FANGMANN ENERGY SERVICES

Innovative Spacer System – Development, Validation and First Field Trial

Introduction

In oil well cementing, the incompatibility of drilling mud and cement slurry is a well-known problem. Spacer systems are commonly applied to separate these two fluids and to remove mud and its filter cake from the borehole. Here, spacer efficiency is essential for the quality of the subsequent cement job and – even more important – for the integrity of the well.

Scope

Resulting from a close cooperation between Technical University Bergakademie Freiberg and Fangmann Energy Services, a customized lab instrument (see Figure 1) was developed to quantify the mud removal capacity of spacer systems. The corresponding procedure included buildup and removal of mud filter cake under dynamic conditions. Employing modified cement crushing tests, the evaluation of the spacer efficiency was quantitatively determined.

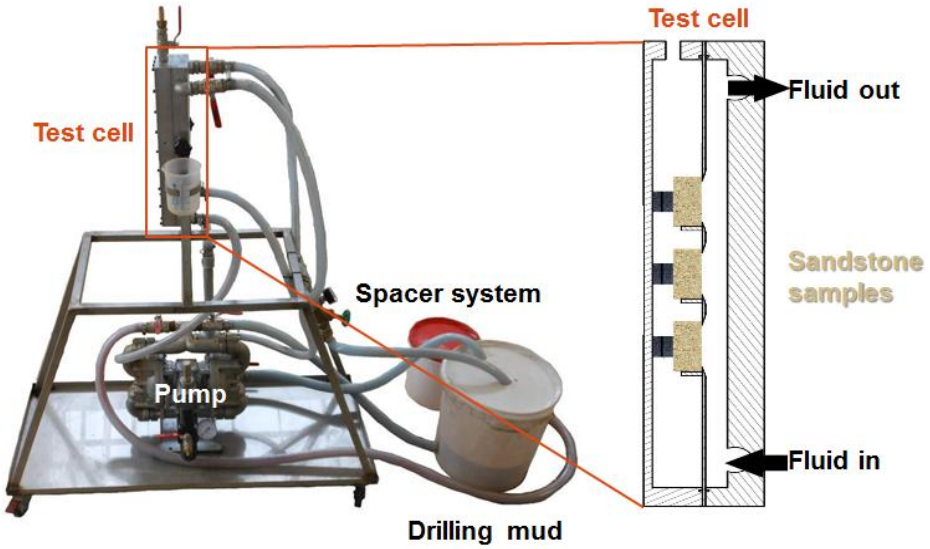

Figure 1: Customized lab instrument for spacer evaluation (left) and close up of test cell for dynamic buildup / removal of mud filter cake (right)

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Lab Results

Figure 2 illustrates the characteristics of fluids and sandstone samples used for lab testing.

Fluid	Type	ρ, kg/L
Water-based mud	Chalk / salt	1.27
Standard Spacer	Barite	1.39
Power Spacer	Barite / particles	1.39
Cement slurry	API Class G	1.90

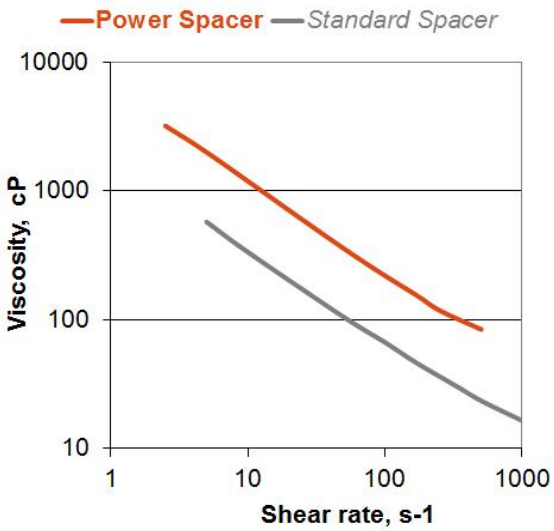

Figure 2: Characteristics of fluid and sandstone samples (left); viscosity of spacer systems, as measured at 22°C (right)

Under these lab conditions, an innovative spacer was tested and compared with a standard barite-based system (Figure 3).

