SCOPE OF DEVELOPMENT OF TECHNOLOGY FOR DRILLING AND PRODUCTION OF DEEP-SEATED GEOTHERMAL RESOURCES

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SUMMARY - A new project named "Development of Techniques for Drilling and Production of Deep-seated Geothermal Energy" was started in fiscal year 1992 by NEDO (New Energy and Industrial Technology Development Organization). Due to recent geothermal development in Japan more extremely promising geothermal resources have been discovered in deeper parts of reservoirs currently being exploited Deep-seated geothermal resources are characterized by high enthalpy fluids and severe physical, chemical and geological conditions. Exploitation of them is very atractive, but at the same time very risky and dangerous. The advanced technology is needed now. This paper presents NEDO's new R&D project aiming at development of geothermal technology.

1. INTRODUCTION

The R&D consists two main items : drilling technology and production technology. Drilling technology encompasses highly advanced drilling bits, down hole motors, drilling mud, and cement slurry. Production technology is composed of PTSD logging technique, PTC monitoring technique, tracer monitoring technique and scale monitoring and prevention technique. The R&D is focused chiefly on the manufacturing of drilling equipments and drilling materials and measurement tools of geothermal reservoirs. These tools are required to work efficiently and reliably in the severe conditions of deep-seated reservoirs.
Deep-seated geothermal reservoirs are characterized by their depth (3,000m-4,000m below surface), high temperature (around 300-400℃), and hard rock named basement rock and intrusive rock.

The R&D has many difficult problems to overcome. The project started in FY 1992 and will finish in FY 2002 requiring about ten years. This project is based on funds from the New Sunshine Project Promoting Headquarters, the Ministry of International Trade and Industry (MITI). The R&D is being conducted by private companies who are contracted by NEDO.

2. DEVELOPMENT OF DRILLING TECHNOLOGY

2.1 Drilling bit

Conventional bits used for drilling deep-seated geothermal reservoirs have easily abraded because of hard rock, and the elastomers of bits have been damaged in high temperature circumstances. The bit being developed is expected to be able to drill hard formations for more than 30 hours continuously, and to be endurable inside boreholes of 350℃ for more than 6 hours at non-drilling operation This bit is based upon the three-cone type bit, is 8 1/2 inches in diameter. Emphasis on bit development includes the seal system bearing structure, cutting structure, gauge wear protection mechanism, and pressure compensated lubrication system The seal system will apply joint seal of elastomer and metal.

2.2 Down Hole Motor (DHM)

Most geothermal wells are usually drilled in limited small areas, for both economical and environmental reasons. Because of this, these wells are completed by directional drilling, and therefore a DHM is necessary. The function of a DHM is to motivate the driving torque by inertia of the flowing drilling mud. The R&D objective is manufacturing an advanced DHM which is capable of operating in the severe conditions of deep-seated geothermal reservoirs, especially in high temperatures of 350℃ at non-drilling operation. A high temperature DHM has hericoidal type motor section with low speed (50-150rpm) and high torque (80HP).

2.3 Drilling mud

The drilling mud plays a important role in deep drilling. The function of the drilling mud is to cool and lubricate the bit, to wash away rock cuttings, and to prevent the bore walls from caving in. In deep-seated reservoirs the drilling depth generally will range from about 2500 m to 4,000m. The most difficult problem which drilling engineers have faced is gelling of the mud due to the high botom hole temperature. The drilling mud being developed is expected to be suitable enough for the logging and drilling operations, after it has stayed for 3 days inside a borehole at a temperature of around 350 ℃. Properties of the new mud will be low plastic viscosity, ranging 10-20 cp, large amount of API filtrate, less than 75 ml, and an adequate mud weight, ranging 1.03-1.20 g/cm^3. Experiment has been conducted aiding materials (viscosifer, deflocculant, lubricant) selection.

2.4 Cement Slurry

It is of the most importance that all casings, except the perforated liners, be firmly cemented into position

Cement slurry must ascend from the shoe of the casing through the narrow surrounding annular space to the surface. The basic specifications of the cement are low density, around 1.35 g/cm^3, high compressive strength, more than 70 kg/cm^2 (in consolidated state), thickening time, more than 3 hours, and a low amount of filtrate, less than 500 ml.

3. DEVELOPMENT OF PRODUCTION TECHNOLOGY

3.1 PTSD logging technique

PTSD logging technique deals with two concerns: manufacturing improved PTSD logging tools, and development of wellbore flow simulation analysis using logging data. PTSD logging tools measure the pressure(P), temperature(T), flow rate(S) and fluid density(D) inside boreholes under both static and dynamic conditions. Productivity of geothermal wells are mainly defined by the property of the fluids (temperature, pressure) and the formation permeability. The tool being developed will be able to work stably and correctly in high temperature conditions up to 400°C, in a deep-seated reservoir. The logging tool constitues basically down hole memory type of aqusition system using corrosive resistance slickline.

3.2 PTC monitoring technique

Production and reinjection of geothermal fluids causes the reservoir to change in its physical and chemical states (P :pressure, T :temperature, C :chemical components, etc.). Predictions of reservoir performance should be based on the monitoring data stated above. PTC monitoring technique is comprised of the PT monitoring tool, the C monitoring tool, and the reservoir performance analysis technique. Pressure is monitored using capillary tubing filled with inert gases (N_2, Ar, etc.). The capillary tubing is inserted at the depth of a feedpoint in the borehole, and the gases transmit reservoir pressure to the well head. Temperature is measured by fibre optics temperature sensor inserted inside the capillary tubing. C mointoring depends on a borehole fluid sampler.

3.3 Tracer monitoring technique

Tracer monitoring technique is a very useful method to evaluate the influence of the reinjected water on steam production. The R&D is aiming at development of many kinds of high temperature tracers (liquid-phase, gas-phase, two-phase tracers).

3.4 Scale monitoring and prevention technique

The geothermal fluids contain many kinds of soluble materials. Some components of these materials easily precipitate from fluids as scales, and sometimes production and reinjection wells and transportaiton, pipelines of power plant become choked with scale, deposits. This is a major problem for geothermal development. The most common scales are silica scale and calcium scale. The R&D efforts intend to develop three engineering systems : a scale detection system, an analytical system of scale formation, and a scale removal and prevention system

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5. REFERENCES

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