HALLIBURTON AquaStim℠ Service

Aquastim℠ Service

Optimized water frac service for unconventional gas reservoirs.

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Water Frac Challenges

- Damage to the fracture face
- Undesirable byproducts reduce fracture conductivity
- Wasted fracture volume
- Less than optimal production

Water Frac Challenges

Historically, fracturing treatments using friction-reduced water for the fracturing fluid have not applied production enhancement technologies other than applying massive amounts of hydraulic horsepower to fracture the formation and place minimal amounts of proppant. From the fracturing fluid perspective, the overall process has not been engineered to provide optimal production results. For example, pumping a large amount of water containing conventional friction reducers into an ultra low permeability reservoir can cause significant damage to the created fracture face surfaces. In addition, it can create undesirable damaging by-products that reduce fracture conductivity. The net result is less than optimal pressure communication to the reservoir resulting in wasted fracture volume and less than optimal production results.

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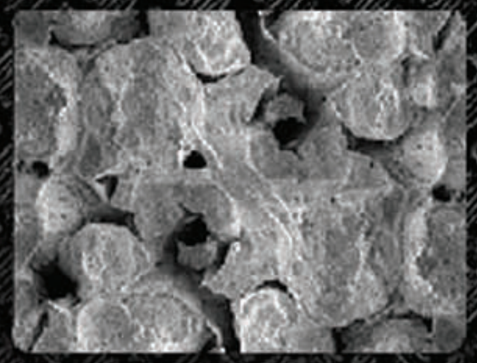
Common Water Frac Treatment Issues That Can Reduce Production

Imbibition of treating water in the fracture face

Damaging compounds

Loss of fracture conductivity

Imbibition/Phase Trapping



Diagenesis Effects

Damaging Compounds

Common Water Frac Treatment Issues

1. Imbibition of treating water into the formation matrix drastically reduces the ability of the formation to produce gas. The extremely low permeability of unconventional gas formations makes the problem even worse.

2. Polymers from conventional friction reducers can reduce fracture conductivity and form damaging compounds when mixed with formation fluids and particulates released from the fracturing process.

3. Diagenesis effects acting within the created fracture system can diminish the productivity following a water frac treatment.

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AquaStim℠ service is the result of recent innovations at the Halliburton Technology Center in Duncan, OK, USA

Recent Innovations

Halliburton's recent R&D efforts have brought needed improvements to water fracturing by developing four new technologies – GasPerm 1000 agent, OptiKleen-WF viscosity reducing agent, FR-56 friction reducer and specially formulated SandWedge conductivity enhancer. These technologies have the potential to revolutionize water fracturing and help increase the world's recoverable reserves of natural gas. A synergistic effect is obtained by combining these additives into the new AquaStim℠ water frac service.

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AquaStim℠ Service Components

GasPerm 1000 surfactant helps remove imbibed water from the fracture face for improved gas production. Can replace methanol.

OptiKleen-WF cleanup enhancer and **FR-56** friction reducer help reduce damage from long polymers both during the treatment and during production.

SandWedge conductivity enhancer helps prevent proppant degradation due to diagenesis and improve load recovery.

Aquastim℠ Service Components

1. GasPerm 1000 service addresses the issue of imbibition of treating water. The surfactant helps remove imbibed water from the fracture face for improved gas production. It also provides a significant environmental benefit by being a replacement for methanol in water block treatments.
2. OptiKleen-WF viscosity reducing agent improves cleanup of the friction reducer during production.
3. The new friction reducer technology in FR-56 agent is designed to reduce fracture damage created by long chain polymers during the treatment.
4. The SandWedge conductivity enhancement system specially designed for water frac treatments helps prevent proppant degradation due to diagenesis, helps improve load recovery and provides better long-term fracture conductivity.

The combination of these new technologies in AquaStim℠ service creates a synergy that can provide higher initial production and improved estimated ultimate recovery.

