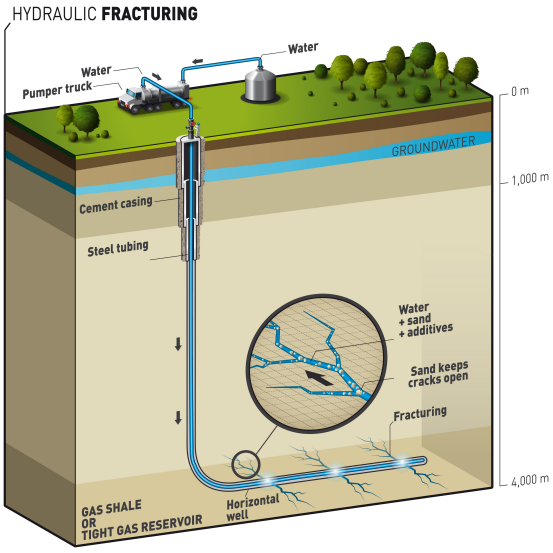
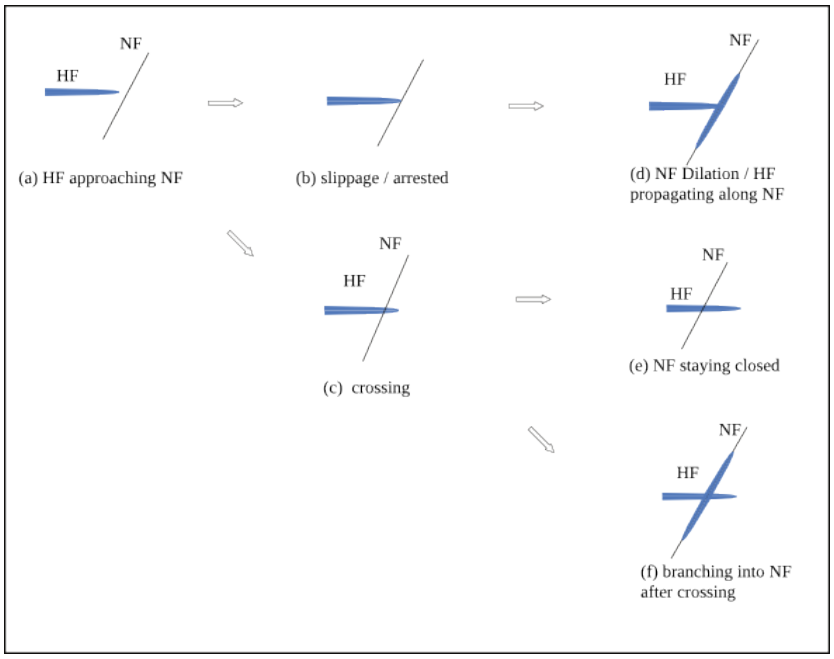
Graduation Project: Fracture interactions in hydraulic fracturing

Hydraulic fracturing is the process that is applied to stimulate oil and gas reservoirs by pumping a high viscous fluid into the underground formation (Fig. 1a). Recently, this technique is increasingly applied for the production of shale gas. Whether or not to produce shale gas in the Netherlands is receiving increased attention and is a topic of broad debate.

A critical question in predicting if a reservoir is beneficial to exploit using hydraulic fracturing, is predicting if an created hydraulic fracture can activate and open natural fractures in the reservoir. This may greatly enhance the permeability of the reservoir and thus increase the production rate. Evidence exists that depending on the pumping pressure a fracture may cross the natural fracture without opening it (Fig. 1b). A numerical model, that is able to predict pumping rates to efficiently open natural fractures, is of great interest to the oil industry.



(a) Hydraulic fracturing



(b) Interaction of an hydraulic fracture (HF) with a natural fracture (NF).

Figure 1: Schematic representation of the hydraulic fracturing process (a) and of the interaction between a hydraulic fracture and a natural fracture (b).

In our group we developed a poroelastic eXtended Finite Element Method (X-FEM) model to predict hydraulic fracturing patterns. The model has been applied successfully for fracture propagation under various loading conditions. Recently Geelen et al. implemented fracture branching in the X-FEM model. However, to use the branching model in our hydraulic fracture model some modification must be made. The first part of this project is to implement fracture branching and merging in the hydraulic fracturing model. The code developed by Geelen et al. may serve as starting point. In the second part of this project the effects of natural fractures on the propagation path of a hydraulic fracture are analysed.

We are looking for students who are interested in advanced numerical techniques that are of interest to the oil industry. The model is programmed in a C++ code.

More information:

- ir. Ernst Remij, GEM-Z 2.128 e.w.remij@tue.nl
- dr.ir. Jacques Huyghe, GEM-Z 2.117 j.m.r.huyghe@tue.nl
- dr.ir. Joris Remmers, GEM-Z 4.130 j.j.c.remmers@tue.nl
- prof.dr.ir. David Smeulders, GEM-Z 2.129 d.m.j.smeulders@tue.nl