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Laboratory experiments versus theory for the initiation of radial hydraulic fracture transverse to a wellbore

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We discuss here a series of comparisons between theoretical predictions and laboratory experiments for the initiation and propagation of a hydraulic fracture transverse to a wellbore. We have chosen four different laboratory experiments performed in different "tight" materials (Cement, PMMA, Niobrara Shale). In all these experiments, the time evolution of several quantities (fracture width, radius, wellbore pressure) were accurately measured and the material and injection parameters were precisely known. The comparisons presented here notably provide a clear evidence of the difference between the wellbore pressure at which a fracture initiates and the maximum pressure recorded during a test (also known as the breakdown pressure). Our theoretical analysis also identifies the dimensionless numbers governing the strong fluid-solid effects at the early stage of growth, which are responsible for the continuous increase of the wellbore pressure after the initiation of the fracture. Our analysis provides a simple way to quantify these early time effects for any given laboratory or field configuration. The good agreement between theoretical predictions and experiments also validates the current state of the art hydraulic fracture mechanics models, at least for the simple planar fracture geometry and the Newtonian fluids investigated here.