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Operators are Already Benefiting from AquaStim℠ Service

Benefiting Operators

Operators are already using AquaStim℠ service with a high degree of success in gas shale and tight-gas reservoirs. In the United States the geographic regions leading the way are the DJ Basin in the Rockies, the Granite Wash fields in the Texas Panhandle, the Woodford Shale in Southeast Oklahoma, and the Barnett Shale in North Texas. In addition, AquaStim℠ service is being introduced in East Texas, South Texas, the Permian Basin, Appalachia, the West Coast, and in Louisiana and in Western Canada. The following case studies illustrate the effectiveness of these new technologies, used individually and in combination.

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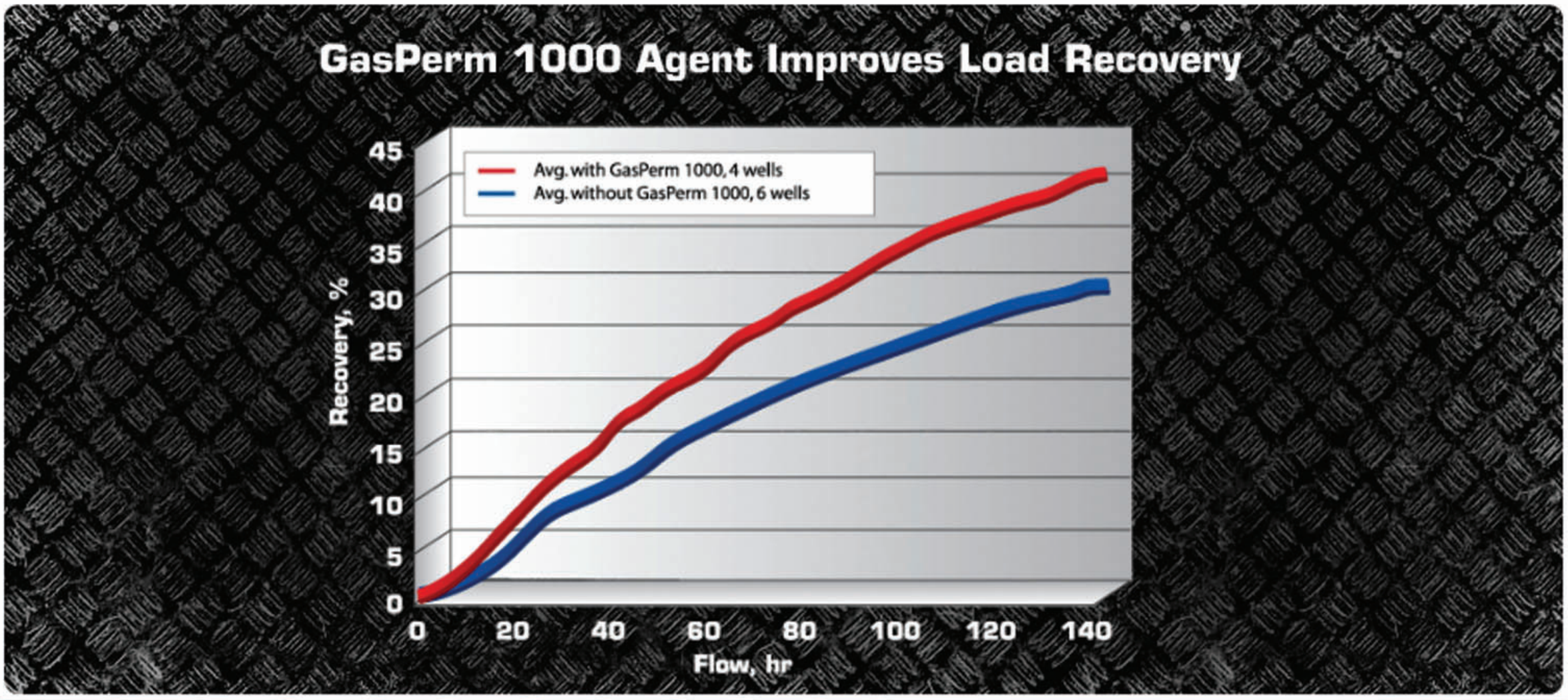

Improves Load Recovery

In Oklahoma, ten horizontal shale wells were recently completed with massive water frac treatments. Four of these wells were fractured using GasPerm 1000 additive. Load recovery from the wells in which GasPerm additive was used was about 40% better than the other wells. GasPerm 1000 microemulsion surfactant reduced water saturation and capillary pressures along the fracture faces, which improved relative permeability to gas. The wells using GasPerm 1000 service had initial gas production among the best wells in the field.

