ISSN (Online) 2393-8021
ISSN (Print) 2394-1588

International Advanced Research Journal in Science, Engineering and Technology
Vol. 2, Issue 11, November 2015

Reviving Abandoned Wells for Energy Extraction

Bitupan Bora[1], Bhaskarjit Borah[2], Arindam Bhattacharjee[3], Prasun Banik[4]

Student, Department of Petroleum Engineering, Dibrugarh University Institute of Engineering and Technology, Dibrugarh University, Dibrugarh, India[1, 2, 3]

Assistant Professor, Department of Petroleum Engineering, Dibrugarh University Institute of Engineering and Technology, Dibrugarh University, Dibrugarh, India[4]

Abstract: The fossil fuels as the major energy source in the current energy scenario will disappear eventually. In such a case it has become a necessity to consider other energy sources for providing our future energy needs. One of the most promising of the energy sources is geothermal energy. Through this paper we will discuss an idea of extracting geothermal energy of the earth using abandoned oil/gas wells. If we use abandoned oil wells present in areas with a favourable geothermal gradient we might be able to harness an economical amount of energy.

Keywords: Geothermal gradient, Re-drilling, No-return valve, temperature logs, saturated steam, well abandonment.

I. INTRODUCTION

Geothermal energy is one of the most talked about sources of renewable energy in today's world. With the correct technology, it has the potential to be regarded as the best source of effective, clean and not to mention renewable energy. "Geothermal" energy is basically the energy of the earth, stored in it in the form of thermal energy. This thermal energy is generated due to the geothermal gradient. So, in order to reduce the costs of building a geothermal energy generation plant, the use of abandoned wells in this regard, in order to exploit the geothermal gradient of the earth, has been a widely considered idea.

After the production of petroleum from a reservoir through a well reaches its limit, i.e. no more production is possible through the same well, it is decided that the well should be plugged or abandoned. This process is done with the minimum costs required and under any government regulations. An abandoned well is of no use to the company which owns the already exploited oilfield where the said well is present. So, if we can somehow use the fact that very deep wells are present at high temperature conditions to our need, then the otherwise useless abandoned wells can be used to our advantage.

For the generation of energy, the abandoned wells are to be 'rebooted' before any kind of energy generation can be done. After the 'rebooting' work is over, a circulating fluid (water) is pumped down to produce saturated steam, which rises up the well, and is used to run a turbine placed above the ground.

II. EXPLAINATION

Geothermal gradient is the main factor which must be considered while attempting any practical applications. The geothermal gradient is the difference obtained in the temperature of the earth as we go outwards from earth's core towards its surface. On an average, the geothermal gradient is 25°C/km. Due to this temperature difference, as given by basics of heat transfer, heat flows from the core outwards, i.e. towards cooler surfaces. This outflow of heat is maintained by continuous radiation and decay of radioactive material in the earth's core. It has been estimated that the total usable geothermal energy resource in Earth's crust to a depth of 10 kilometres is about 100 million exa-joules, which is 300,000 times the world's annual energy consumption. Unfortunately, only a tiny fraction of this energy is extractable at a price that is profitable in today's energy market.

There are various types of sources of geothermal gradient – Hydrothermal reservoirs, Geo-pressurized zones, Hot-dry rock, normal geothermal gradient and magma. In this discussion, we will limit ourselves to the normal geothermal gradient. It is produced anywhere in the globe, but very few initiatives have been taken to take advantage of it.

All of this is well documented and known to everyone, but the question remains- How do we use this energy resource? How do we use it so that it provides us with maximum energy output with minimum costs? – These are questions which need to be answered.

We shall try, through this paper, to explore an idea of how to use abandoned wells to our advantage in this regard.

