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SINGLE BOREHOLE GEOTHERMAL ENERGY EXTRACTION SYSTEM FOR ELECTRICAL POWER GENERATION

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ABSTRACT

The Extraction System utilises heat transfered from the geothermal fluids into a closed combined Heat Pipe/Organic Rankine Cycle. The system overcomes problems of reinjection, two phase fluid movement and enviromental pollution by bringing a clean secondary fluid to the surface. Reservoir fracturing and primary fluid movement will also be covered.

HOW THE SYSTEM WORKS

One of the innovations is the use of thermal/fluid heat transfer. Special fluids operate in a closed pipe circuit to transfer heat from the bottom of the well to the top via vaporised fluids moving at near sonic velocities. The minimum depth of hole needed to provide power enough to drive turbogenerators depends on the geothermal gradient: in some geographical areas this is from as shallow as 900m.

Downhole, these wells are completed by casing and perforating through up to 1,000m of fractured hot rocks, in either a dry or a hydrothermal field. Reservoir heat is transferred to the wellbore by convection-type circulation over the 1,000m of exposed formation. Additional horizontal drilling and hydraulic fracturing to aid this process can be utilised. In truly dry holes, addition of a second working fluid to the formation makes internal circulation possible.

Inside the casing, a closed 203mm tube is inserted, containing a sintered copper or stainless capillary type liner (see Fig. 1). This liner extends over the lower 1,000m of its interior surface. Inside the tubing, a concentric, well-insulated 63mm diameter working fluid return string sprays condensed liquid through perforations onto the sintered metal heat exchanger. The capillary action of the sintered wick transfers a thin film of working fluid around the circumference. The vaporised fluid then flows up the tubing return annulus, to the surface turbine unit. Cooling water provides a strong temperature differential for efficient energy extraction.

The working fluid flows down the 63mm return tube by gravity, against reduced backpressure of the hot vaporised fluid. A backup feed pump is available to start the system.

Since there is no interchange between working fluids and external heat source fluids located in the casing-tubing annulus, the system life is as high as 20-25 years.

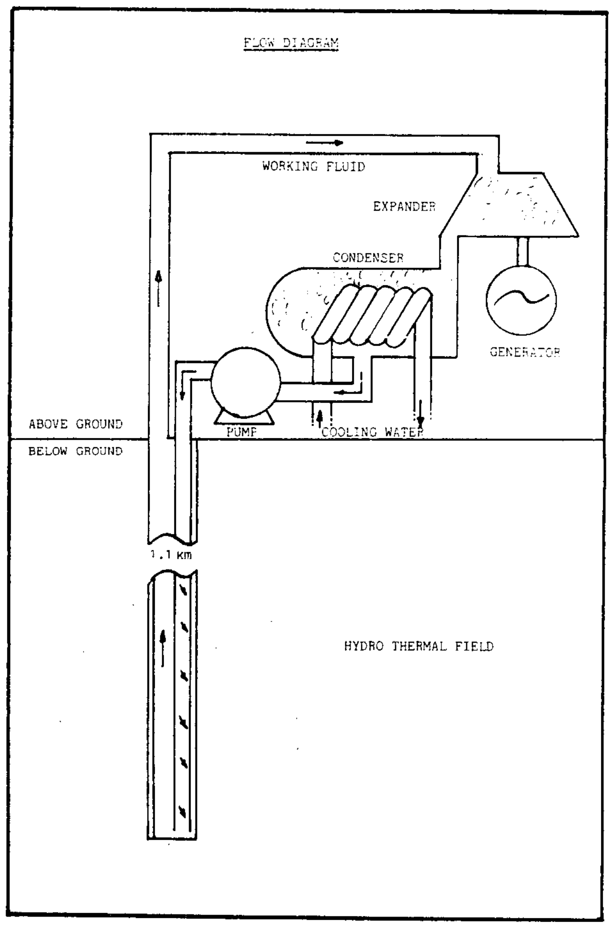

FIGURE 1

THE ADVANTAGES OF A SINGLE BOREHOLE SYSTEM

Most geothermal power stations today are based on two-hole extraction systems, the reason being that the geothermal fluids are not pure: there are many contaminants that cause environmental pollution. These two-hole systems normally extract geothermal fluids from one hole and re-inject the cooled fluids down a second well. This removal of fluid itself causes a whole host of problems: corrosion, silting of well, two-phase fluid movement, subsidence and many other lesser problems.

With the single borehole system, pressure in the geothermal fluids is maintained as the fluid is not removed from the field. This has many advantages, as no drop in pressure means that the geothermal fluids do not turn into aggressive corrosive contaminants. Also, because the pressure is maintained, suspended solids stay in suspension and do not drop out to silt up the well.

However, by far the most important advantage of the single borehole system is that no environmental pollution is caused. This is a very important claim, as all the traditional methods of power generation cause environmental pollution. Some examples are:

- Fossil fuels cause "acid rain"

- Nuclear power causes radioactive waste

CREATION OF A RESERVOIR

Single borehole systems to date are very rare. This is due to the inability to create a dynamic method of heat extraction. The creation of a suitable geothermal reservoir which can transfer geothermal heat from a large catchment area, not by conduction but by the circulation of either a naturally occuring or an artificially created geothermal fluid, is also a necessity for a single borehole system.

There are many areas around the world where there are natural reservoirs: obvious examples are geysers and hot springs (Ref. 1). Hydrothermal and steam fields are also suitable sites for single borehole systems. Hot dry rock applications, though, need the creation of an artificial reservoir (Ref. 2). This is normally achieved by a combination of horizontal drilling, downhole fracturing and the use of special circulating fluids.

ECONOMIC ADVANTAGES OF THE ONE-HOLE SYSTEM

One of the major advantages of a single borehole system is that wells drilled for other purposes can be utilised for geothermal. Some examples are: unsuccessful or dried-up oil and gas wells and test bores. Normally, the high cost of drilling these is just written off. The conversion of these wells is quite simple if utilisation has been decided before the borehole has been plugged.

As the single borehole extraction system makes use of low boiling point organic fluids, then these wells, which are not normally drilled in geothermally rich areas, still have high enough bottomhole temperatures to be an economic proposition.

UTILISING READY-DRILLED HOLES FOR GEOTHERMAL

In areas like the North Sea (U.K.), oil drilling is carried out from platforms. Normally up to 20 wells are drilled from one platform, though not all of these are productive. The use of a small proportion of wells for the extraction of geothermal heat could provide adequate electrical supply for the platform.

The North Sea has got the added advantage of a large volume of relatively cold (5 deg. C) sea water that provides a good heat sink.

DRILLING HOLES SPECIALLY IN GEOTHERMALLY RICH AREAS

It is economically viable to drill purpose-made bores in areas where the earth's crust is thin, such as the offshore regions of China, the Middle East, Southeast Asia, down the Atlantic Ocean and along the west coast of North and South America.

Studies show (Ref. 3) the system can extract 2.5mw of electrical power from rocks hotter than 150 degrees Centigrade. In isolated areas the geothermally powered generator can supply economical power for irrigation pumps, lighting, heating and other applications.

For further technical information and licence details, contact the writer.

REFERENCES

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