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Abstract

Filter-Cake Only Regain Conductivity Analysis, as well as an analysis using typical Conductivity procedures, were performed by an independent laboratory to show the effectiveness of one of Hallux Talon's High Temperature Mannanases in degrading filter-cakes produced under extreme leak-off conditions and elevated temperatures (180°F and 250°F). Also a filter-cake degradation effectiveness comparison of other currently used breakers in the industry derived from the Proppant Consortium database (2007-2010) is provided.



Generic Borate Formulations

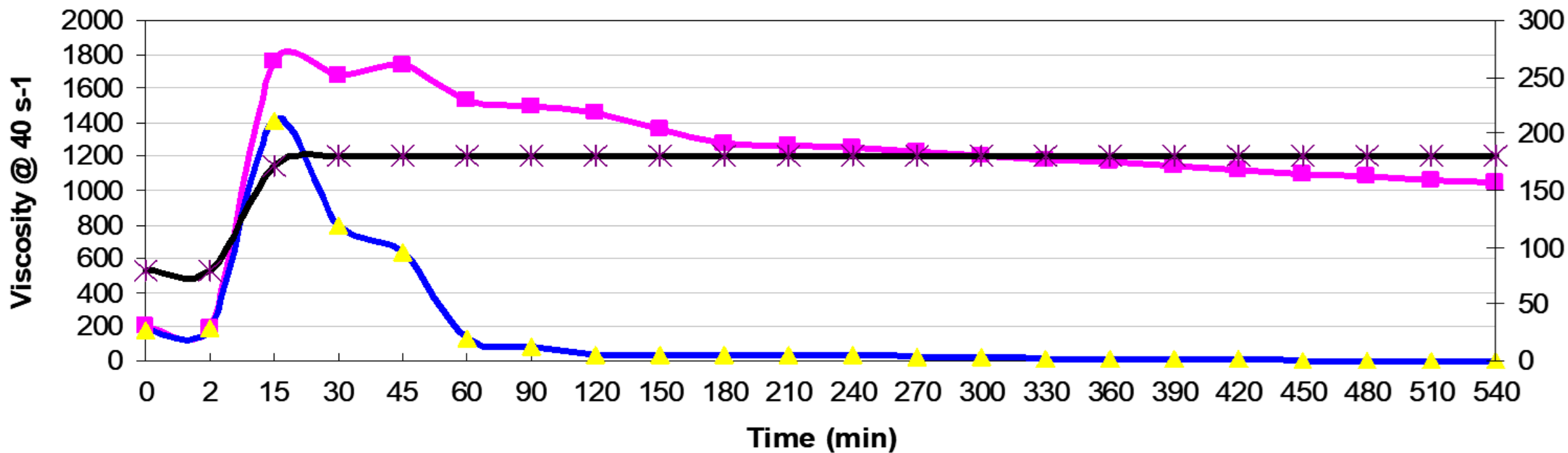
@ 180°F, 4000 psi Closure

180°F Generic LT Borate	250°F Generic HT Borate
Spring Tap Water	Spring Tap Water
30 ppt Guar (Slurried Polymer)	40 ppt Guar (Slurried Polymer)
0.7 gpt Choline Chloride (70%)	0.7 gpt Choline Chloride (70%)
1.0 gpt Potassium Carbonate (40%)	0.8 gpt Potassium Hydroxide/ Potassium Carbonate Buffer
1.0 gpt Boric Acid Crosslinker	1.5 gpt Slurried Borate Salt
1.0 gpt AES Enzyme HTHP	1.0 gpt AES Enzyme HTHP

Fann 50 fluid stability: At test temperatures of 180°F and 250°F, fluid needs to maintain a minimum of 100 cps @ 40s-1 for 1 hour (at 160°F and 230°F respectively) based on Proppant Consortium requirements.