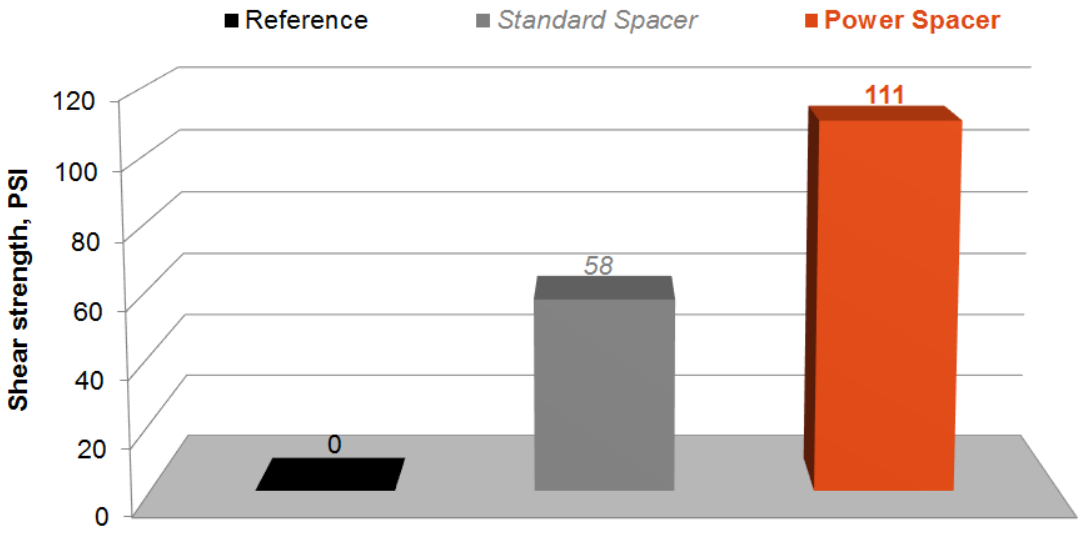

Figure 3: Mud removal efficiency of spacer systems; as a reference, no spacer was used

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Field Results

Preparing the first field trial of this innovative product in a geothermal well, the impact of different factors (e.g. pumping rate, flow velocity, contact time, etc.) on mud removal efficiency was defined. Accordingly, the formulation and application of this new fluid was optimized. Figure 4 sums up well conditions and fluid characteristics; whereas Figure 5 illustrates pumping profile and equipment on site.

Well Conditions	
MD	2,400 m
TVD	2,400 m
BHP	4,500 psi
BHST	86°C
BHCT	65°C

Fluids	
Tail cement	1.90 kg/L
Lead cement	1.60 kg/L
Power Spacer	1.32 kg/L
Mud	1.20 kg/L

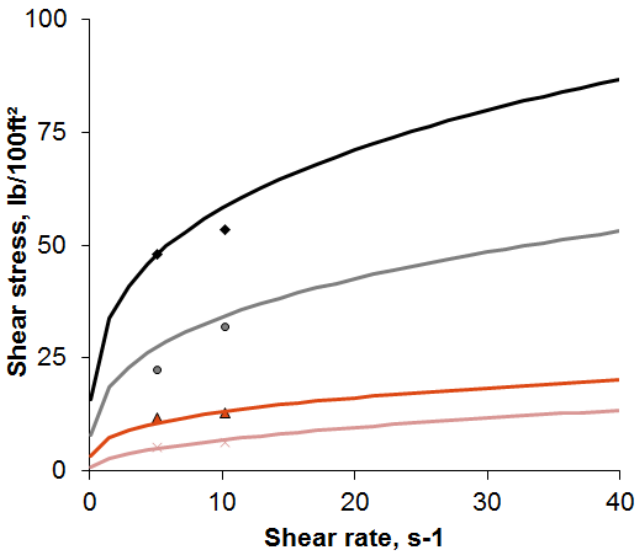

Figure 4: Well conditions, fluid densities and their rheological profile

Fluid	WHP, bar	Pump rate, L/min	Volume, m³
Power Spacer	30	800	5.2
Lead cement	20 - 25	800	44.0
Tail cement	25 - 33	800	7.0

Figure 5: Pumping profile and equipment on site

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The quality of the subsequent cement job and hence the mud removal capacity of our innovative system was quantified through cement bond log-measurements (see Figure 6).

