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Hydraulic Fracture Feasibility, Design, On-Site Supervision and Post Job Evaluation in Southeast Pakistan Gas Fields

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Abstract

This paper presents the results of a fracture feasibility and design study, treatment execution and post treatment evaluation for a hydraulic fracture campaign in the Sawan and Miano Gas fields, located in the Sindh Province, Pakistan. This first successful fracture campaign (in four wells) was conducted from December 2005 to July 2006. One well is located in the Miano and three wells in the Sawan gas field targeting the Lower Goru B and Lower Goru C sands at depths of about 3,300 m. Several injection tests and minifracs prior to the main treatment were performed to quantify closure stress, fluid leakoff, perforation friction, near-wellbore tortuosity, and fracture complexity. Issues such as formation water sensitivity and fines migration are discussed. High reservoir temperature, proppant flowback issues and risk of fracing into a water transition zone are some of the challenges faced during the fracture campaign. A variety of fracture design sensitivities were performed to evaluate the effects of pad size, treatment size, fluid and proppant types on fracture geometry, conductivity and gas production.

In the Sawan, fracturing was found to be simple as opposed to more complex fracturing in the Miano area. Permeability ranges from low 0.06 mD to moderate 8 mD in the four fractured wells. Treatment designs were adjusted accordingly to minimize screen-out risk and maximize fracture stimulation efficiency. To help reduce proppant flowback into the wellbore, partially cured, resin-coated proppant was pumped at the end of the treatments. A low-polymer loading, high-temperature, CMHPG fracturing fluid was used due to a high-temperature reservoir. This type of fluid provided high fluid viscosity for proppant transport while also minimizing polymer damage to the proppant pack. The fracture campaign has successfully increased the gas production by two to four folds.

Introduction

The Miano and Sawan gas fields are located approximately 80 kms south of Sukkur in the Sindh Province, Pakistan (**Figure 1**). The Miano field was discovered in 1993 and Sawan field was discovered in 1996. The produced gas is dry and condensate drop out is very little during the entire field life. The main reservoirs are the Lower Goru sands. Prior to this fracture campaign, wells had been producing from the higher permeability zones. To sustain gas supply for the plant, a number of wells in lower permeability areas were evaluated for hydraulic fracture stimulation. The primary targets for propped fracture treatments were the low to moderate permeability Lower Goru intervals. The sands are classified as sublith-arenites to lithic arenites with a high content of partially altered basic volcanic rock fragments and pore-lining or pore filling iron chlorite cement.[1] The main reservoir of the Lower Goru C interval is represented by bioturbated and cross-bedded delta front sandstones.[2]

Hydraulic Fracture Feasibility and Design

A total of four wells were selected for this study (Well-A in the Miano field and Well-B, Well-C, and Well-D in the Sawan field). **Table 1** shows the reservoir and fracture properties for the four fractured wells. The permeability ranges from low 0.06 mD to moderate 8 mD. The initial average pore pressure is about 4,700 psi in the Miano field and 5,300 to 5,400 psi in the Sawan field. The reservoir temperature ranges from 335 to 350ºF. The objective of the study was to evaluate the feasibility of hydraulic fracturing and provide a fracture design for the Lower Goru C and B intervals. **Figure 2** shows a log correlation of wells in the study area (excluding the newly drilled Well D).