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Description of the master’s thesis

Naturally fractured reservoirs (NFRs) account for a large fraction of the world water and energy resources. The geological complexity and high permeability contrast of naturally fractured reservoirs make it very challenging to accurately predict flow through these reservoirs. Simulating flow through fractured porous media has been a research topic for several decades. The simulators are becoming increasingly powerful and efficient. However, accurate simulations of flow through real field NFRs examples still suffer from limited CPU capacity. Such accurate and efficient models and simulation techniques for flow through fractured porous media are crucial to optimize reservoir management strategies, e.g., in terms of ultimate recovery and natural porous media volume (NPV) for hydrocarbon reserves.

The embedded discrete fracture model (EDFM), in which fractures are represented explicitly and coupled to the matrix through a transfer function, leads to accurate solutions with much lower computational costs compared with alternative discrete fracture network models. However, NFRs are geologically too complex to be fully represented in an EDFM, because of limited computational capacity. Therefore, a hierarchical model is utilized which combines the EDFM with fracture upscaling. In the hierarchical fractured model (HFM), small and medium scale fractures are upscaled into an effective matrix rock permeability while large-scale fractures are explicitly represented by the EDFM. Though the basic idea of EDFM has been developed and evolved during the last decade, its application to realistic fields involves answering several concerns mainly related to determination of the scale which is the basis of splitting the homogenized and explicit fractures. For the homogenized fractures, in addition, a method which is efficient (specially when dynamic properties are upscaled, such as relative permeabilities) and accurate (e.g., flow-based upscaling or analytical approaches) need to be explored. A hierarchical fracture modeling approach in the EDFM framework (and other discrete-fracture-network models) is applicable only when these concerns are considered. Unfortunately the EDFM literature does not involve any systematic study addressing these important concerns. As such, this thesis work is dedicated to address them.

In the first part of this work the grid sensitivity of the EDFM is studied for both single and multiphase flow. The EDFM showed to be sensitive for matrix and fracture grid orientation as well as the relative grid size resolution. These issues are resolved on a fine grid. The solution’s accuracy showed to be dominated by the matrix grid resolution. The second part consists of a study of different fracture upscale criteria in the HFM framework. Flow-based upscale criteria showed to have a significant advantage over the classical length-based upscale criterion.