Mechanical Engineering Master's Defense

Flow Induced Stress Analysis in Poroelastic Medium

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abstract

Hydraulic fracturing is an effective technique used in well stimulation to increase petroleum well production. A combination of multi-stage hydraulic fracturing and horizontal drilling has led to the recent boom in shale gas production which has changed the energy landscape of North America.

During the fracking process, highly pressurized mixture of water and proppants (sand and chemicals) is injected into to a crack, which fractures the surrounding rock structure and proppants help in keeping the fracture open. Over a longer period, however, these fractures tend to close due to the difference between the compressive stress exerted by the reservoir on the fracture and the fluid pressure inside the fracture. During production, fluid pressure inside the fracture is reduced further which can accelerate the closure of a fracture.

In this thesis, we study the stress distribution around a hydraulic fracture caused by fluid production. It is shown that fluid flow can induce a very high hoop stress near the fracture tip. As the pressure gradient increases stress concentration increases. If fracture is considered to be a single line along the X axis depicting very long fracture, stress distribution along the fracture decreases, but the stress concentration at the fracture tip increases and approaches infinity as even thinner fracture dimensions are considered.

This study can further help in studying fracture closure problems and developing better proppants to help sustain this additional stress and thus avoid any hindrances in the well production.

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