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MRS Bulletin

Geothermal energy: Chance and challenge

Increasing demand for base-load energy from renewable sources and ambitious climate protection goals have created major interest in the potential of deep geothermal energy, which is transitioning from a niche technology to a key element in the future energy mix. Today, about 11 GW electricity and 50 GW heat from geothermal reservoirs are obtained worldwide, and there is much potential for improvement. Exploration, development, and productivity enhancement are needed to make geothermal energy utilization feasible in a safe and responsible manner. For the control and mitigation of environmentally adverse effects, detailed knowledge of stress, rock permeability, and chemical composition of deep fluids is crucial. Mitigation of induced seismicity is important, including far-field stress transfer, leakage of deep reservoir fluids to groundwater, and emission of fluids and gases to the environment. Most technologies require at least two wells: A production well to recover water with an appropriate temperature, and an injection well to return the water into the ground. Borehole integrity without leakage and reservoir treatment without generating induced seismicity are key for environmentally safe installation. The critical parameter is permeability of the rocks in the geothermal reservoir, which affects heat and mass transfer. Most hydrothermal and petrothermal geothermal systems can be developed by so-called "Engineered Geothermal Systems (EGS)" technologies to guarantee economic feasibility and system stability.

These specific technologies represent the sum of the engineering measures required to optimize the exploitation of low permeability reservoirs; technologies adapted to highly saline waters are also in demand. Basic research on corrosion processes and materials properties is needed to develop preventative methods of corrosion protection for plant components such as pumps, pipes, and heat exchangers. Novel technology development to reduce corrosion and scaling focuses on innovative composite casing materials.

Characterizing fluids and understanding corrosion mechanisms are crucial for responsible management strategies and technologies for the specific constraints of geothermal plants. The interface between research and industry offers huge potential for synergies and a fast transfer from laboratory scale to industrial application. This process has to be accompanied by open risk communication to build and maintain trust and confidence, and to facilitate a high degree of consensus and support by the public.

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