SPE 115214

Using Prefrac Test Information to Predict and Avoid Screenout Associated with Slickwater Frac in Tight Gas Sands at the Wattenberg Field in the Denver-Julesburg Basin

Yuanhai Yang, Guonong Hu, Anne Kremer, Anadarko Petroleum Corporation

This paper was prepared for presentation at the 2008 SPE Annual Technical Conference and Exhibition held in Denver, Colorado, USA, 21–24 September 2008.

Abstract

Slick water hydraulic fracturing is becoming more attractive as more tight formations and economically marginal reservoirs are developed. However, its economic advantage can not cajole us to ignore sand screen-out problem largely caused by its poor sand carrying capability. By studying pressure declining characteristics of leak-off tests and the corresponding frac job results, the authors have successfully correlated the pressure declining gradient of leak-off tests with the likeliness of sand screen-out. This method has been effectively applied to predict the likeliness of sand screen-out at the beginning of frac jobs, and avoid sand screen-out during frac jobs.

Introduction

The J Sand sandstone is a typical tight gas formation, continuously covering the Wattenberg field in the Denver-Julesburg basin (Fig 1). Intensive digenesis effects have substantially reduced its permeability to sub milli-Darcy magnitude. Combined effects of low permeability and low initial reservoir pressure resulted in no gas production without stimulation. Prior to 2000, heavy gel fracs were dominant at the Wattenberg field. A typical frac design entailed 200k-300 lb sand and 100k-150k gallons fluid. A frac job was pumped at 25 gallon per minute with a maximum sand concentration of 5 lb per gallon. The high cost and reservoir damage concerns associated with heavy gel fracs made operators reconsidering the option of slick water frac.

While the slick water frac carries the promise of cost saving and formation protection, it side blinded us with an extremely high rate of sand screen-out. During the first two years when slick water frac was introduced to the Wattenberg field to stimulate the J sand, more than 20 percent frac jobs reported sand screen-out, or other difficulties to pump sand. Sand screen-out not only imposes safety hazard, it also sacrifices the effectiveness of reservoir stimulation because only a fraction of a frac job has been completed. Therefore, sand screen-out became the major obstacle prevents its large scale application at the Wattenberg field.

The correlation between pressure declining gradient of leak off test and screen out

A frac job is the interaction between frac itself and the formation. If the frac is consistent in terms of frac design, well bore condition, and frac implementation, it will left us the formation condition the only factor that may cause sand screen out. Considering the heterogeneous nature of tight sandstone, this suggestion is viable. Therefore, the plan of this investigation is to eliminate the influences associated with frac itself and search for an indicator of reservoir condition that might cause sand screen out.

As a fixed part of a frac design, a leak off test is conduced before the real frac job (Fig 2). This leak off test starts with a small volume of clear fluid (water). Once the pumping pressure exceeds the formation fracturing pressure, the formation is broken down. Subsequently, pumps are shut off and the leak off test starts by recording the pressure declining. By examining the characteristics of the pressure declining, our intention is to correlate the pressure declining features with the reservoir conditions that might cause sand screen out. In other words, we want to use the pressure declining feature to predict the likeliness of sand screen out before the real frac job starts and mitigation measures can be taken.

As the first step, we selected 96 fracs that share the same frac design and implementation, such as the same pumping rate,