Modeling of heat extraction from depleted oil and gas wells

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As against conventional non-renewable energy resources, geothermal energy possesses the potential to diversify the energy utilization structure and providing base load electricity to meet the global energy demands of the future generations. There come the costs of environmental degradation and climate change with exploitative use of fossil fuels, whereas, geothermal energy has extensive application prospects in the demanding field of renewable energy. Geothermal energy production has relatively less investments and is pollutant-free. As a result, it's a green, environment-friendly, low carbon, renewable and sustainable source of energy. As compared to other renewable sources of energy, the heat energy extraction from underground reservoirs does not depend on weather conditions. The cost of drilling geothermal wells is nearly 40% of the total investment cost that goes into setting up a geothermal plant. However, this problem can potentially be tackled by utilizing the currently decommissioned and abandoned oil and gas wells for geothermal purposes. This will also help curb the harmful emissions from orphaned wells as well as prevent contamination of ground water. Retrofitting an abandoned well to produce geothermal energy also saves the cost of exploring sites for geothermal fields. The estimated potential for the geothermal energy that can be harnessed in India is about 10 million kW. In this study, abandoned oil and gas wells have been simulated as a source of geothermal power to generate electricity. We have coupled thermal reservoir with bore well heat transfer and laminar flow model to perform simulations. On retrofitting concentric pipes in an abandoned well, water is circulated down through the outer pipe and extracted back through the shorter insulated inner pipe. Numerical simulations using finite element method to assess the production temperature with various operating parameters such as injection mass flow rate, reinjection temperature, well depth and geothermal gradient are performed. The results of the study show that increasing mass flow rate leads to a higher heat extraction rate as compared to the lower mass flow rate. The result also shows that heat extraction increased with the well depth for all injection parameters (i.e. injection temperature and mass flow rate). The study shows that at higher injection temperature, the net heat extraction rate with time from the reservoir decreases due to lower temperature difference between injected fluid and reservoir formation temperature.