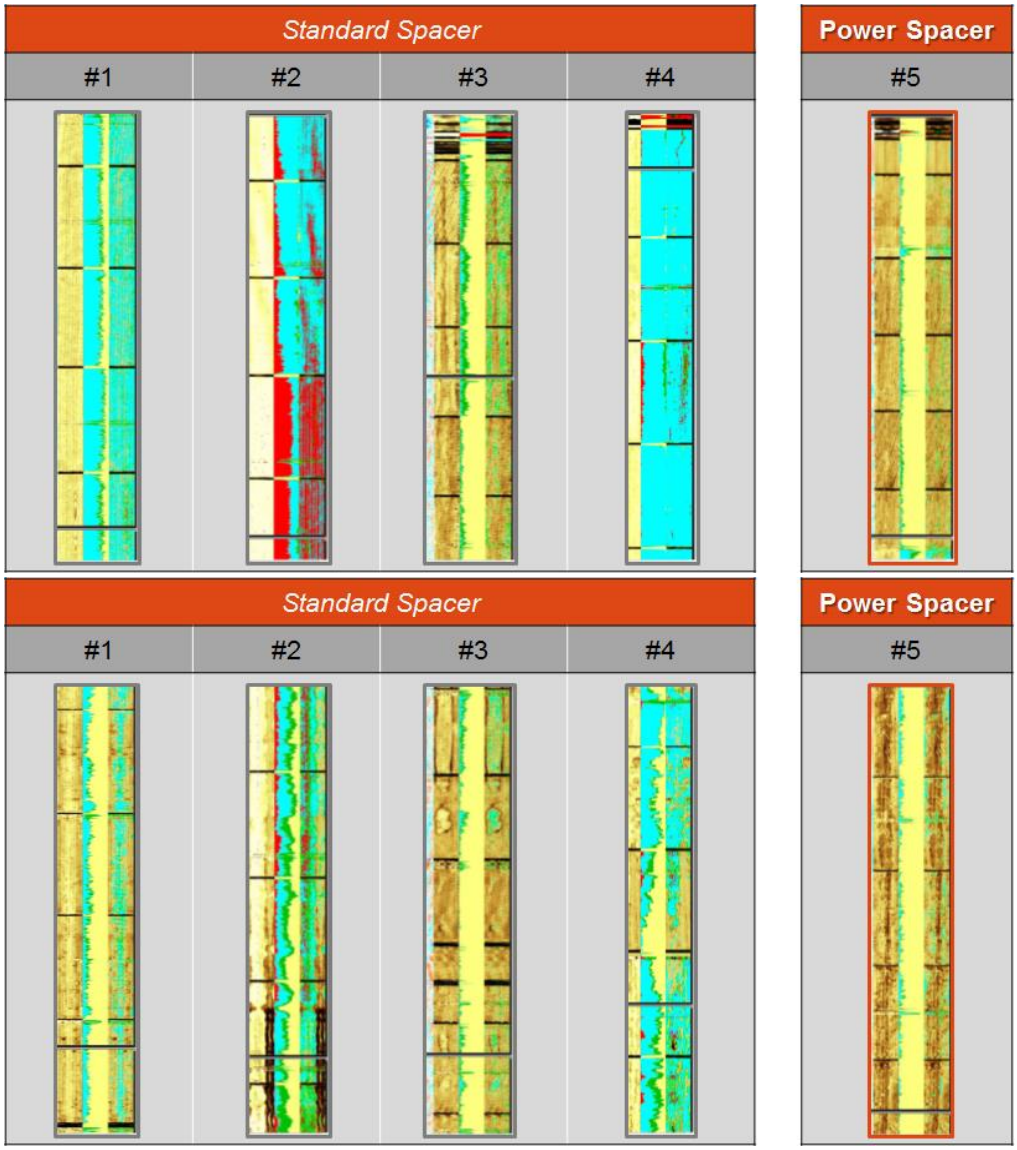

Figure 6: 9 ⅝" Liner USIT logs of overlap (top) and shoe (bottom) from 5 different wells

Summary

Laboratory and field results impressively proved the enhanced efficiency of the Power Spacer. This state-of-the art product helped to deliver an excellent cement job, hence optimal zonal isolation.

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