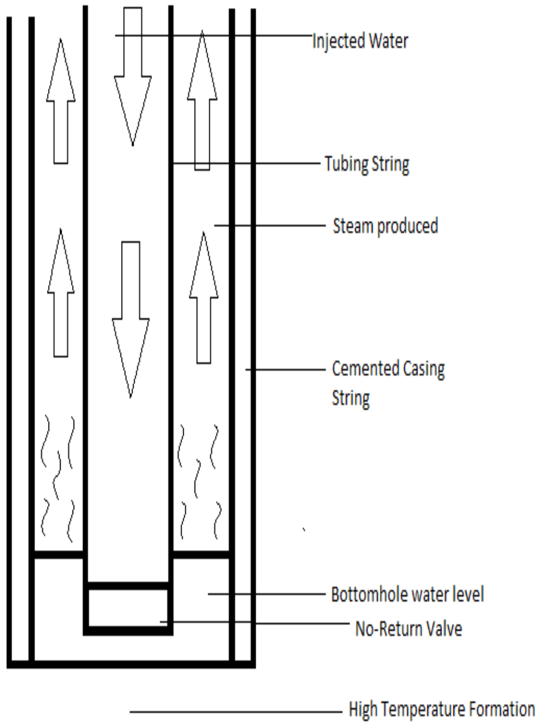
Well abandonment practice is very important in the oil industry for proper decommissioning of an exploited well. Proper well abandonment accomplishes the following:

1) Elimination of any hazards occurring due to the well,
2) Elimination of any pathways which may lead to contamination, and
3) Prevention of hydrologic changes in the aquifer system, like changes in hydraulic head and mixing between aquifers.

Effective well abandonment requires a proper knowledge of the well construction, geology of surrounding formations etc. Hence a proper 'characterization' of the well is necessarybefore any procedures can be undertaken. This is done by using any and all log data available and also collecting new log data. Then the well is prepared for abandonment by clearing the borehole of any obstructions. Then begins the process of well abandonment. The well is filled up with cement and 'abandonment mud', which seals off the perforations and the whole well itself from the surrounding formations. We will not go into the actual well abandonment procedures and limit ourselves to only the above discussed information.

Therefore, to summarize that a well must be abandoned in a manner that ensures effective hydraulic isolation between porous zones, prevents fluid leakage to and from the wells, and provides a long-term integrity of the wellbore.

Now, the idea is to create an assembly at wellbore bottom which will lead to production of steam by using geothermal gradient of the surrounding formations. For this to work, the abandoned well needs to be 'rebooted' or reconstructed to suit our purposes. We will use effective drilling techniques to drill into the cement which was used to seal off the well. Now, the new wellbore we create will obviously be smaller than the previous one. Though we still have the temperature logs taken during the previous drilling practice, there will be some change in the temperature, hence new logs need to be taken or the previous logs should be adjusted by some parameters. The new logs will be taken at frequent intervals to determine the depth which will be best suited to our purposes. The drilling is done upto just above the production zone. In the re-drilling process, a special diamond bit with coating can be used. Certain acids can be added to the drilling fluid used in order to weaken the cement, and thereby reduce valuable drilling time. The drilling fluid used will depend on the cement characteristics and diameter of the casing.



Bottomhole Arrangement for Geothermal Energy Extraction

After drilling is done, we place a tubing of optimum parameters in the well, just as is done in normal oil production operations. The placement of tubing is to provide separate conduits for flow of water and steam.

The procedure for steam extraction is described as follows:

The bottomhole assembly we have considered is as shown in the above figure. After 'rebooting' the abandoned well as explained above and as shown in above figure we shall start the steam production. The top of the tubing is connected through pipes to a source of feed water. The feed water is present at a higher pressure than normal; in order to reduce the water's boiling point. Feed water is injected at a high pressure into the well through the tubing. At the bottom of the tubing is a pressure-operated 'No-return Valve'. This valve is designed in such a way that at a certain pressure above the valve, it opens and allows the feed water to pass into the wellbore bottom. The valve does not allow the water at wellbore bottom to return to the tubing. Now the steam generation starts. Heat flows through the cemented casing from the formation to the wellbore, due to the temperature difference between the wellbore bottom and the surrounding formation. The formation temperature is as can be calculated from the geothermal gradient of the area. Wellbore temperature is calculated by using the temperature logs done during re-drilling. Now as the heat continues to flow to the water and continually increases its temperature. The water is converted to steam, as its temperature continues to rise. The steam rises through the casing-tubing annulus and is collected at the surface to be used to run turbines. If we use this method for steam production we will gain two advantages-

