4.4.5 Extending the Temperature Range of Electric Submersible Pumps to 338 °C - Hotline IV - High-temperature ESP

Presentation Number: 019
Investigator: Dhruva, Brindesh (Schlumberger Technology Corp.)
Objectives: To increase the temperature rating of high-temperature ESPs.
Average Overall Score: 2.7/4.0

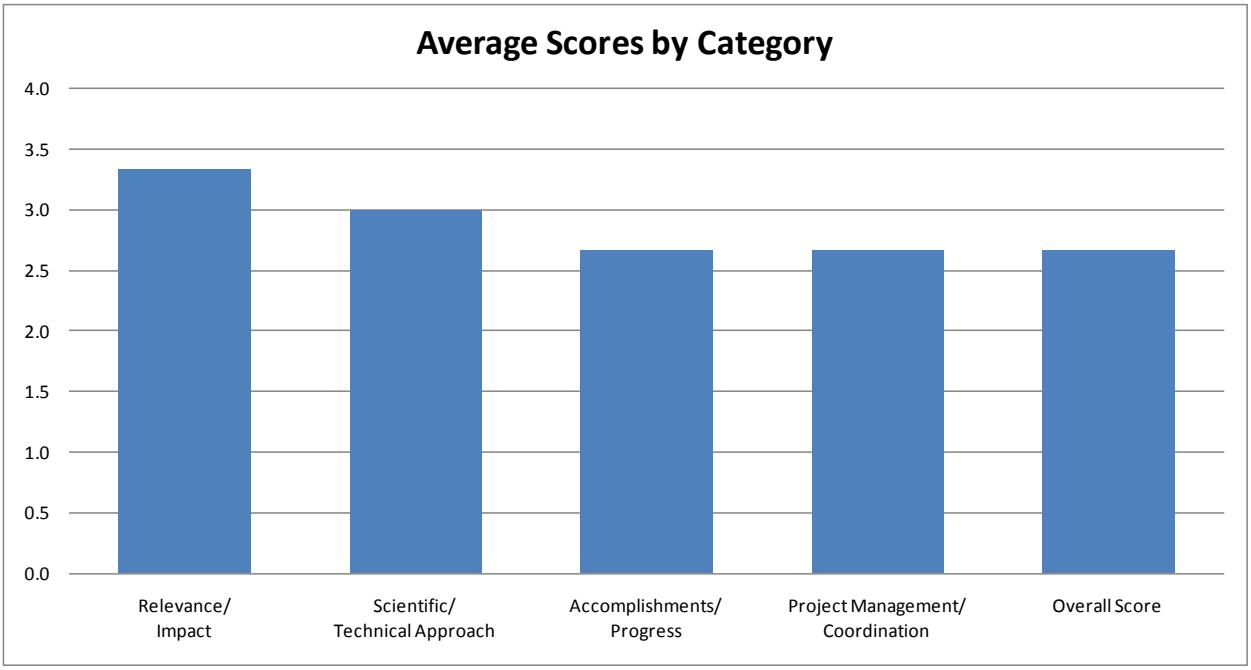

Figure 26: Extending the Temperature Range of Electric Submersible Pumps to 338 °C - Hotline IV - High-temperature ESP

4.4.5.1 Relevance/Impact of the Research

Ratings of Three-member Peer Review Panel: Good (3), Good (3), Outstanding (4)

Supporting comments:

- This is a broad-reach project to improve the thermal resistance of down-hole pumps. The approach is to examine simultaneously all parts of the system and to make improvements in all components commensurate with reaching the desired goal. This means examining and improving a wide range of materials, including e.g. elastomers for seals, electrical insulators, bearings etc. As such, the results of this research , while being specifically applicable to pumps, should have more general applicability to many geothermal problems.

- Pumps that can operate at higher temperatures are key to developing economic EGS reservoirs.

- As noted in reviews of other projects, down-hole pumps capable of moving large quantities of hot (300 ^{o}C) geothermal fluid from substantial depths to the wellhead will be essential to the success of Enhanced Geothermal Systems for electric power production. Such pumps do not

now exist. A major barrier to their development is the temperature requirement.