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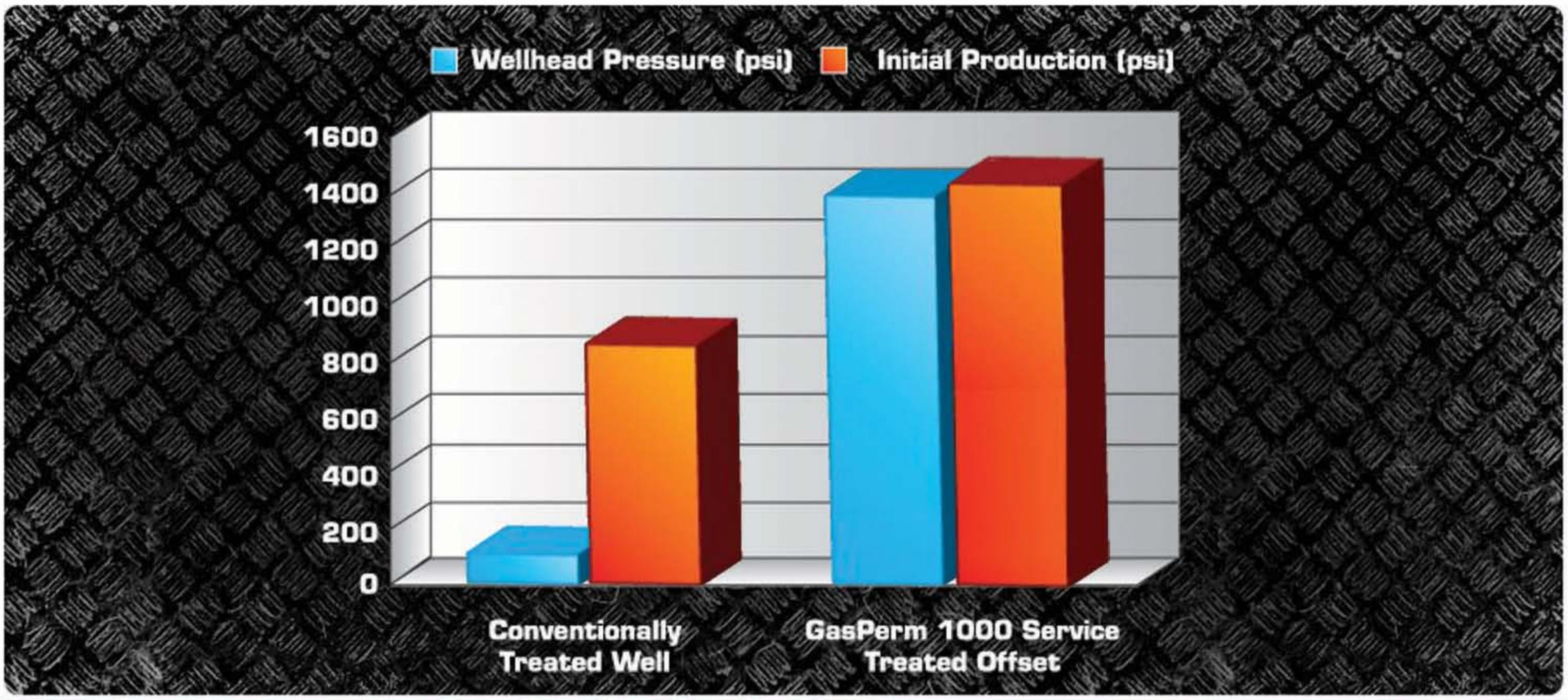

Pays Off in The Cotton Valley

In East Texas, a Cotton Valley tight gas sand well was fracture stimulated using GasPerm 1000, SandWedge and OptiKleen-WF™ agents. Results: Over 14 times the wellhead pressure and almost twice the initial production.