1. The design of tubing is in our hands. We design a tubing of

a. Radius = K/h

where

K = thermal conductivity of the material of tubing

h = surface heat-transfer coefficient

Therefore we will design a tubing of parameters such that there is minimum hear transfer from steam.

b. Another fact is that for both injection and production purpose, a single well is enough.

This is the whole idea in a nutshell.

III. PROBLEMS ENCOUNTERED

Though the process sounds simple enough in theory, there will obviously be many challenges that have to be identified and correction measures have to be applied accordingly. We shall now look at some of the problems that we think we shall encounter.

1. Problems of heat transfer and conservation: While rising through the tubing, it is inevitable that there will be some heat losses. Such losses have to be minimized if we are to extract an economical amount of heat. We can do so by proper design of the tubing (as discussed in the explanation part) so that there is minimum amount of heat losses from the steam.

2. Total effective power generated: Ours is a theoretical model, so it is not possible for us to calculate

how much power we can generate, as many parameters are required which cannot be found without assessing a field site.

3. The process needs to be commercially viable i.e. profit oriented. In today's world, everything is profit oriented, any new technologies, ideas are not invested upon unless the investor sees a profit in them. Basically we should get an output of greater margin than the input.

4. Location of wells is a crucial factor. For example, in abandoned wells in remote areas it is not profitable to start the process as the initial costs will be too great.

5. Advanced technology is needed to monitor phase changes. We need to monitor the phase changes at wellbore bottom, to determine when we need to inject fresh amount of feed water for continued steam production.

6. We must conduct the operations in an environmentally friendly way; otherwise we might as well disregard the whole idea. The basic need of this concept is that it should not pose any threat to the environment.

7. Geothermal energy – renewable or non-renewable? On one hand, yes, of course geothermal energy is classified under renewable energy sources, when its exploitation comes into question, it has been seen that with progressing time, extraction declines. This happens because we are using up the heat faster than it is being generated. So, geothermal energy can be seen as a non-renewable energy source only upto a certain limit. So, its use must be managed correctly for profitable exploitation.

IV. CONCLUSION

After the above discussion, we can conclude that if we can use put idea into practice, it could become useful in the near future. Though, not as profitable as oil and gas extraction, it might be the answer to all our future energy needs. If appropriate technology is developed, then the geothermal energy can surely lessen the burden of other energy sources. But cost and environmental concerns need tobe addressed for utilising this energy source which is still in its nascent stage.

ACKNOWLEDGEMENT

We sincerely thank our families for their continued support during the writing of this paper. We, the students, Arindam, Bhaskarjit and Bitupan, also would like to extend our thanks to Prasun Banik sir, our respected faculty member and also the co-author of this paper for his continued support in this endeavour. Without his continued help, the completion of this paper would not have been possible.

REFERENCES

[1] Herman Bieber, Howard Geller, Alan Chachich, David Greene, Fred Denny, Joseph Priest, Bernard Finn, Rosalie Ruegg, John Firor, Harold Wallace, Ellen J. Zeman (Editorial Board),Macmillan Encyclopedia of Energy, Broadway New York: Macmillan Reference USA, 2001.

[2] H.R. Warner Jr., SPE Petroleum Engineering Handbook, Richardson, USA: Society of Petroleum Engineers, 2007, Volume VI: Emerging Peripherals and Technologies.

[3] (2003) theEnvironmental Studies Page on Encyclopedia.com. [Online].Available:http://www.encyclopedia.com/topic/Geothermal_Gradient.aspx.