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A Review on Different Generations of Geo-Thermal Energy and Power Plants

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Abstract: The geothermal energy is the heat energy generated from the radioactive decay of minerals and stored in the earth. These geothermal resources are more than adequate to supply all human energy needs for many years. Only few numbers of sources are used so far.this geothermal heat source is converted into the geothermal electricity directly. These geothermal sources ate in different forms as hot water, dry hot steam, and hot rock. Depending upon the types of sources there are different types of plants were set and installed. They are single, double flash power plants, binary power plants and dry steam plants. The enhanced geothermal system is seen without the use of the natural convective hydrothermal resources. which represent a path for turning the enormous resources provided by geothermal energy into electricity for human consumption efficiently and on a large scale. This method consists of excavation of deep rocks, enhanced heat extraction from rock, enclosed heat transmission from heated water reservoir to the power plant. The enhanced geo thermal systems generate the geothermal electricity without the need of the natural convective resources. Induced seismicity is expected in the EGS Which involves pumping fluids to enhance or create permeability through the use of hydraulic fracturing techniques.

Keywords: *Geothermal energy, critical CO2, enhanced geothermal systems, HDR reservoir, induced seismicity.*

I. Introduction

The energy collected from the renewable sources is known as the renewable energy. Such as wind, tides, geothermal heat, sunlight, waves, and rain [1]. Geothermal energy is the power generated by the geothermal source and which is stored in earth. The geothermal energy of the earth originates from the radioactive decay of minerals and the original formation of planetwhich is uncertain or possibly equal in proportions [2, 3]. The geo thermal energy is very kind to environment.it always offers constant efficient and the minimum efficient clean energy supply with minimum impact on its surroundings. Even the huge amount of thermal energy is stored but very little of it is usable for mankind [4,5]. As this is the renewable source it is considered as a solution for the energy shortage and environment problems in the world [6]. In the year 2017, the united states led the world in the production of the geothermal energy with 12.9 GW of installed capacity [7]. The largest group of geothermal plants in the world is located at the Geysers in California [8]. This geothermal energy is considered as very sustainable renewable energy because the heat extraction is small comparedto earth's heat content [9].

II. Favourable regions for Geo-thermal generation

There are certain regions that are very attractive for the generation of geothermal electricity which are thermally active areas in the crust of the earth and near the boundaries of the tectonic olates. Colombia is located on the pacific ring of fire which has the substantial advantage of developing the geothermal energy power plants, because in this area subsoil which is near the surface of the earth has the very high gradient of temperature due to the activity of the volcanoes. So that these conditions are said to be favourable for the use of the geothermal energy for all purposes [10,11].

According to Geo-thermal Power plants, these plants come under the different types of systems which are similar to turbine thermal power stations in that heat from fuel source used as heat water where as in the geothermal power plants from the earth core.

Table 1

Dry Steam Power Station	These dry steam power stations are the simplest and the oldest design. This requires a resource which can produce a dry steam [12] in these sites water is present in the reservoir but no water is produced on the surface [12]. This type of dry steam power directly uses geothermal steam of 150 ^{0}C [13] the power to the field and electricity is produced by the rotating turbines. Thenthe steam is emitted to a condenser. Then the steam turns in to a liquid then again to water [14] later the water-cooled and allowed to flow down into a pipe that which can conduct the condensate back into deep wells the place where it can be reheated and can be produced again.
Single Flash Steam Power Plant	Flash system is used in the elimination of a large portion of energy in liquid from the separator due to low steam quality that emerge from the 2-phase fluid which is flowing from the expansion valve. This type of flash steam uses geothermal steam above 190 ^{0}C [13] high temperatures produce more liquid and steam for natural pressure conditions. The separation process of steam from liquid occurs either by vertical separator under cyclonic motion or by horizontal separator under gravitational effect this is done in ORC power plants [15,16].
Double Flash Steam Power Plant	This system is preferred over the single flash system power plant depending on the conditions of the resource. It produces more steam due to the use of two separators. Two stage steam turbinesare used due to the use of two separators, these two turbines which one can take care of high pressure and other about low pressure. All steams get directed to a steam turbine by separate pipelines.[17]
Binary Power Plant	These are most recent development and can accept fluid temperature as low as 57^0 C [18]. moderately hot geothermal water is passed by a secondary fluid with much lowering point than water, this causes the secondary fluid to vaporize which can drives the turbine [17]. It is possible to run an ORC geothermal power plant by using fluid having a temperature of 200^0 C. through the use of different secondary working fluids[19].Both the organic cycles are used [20].