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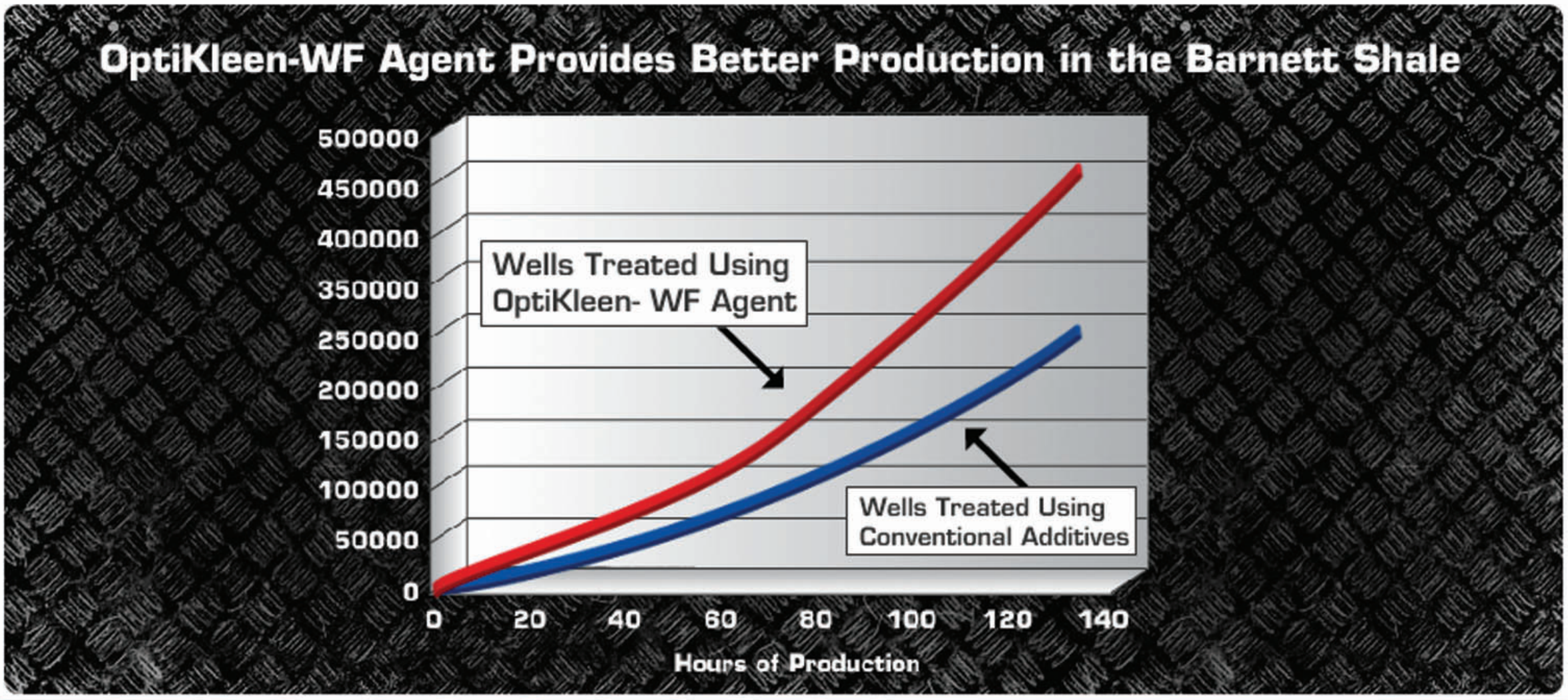

OptiKleen-WF Agent

In North Texas, OptiKleen-WF agent was used in fracture treatments on wells in the Barnett Shale. The three wells treated with OptiKleen-WF agent provided almost twice the cumulative production of the three wells treated using conventional additives.

