. Geothermal source is far away from town around 1800 m. The distance between geothermal source and heating center is 110 m. and conditioned hot water was circulated between heat center and town and created city blocks with bringing thermal water taken from well to heat center. Water temperature and flow rate obtained from well are 86 ºC and 37 Lt/sc, respectively.**

Keywords **– Citgol Municipality, Energy, Geothermal, Geothermal Heating System.**

I. INTRODUCTION

Geothermal regional heating applications are generally more productive traditional energy sources such as coal and petroleum etc. Studies made show that geothermal regional heating systems in our country can be work much more efficient [1].

From a different viewpoint, in order to keep our living environment clean and to leave a livable world to next generations, people tend to find new, healthy, clean and renewable energy sources. One of the most important new energy sources is geothermal energy, as well.

As is known, fossil fuels are limited, expensive and contaminating, and it brings obligation of a mediator choice making between human comfort, finance and rational use of energy sources in urban living. For this reason, geothermal energy has an important place in this situation [2]. Production cost of geothermal energy is lower than other energy sources. This cost is reduced more when integrated usages come into question [3, 4].

Geothermal energy is a boundless and renewable energy sources. Because water creating geothermal fluid is meteoric-based, reservoir rocks in underground is continuously fed, and exhaustion of this rocks are not possible as long as there is no over usage compared with feeding [5].

In project management, the reason of characteristics affecting technical and economical security and productivity of an investment negatively and seriously is that a geothermal development is lacking in a modern project management, which is required to have. This lack is institutional, technical, and economical problems [6].

In this study, the project design and application of regional heating system with geothermal energy in Çitgöl Municipality subordinated Simav district, and Kütahya city were discoursed [12].

II. PROJECT DESCRIPTION

In the performed project, heating project with geothermal energy in Citgol Municipality consists of planning (design), application, and usage stages after preliminary preparation. Therefore, performing of a geothermal region heating system (project designing) involves many processes from determination of source to production and final management [6]. These processes were performed in five different stages.

Performing project like this way provided to approach all factors affecting quality during project process as a whole. Therefore, it is a reality that the cost and quality of geothermal projects are affected by planning stage at most. In other words, planning stage of comprehensive and big budgeted geothermal projects has a big importance with regards to cost and quality. The ratio of duties originated from fixing quality problems and faults within total cost in industrial projects is 12% in USA, and it is up to 15% in our country [8]. While attaching required importance to planning and management stages increases investment costs, it reacts reducing effect of project cost in mid and long term [9]. In this project, how project stages are affected cost and quality are shown in figure 1.

Fig. 1. Effect of Project Stages to Cost and Quality [7].

As shown in Figure 1, it's clearly seen that planning stage is the most effecting power on project cost and quality during project process of geothermal regional heating project. For this reason, planning stage of comprehensive and costly geothermal project is very important for cost and quality. Improving process of a geothermal regional heating project involves many participants from public and private industry. In this environment, communication within process affects project quality, cost and time directly or indirectly [10, 11]. It's understood from here that it is indispensible to have a systematic planning and management approach for regional heating project with geothermal energy.

The stages during performing project in project work done are shown in Figure 2.

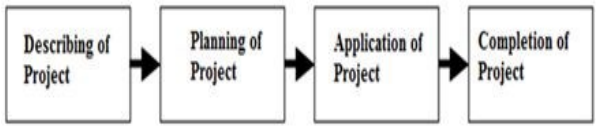

Fig. 2. Working stages in project application [7].

The management process of a project starts with describing that project. We did project planning as a project director in order to reach project time, project cost, project scope, and quality goal.

III. Project Stages of Citgol Geothermal Regional Heating

Followed steps of Citgol geothermal regional heating system, from project and production steps to usage steps, were elaborately explained below.

A. Existence of Available Geothermal Energy

In order to consider and being started a geothermal heating project; first of all, a geothermal area has to be located in aforementioned area. Citgol Municipality has geothermal area, as well, and it has subsisted as a small hot spring from 1984 to present. Citgol Hot Spring region was shown in Figure 3.


Fig. 3. Citgol Hot Spring Region

B. Thermal Water Ownership

All rights of geothermal water in Turkey belong to public like all underground sources, and it's used by special provincial administration. Special provincial administration gave right of usage of Citgol town geothermal area to Citgol Municipality, and Municipality performs investments in relevant area.

C. Properties of Geothermal Area

In this stage of project, existing information about Citgol Geothermal Area was evaluated, and studies were done to get missing information, too. As is not seen in many applications, taking cognizance of characteristics of geothermal water in natural output (temperature, flow rate, chemical content) and basing upon economic and technical pre-study was not only criteria in our Citgol regional heating system project. First of all, geologic, geophysics, geochemical, and hydrogeological studies were done, and reservoir was evaluated with obtained data from these studies. As a result of these studies [5], it was determined to have enough reservoir, and was passed to working step of Citgol town regional heating project.

D. Technical and Economic Prefeasibility

After pre-studies done:

- Defined characteristics of geothermal area.
- Calculated heat load of region that will attach to region heat system.
- Socio-economic structure of region that will be applied region heat system.
- Distance between geothermal area and region.
- Financing costs of project.
- Alternative energy costs and other inputs were considered, as well, and prefeasibility study was performed.

Obtained results after prefeasibility studies done showed that project is suitable with regards to technical and costs. After this result, it was passed to reservoir evaluation step, which is another step of regional heating system studies.

E. Evaluation of Reservoir

After studies performed with geologic, geophysics, geochemical, and hydrogeological studies, reservoir evaluation was done with using required techniques and methods in order to determine the situation and potential of geothermal area.

