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Flow Behavior of a $ScCO_2$-Stimulated Geothermal Reservoir under in-situ Stress and Temperature Conditions

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Abstract : The development of technically-sound enhanced geothermal systems (EGSs) is identified as a viable solution for world growing energy demand with immense potential, low carbon dioxide emission and importantly, as an environmentally friendly option for renewable energy production. The use of supercritical carbon dioxide ($ScCO_2$) as the working fluid in EGSs by replacing traditional water-based method is promising due to multiple advantages prevail in $ScCO_2$-injection for underground reservoir stimulation. The evolution of reservoir stimulation using $ScCO_2$ and the understanding of the flow behavior of a $ScCO_2$-stimulated geothermal reservoir is vital in applying $ScCO_2$-EGSs as a replacement for water-based EGSs. The study is therefore aimed to investigate the flow behavior of a $ScCO_2$-fractured rock medium at in-situ stress and temperature conditions. A series of permeability tests were conducted for $ScCO_2$ fractured Harcourt granite rock specimens at 90ºC, under varying confining pressures from 5–60 MPa using the high-pressure and high-temperature tri-axial set up which can simulate deep geological conditions. The permeability of the $ScCO_2$-fractured rock specimens was compared with that of water-fractured rock specimens. The results show that the permeability of the $ScCO_2$-fractured rock specimens is one order higher than that of water-fractured rock specimens and the permeability exhibits a non-linear reduction with increasing confining pressure due to the stress-induced fracture closure. Further, the enhanced permeability of the $ScCO_2$-induced fracture with multiple secondary branches was explained by exploring the CT images of the rock specimens. However, a single plain fracture was induced under water-based fracturing.

Keywords : supercritical carbon dioxide, fracture permeability, granite, enhanced geothermal systems
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