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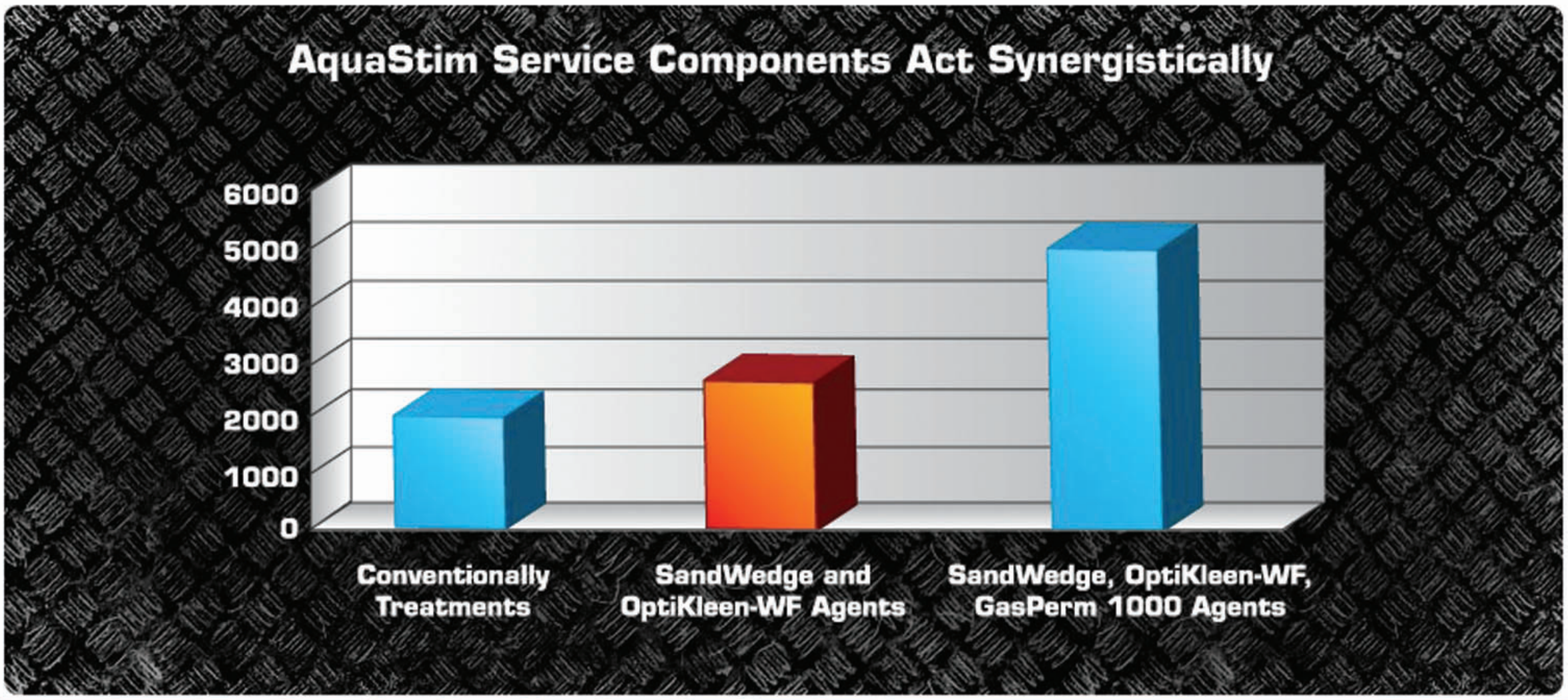

Aquastim℠ Service Components Act Synergistically

In the Texas Panhandle's Granite Wash formation, eight infill wells have been completed to date. Of those, two wells had conventional treatments and showed an average initial production of 1,974 Mcf/d. Three wells were treated with SandWedge and OptiKleen-WF agents and showed an average IP of 2,679 Mcf/d for a 36% increase. Three additional wells were treated with SandWedge, OptiKleen-WF, and GasPerm 1000 agents, and the resulting average IP was 5,135 Mcf/d. The combined technologies created a 160% increase in initial production over conventional treatments. Of course, all wells may not respond this prolifically, but operators are getting impressive results with AquaStim service.

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To find out more about how Halliburton's new AquaStim optimized water frac service can help make your unconventional reservoirs more productive, contact your local Halliburton representative or email stimulation@Halliburton.com. Also, you can visit our website www.halliburton.com/reliability.