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Carbon Dioxide as a Geothermal Heat Mining Fluid in Sedimentary Basins – Technical and Economic Analysis of Its Use in Hydrocarbon Fields

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ABSTRACT

Geothermal power systems have been successfully deployed around the world for well over a century, but the vast majority of such installations have harnessed hot water from hard rock formations. Geothermal power production from sedimentary basins has more recently been demonstrated. The use of such typically-shallower, naturally-permeable geologic units can drastically reduce drilling risk and cost but can present other challenges. For instance, in many cases, fluids from sedimentary basins are produced at much lower temperatures than traditional geothermal resources, necessitating the use of often-expensive binary power systems and requiring very high fluid flow rates to generate sufficient power to justify the investment in infrastructure. While productive hydrocarbon fields are a natural location in which to develop sedimentary basin geothermal systems, having much of the costly infrastructure (e.g., wells) and power consumers in place, few geothermal systems have been installed in such locations to date. Here, we present an alternative method for installing geothermal power facilities in sedimentary basin hydrocarbon fields – using carbon dioxide (CO2) as the heat transfer fluid, either in the power system, in the subsurface, or in both zones – which we term Carbon Dioxide Plume Geothermal (CPG). In this work, we examine geothermal system costs, thermal energy conversion efficiency, and total power production potential of CPG facilities in hydrocarbon fields. Parameters that are varied in the analysis include turbine inlet temperature, fluid production rate and composition, power system installation and operating costs, sales price of electricity, and value of renewable energy and/or carbon credits. We find that CO2 power systems offer advantages in terms of overall cost, system size, and efficiency compared to legacy technologies. While heat extraction from the water/brine + hydrocarbon production streams presents some challenges, the value of power production in offsetting hydrocarbon field operating costs and extending field lifespan can be significant.