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The Impact of Effective Fracture Area and Conductivity on Fracture Deliverability and Stimulation Value

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Abstract

The economic success of stimulated wells may be defined by the Return on Fracturing Investment (ROFI): the well performance relative to the cost of the hydraulic fracture stimulation employed. Hydraulic fracture deliverability is largely defined by the effective fracture area, which is that portion of the created fracture area exhibiting sufficient conductivity contrast within the productive reservoir interval. Previous studies demonstrating that stimulated well performance can be improved by increasing fracture conductivity have generally addressed characteristics of the proppant pack: optimized proppant properties, increased proppant size, increased proppant volume, and minimized damage to the created fracture permeability. Improving overall fracture area has typically been addressed by employing larger treatments and proppant volumes. Thus, previous approaches to enhancing fracture deliverability have resulted in increased stimulation cost, which, unless accompanied by a similar scale of increase in well productivity, has negative implications on ROFI.

The decades-old theory of increasing fracture deliverability by placing proppant in partial monolayers (PMLs) rather than multi-layer packs was resurrected in 2004 with the introduction of ultra-lightweight (ULW) proppant. The theory states that a partial monolayer exhibits conductivity equivalent to 15 to 20 layers of proppant in a packed fracture, which equates to a difference in areal proppant concentration of greater than 20X. In addition to enabling placement in a partial monolayer, the transportability of ULW proppant has been shown to provide greatly increased effective fracture area. Case histories of PML fracturing treatments have consistently illustrated stimulated production increases well beyond expectations, effectively validating the productivity benefits of the process.

The focus of this paper is to characterize the ROFI implications of PML designs using ultra-lightweight proppants in comparison to typical packed fracture designs using conventional proppants. Advanced fracture modeling will be used to illustrate the effects of fracture conductivity (proppant type, concentration, & damage) and effective fracture area on well performance. Normalized stimulation costs of the respective designs will be assessed against the resultant fracture deliverability and projected ROFIs.

Introduction

Proppants are placed in the fracture to provide a preferential pathway to the wellbore once the hydraulic treating pressure is relieved. Successful well stimulation requires that these created fracture pathways provide permeability orders of magnitude greater than the reservoir matrix permeability. The proppant placed in a fracture is perhaps the most vital part of a fracture stimulation treatment since it provides the connection for hydrocarbons to flow between the reservoir and the producing wellbore¹.

Hydraulic fracture deliverability is largely defined by the *effective fracture area*, which is that portion of the created fracture area exhibiting sufficient conductivity contrast within the productive reservoir interval to promote timely drainage of the desired hydrocarbons from the reservoir to the wellbore. Effective fracture area is usually considered synonymous with conductive fracture area but, is not necessarily the same as the so called propped fracture area. Only those portions of the propped fracture area which exhibit sufficient conductivity contrast to the reservoir are considered to be conductive fracture