Sustainability of heat extraction from decommissioned petroleum wells

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Abstract

Abandoned wells impose enduring liabilities to petroleum companies and/or governments. However, the depth and abundance of abandoned petroleum wells make them an economically attractive source of geothermal energy. Geothermal energy can be harvested from oil/gas wells and used to generate electricity, used directly for heating, incorporated into water desalination processes, or used by heat pumps for heating/cooling applications. The present paper examines the possibility of extracting geothermal energy from abandoned oil/gas wells using a downhole double-pipe heat exchanger. Using in-situ data, the effects of key parameters such as geothermal gradient, ground temperature values, and the flow inside of the tubes are evaluated. In order to provide a constant power production the inlet temperature it is proposed to adjust the temperature of the inlet fluid, so that that the difference between outlet and inlet temperatures is kept at a desirable value. Effect of adding insulation jacket on the inner pipe of the geothermal heat ground exchanger is studied. The feasibility of converting geothermal heat to electricity is evaluated by developing a thermodynamic model to assess the thermodynamic efficiency of binary power production cycles. Using the results of heat transfer model and applying them into the thermodynamic model, the optimum (or most sustainable) rate of heat extraction is found. It is found that the sustainability of long term geothermal heat extraction depends on the balance between the rate at which geothermal energy is extracted and the rate at which the ground formation can replace its geothermal heat content. The results suggest that abandoned petroleum wells can be economically reused for the purpose of sustainable geothermal energy production.