The research conducted in this project is part of a larger industrial program to improve down-hole pump technology. Because it fits into the overall pump technology effort, it is likely to lead to commercial pumps with the necessary geothermal characteristics. However, the present project is concerned only with pumps that will operate reliably at the 300 ^{o}C temperature. Other operating parameters, such as motor power and pump diameter are not considered here.

4.4.5.2 Scientific/Technical Approach

Ratings of Three-member Peer Review Panel: Good (3), Good (3), Good (3)

Supporting comments:

- The scientific approach is good. It starts with an examination of failed components, (what failed, how it failed and what was the underlying cause) and then proceeded to address the needed corrections. Usually these related to the identification and selection of better materials, but there were also more global improvements, e.g. simplifying installation on the rig floor and integration of a new high-temperature monitoring system.

- The approach to this problem is to evaluate all the non-metallic parts of the pump motor assembly and to try to build the electrical portion of the pump to withstand higher operating temperatures. Since the electrical part of the pump has to survive both the high temperature of the brine and the increased temperature caused by rejection of heat from the electric components of the pump, improving the efficiency of the mechanical pump and the electric components would reduce heat rejection and therefore enable the pump to operate in higher temperature EGS reservoirs. I thought it might be good to look at the mechanical efficiencies of the pump.

- The overall technical approach is to examine all components and materials in existing down-hole pumps with the higher temperature ratings, and to study prior failure of pumps in commercial service to identify the weak points. The development work then will focus on the weak links. This approach seems to have been successful to date in:

  1) achieving incremental improvements in pump performance at temperatures greater than those for which existing commercial pumps are qualified, and
  2) identifying critical areas in which improvements are required for 300 degree service.

4.4.5.3 Accomplishments, Expected Outcomes and Progress

Ratings of Three-member Peer Review Panel: Fair (2), Good (3), Good (3)

Supporting comments:

- Progress has suffered a number of setbacks, some of which were probably beyond the control of the project managers, but the project is definitely behind schedule.

- The comparative data used in the presentation might not be isolated enough to be useful. For example a 1500 HP motor and a 320 HP motor were displayed operating at temperatures of

218/288 °C and 150/205 °C, respectively. The first temperature was the brine temperature and the second temperature was the motor temperature. Since the motor temperatures were not measured it's not clear how the second temperature was obtained. This data needs to be validated. One pump has been tested to 260 °C. They still have a ways to go.

- Since the company conducting the research is already in the down-hole pump development business, the facilities, equipment and corporate experience available to this project's researchers are excellent. Coordination with another research team in the same company conducting related research is an advantage. Analysis has identified the pump motor temperature as being greater than that of the geothermal fluid to be pumped, and a probable cause of pump failure. A method for predicting pump motor temperatures suggests thermal limits for internal motor components. Thermal testing of a motor at 260 °C was accomplished.

4.4.5.4 Project Management/Coordination

Ratings of Three-member Peer Review Panel: Fair (2), Good (3), Good (3)

Supporting comments:

- Project management appears well organized, apart from the fact the project is, in fact, behind schedule (see above)

- Coordination with researchers and industry (Conoco Phillips).

- This company has a well defined schedule for carrying out R&D projects from concept to field testing of prototypes, and this project fits nicely into the plan. Due in part to unexpected circumstances, this project is behind schedule and will run short of DOE financing before reaching the planned objectives, However, the future demand for a suitable pump appears great enough that the company evidently plans to carry out additional research at its own expense to continue development of a pump suitable for EGS service.

- Any decision points were not identified in this paper.

4.4.5.5 Overall

Ratings of Three-member Peer Review Panel: Good (3), Fair (2), Good (3)

Supporting comments:

- A useful project, with the object of increasing pump performance. The approach looks systematic; it considers all components in turn , with the object of increasing the performance of all the components simultaneously so as to improve the performance of the entire system. The improvements, and experience gained, should be of broad value in advancing the thermal resistance of a wide range of down-hole geothermal equipment.

- This team has a ways to go to get to the 300 °C goal, the current test is only 260 °C.

- The company had made significant progress in improving the temperature resistance of down-hole pumps. The long range plan appears to favor meeting the temperature criteria first, then

scaling up the size and pumping capacity. This is a good approach because thermal issues are likely to be more difficult to overcome, Furthermore, the commitment of this company to develop pumps suitable for EGS service is an asset.

4.4.5.6 PI Response

No response.