III. Enhanced Geo-Thermal System

This term enhanced geothermal system has iota roots in the early 1970s when the team from Los Alamos National Laboratories began the hot dry rock project at Fentonn Hill[21-24].HDR was known as hot fractured rock because either it is need to be fractured for virtually permeable formations are presence of natural fractures in it[25,26] or also called as hot wet rock due to reason when it is established the formations were not completely dry and also contained some fluids[27]. This include deep heat mining [28,29] and deep earth geothermal. These all the above mentioned implies the use of Petro thermalsystems [30, 31].

IV. Super-Analytical CO_2 as Operative Fluid in Enhanced Geo-Thermal System

This concept uses the super critical CO2 as the heat transfer fluid and heat contained in it transferred to the working fluid on the surface which is necessary for running the turbine. 3 well arrangements are there which includes the 2 production well and the injection well with a 60^0 C of an initial temperature gradient but further research done by Pruess [32, 33]

V. Mechanism (Geo-Thermal System)

This working process takes place by two stages

1. Creation of an engineered HDR reservoir
2. by using super critical CO2 as a fracturing fluid
3. Circulation of supercritical CO2 as a heat extraction fluid.

by the injection of supercritical CO2 into hot impermeable rock the fracturing is done [34]. At the first joints intersecting the well bore will be opened and the pumping is continued then the joints opened will be more and interconnected by forming a multiple connected region of pressure dilated joints in the mass of the rock which surrounds the pack off wellbore interval, then it creates the fractured HDR reservoir. At first step of starting the pore water in the system will be removed from the central zone of the stimulated volume. first the fluid is single water phase later it is changed into the to the two-phase flow of CO2 water mixture [32]. Again, with the time change the passage of the fluid will be changed to the single-phase fluid.

Working on thus concept indicates there are 3 zones during the development of the reservoir [35]. They are as follows

a) Core zone
b) Surrounding zone
c) Outer zone

The core zone consists of the single phase dry super critical CO2, surrounding zone consists of two-phase CO2 water mixture and the outer zone consists of single-phase water with some dissolved CO2

VI. Induced Seismicity

Low carbon is generally available as energy source [36] and the geothermal systems are part of the vey important need for the electricity and heating sector and featurein the energy strategies of the USA [37] and Switzerland [38]. The geothermal systems extract hot water from natural aquifers at a depth of 2-5 kilometres, if aquifer doesn't have enough depth the geothermal systems can be moved to other place [39]. The moving of EGS or deployment of EGS, while promising leads to concerns over induced seismicity [40-42]. Many geo energy applications, such as conventional oil and gas production, enhanced oil recovery, hydraulic fracturing, waste water injection, or geological CO2 storage, carry the risk of induced seismicity [43,44] USA [44] Canada [45] and the Netherlands [46] are already experiencing unmatched levels of non-geothermal induced seismicity. At the starting only a handful of EGS exist worldwide [47]. Many research programs on EGS seismicity have been recently followed [48, 49]. And then several projects have already led to seismic events being felt during stimulation [50]. Many public concernshave raised when the seismic events are felt, which are potentially leaded to projects being rejected or new projects being neglected [40, 51, 52]. Despite of the substantial uncertainties ongoing and planned EGS require the use of good practise regarding the induced seismicity assessment and management [53-57].

VII. Conclusion

In this paper we clarifies about the Geo-thermal energy which is renewable energy resource and there set up of the geothermal power plants based on the flash systems for production of the geothermal electricity through those plants. And there are several phases of fluids in the enhanced geothermal system and seen the many aspects about the fractured HDR reservoir method in the enhanced geothermal systems. Induced seismicity is most important techniques as it is important for the generation of the electricity frequently from the geothermal resources.

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