Regional heating systems are high cost project. Reservoir studies to evaluate about area comes important costs up in geothermal projects. However, these costs have pretty low percentage within total cost in full-scale projects especially like regional heating systems.

Therefore, it causes to very serious adverse outcome to not study prefeasibility like reservoir studies in this kind of full-scale regional heating system projects. All prefeasibility studies and calculations required for project were performed in order to not encountering this type of adverse situation. After this study, it was passed to heat load analysis that is another step of regional heating system.

F. Calculating of Heat Load Analyze

First of all, defining a system design load as big as that is defined by reservoir potential was performed. In system design, buildings found in residential area are classified by physical properties for heat load calculation, and heat load calculation was done. Buildings in residential area are generally ferroconcrete and two-story houses. Houses have average size of 115 m^2 and isolation (jacketing) is scarcely any.

After studies done, well number, production well heat center, and size of heat center distribution network that will be used in regional heating were determined. On the basis of these characteristics, it was passed to system design and production of system project that is another step of regional heating system in order to be performed more detailed technical and economic analysis and feasibility studies.

G. Design and Project of Citgol Municipality Regional Heating

Depending on system size and reservoir characteristic that are decisive after studies done, specification of geothermal fluid of geothermal regional heating system, transmission line, heat transfer center, and heat distribution projects were performed. Citgol Municipality regional heating system project was schematically shown

in Figure 4. Also, it was shown a maximum effort and was taken required precautions to keep corrosion problems in minimum by considering physicochemical properties of geothermal fluid in the project performed. Citgol Municipality and the person who performed the project did the control of prepared project.

Fig. 4. Citgol Municipality Regional Heating Project as Schematic.

H. Production

The configuration of system according to performed project was implemented by putting in a tender under free competition conditions, and production was carried out in trust of control group. During project actualization, it was made changes by being accepted people who designed and drawn. Changes occurring due to obligation in production step were provided to perform and deliver by the contractor of the project who won the tender.

Besides, an 88 mm compensator in the base line installing was added, and both a sliding and constant abutments were placed to work compensator properly. The compensator, sliding and constant abutments were shown in Figure 5.

Fig. 5. Compensator, Sliding and Constant Abutments

The most important operation in construction of regional heating lines is weld. Quality of performed welding establishes future quality, safety and working life of heating line. Welding process during regional heating process production was carried out in two steps. First, mouth of pipes well and eliminating root pass well was provided to get faultless and quality welding. During welding process, two welders started welding process in same time, and each welder welded side of pipe.

After finishing the welding of root pass, root pass was ground by using mechanical stones, slag located in weld surface was cleaned, and other welds were made ready for welding passes. As is root pass, both welders started welding process in same time, and they welded the side of pipes. Cellulosic electrode was used for root pass, and basic electrode was used for hot and cap pass in welding process. After completed welding processes, 25% of total weld area were radioed by X-ray method. Pipe coupling locations were checked with using penetrant liquid method. Coordinate of pipe coupling locations and compensator coupling locations through whole base line were engraved on project. Welded connection and weld area isolation are seen in Figure 6.

Hydrostatic test of produced line was performed during line construction. Pressure that the line will operate was obtained, it was kept in this pressure for a length of time, and test was capped in hydrostatic tests.

Fig. 6. Welded Connection and Weld Area Isolation.

The number of tested parts was defined according to total line length, valve station location, and discharge situation. Main line of this test was subjected to hydrostatic test in around every 850 m in two levels. Other inner city hydrostatic tests were performed after completing the formation of each city block. In Figure 7, Hydrostatic test done on main line was seen.

After finishing hydrostatic test, line was completed by combining test points.

I. Making Heating System in Buildings

While substructure construction of Citgol geothermal energy regional heating system was continuing, it was started making geothermal energy transfer system and heating installment of buildings that will be located within this system, in the meantime. Also, buildings that already have central heating system were accorded to geothermal energy system. In other words, system modification was done.

Fig. 7. Hydrostatic Test Done on Main Line.

Choosing locale heaters (radiator etc.) were established according to water temperature. In performed system, geothermal energy temperature average was practiced by considering 75/55 ^{o}C temperature regime.

J. Test and Acceptance

Test and acceptance process were defined during design and project of system, and it was informed to Contractor Company in tender.

A leading acceptance team was created by civil works director of Citgol Municipality Tests for tests and acceptance of produced system. In the acceptance team, a machine engineer, a civil engineer, and welding engineer performed tests and controls with suitability to project, anticipating performance aspects, and as of all components.

K. Operation and Monitoring

After producing, testing and controlling of system, the system was put into use and was started to operate by trained key staff, which is in the field from starting project to produce.

System is continuously monitored with taking under supervision by methods defined during operation.

IV. Discussion

In this study, the project design and application of regional heating system with geothermal energy in Citgol Municipality subordinated Simav district, and Kutahya city were discoursed. The realization (designing) of a geothermal district heating system involves many processes from the identification of the source to the construction and finally operation. The project process was carried out in eleven different steps. This process of the project process ensures that all the factors that affect the quality of the project process are handled as a whole.

V. Conclusions

The planning stage of the geothermal district heating project is the most costly and the quality of the project. The development process of a geothermal district heating project involves many participants from the public and private sectors. In this environment, communication within the process; it affects the quality, cost and time of the project indirectly and directly. It's understood from

here that it is indispensable to have a systematic planning and management approach for regional heating project with geothermal energy. Each of the eleven different steps identified in the project process is linked to one another. From the first step to the last step, the order has been traced.After the study, the system was switched on and used. This study is presented at İnternational Congress on Afro-Eurasion Research III by oral presentation[12].

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