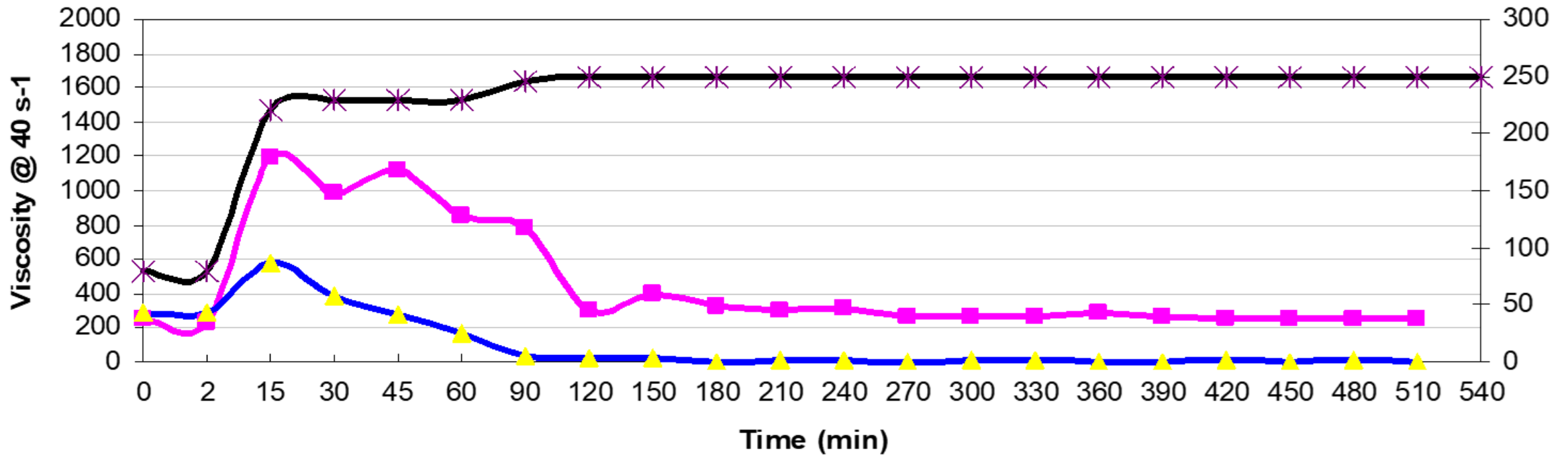
30 ppt Guar @ 180°F
HTHP Viscometer pH 9.64
0.7 gpt Clay Treat 2C, 7.5 gpt GLFC-5D, 0.8 gpt BF-7L, 1 gpt XLW-30, 1 gpt
Hallux Talon Enzyme HT



■ Baseline-no breaker
 ▲ Enzyme HT 1.0 gpt
 ✱ Temp °F



40 ppt Guar @ 230-250°F
HTHP Viscometer pH 9.64
0.7 gpt Clay Treat 2C, 10 gpt GLFC-5D, 0.7 gpt BF-9L, 1 gpt XLW-30, 1 gpt
Hallux Talon Enzyme HT



■ Baseline-no breaker
 ▲ Enzyme HT 1.0 gpt
 ✱ Temp °F



Generic Borate @ 180°F and 250°F, 4000 psi Closure Filter-Cake Only Regain Conductivity Analysis

Liquid Flow Rate after shut-in	0.5-2 ml/min	2 ml/min	2 ml/min	2-10 ml/min	25 ml/min	After Gas flow*
Hours at Closure and Temperature	1 hour	2 hour	5 hour	20 hour	25 hour	50 hours
Breaker Type						
1 gpt Hallux Talon Enzyme HT (180°F)	22.89	18.45	24.06	62.10%	56.10%	95.56%
1 gpt Hallux Talon Enzyme HT (250°F)	16.87	17.84	15.4	12.7	67.3%	80.44%

*Please note that “After Gas Flow” regain conductivity results are always relative, since the objective is to simulate “High Rate Dry” Gas Wells. Polymer is basically dehydrated and only occupies a very small area of the proppant pack pore volume (damage) as compared to “Wet” hydrated polymer in the liquid phase. Therefore, a more accurate effectiveness comparison can be made using the **25 hour liquid flow clean-up regain** numbers.



Generic Borate @ 180°F, 4000 psi Closure Proppant Consortium 2007-2010 Comparison Data

Liquid Flow Rate after shut-in	0.5-2 ml/min	2 ml/min	2 ml/min	2-10 ml/min	25 ml/min	After Gas flow*
Breaker Type @ Closure and Temperature	1 hour	2 hour	5 hour	20 hour	25 hour	50 hours
No breaker	6.7	6.4	7.8	11	17%	
0.1 ppt AP (Ammonium Persulfate)	13.4	12.2	11	9.4	18%	
0.2 ppt AP (Ammonium Persulfate)	4.6	4.6	6.7	7.1	22%	
1 gpt Verenium Enzyme (10%) + 1 ppt Encap AP (200°F) 2013	2.5	9.2	9.9	12.2%	17.9%	54.5%
0.1 ppt AP + 5 ppt Encap AP HP	12	19.1	17	19.3	30%	
1 gpt Hallux Talon Enzyme HT	22.89	18.45	24.06	62.10%	56.10%	95.56%

Generic Borate @ 250°F, 4000 psi Closure Proppant Consortium 2007-2010 Comparison Data

Liquid Flow Rate after shut-in	0.5-2 ml/min	2 ml/min	2 ml/min	2-10 ml/min	25 ml/min	After Gas flow*
At Closure and Temp	1 hour	2 hour	5 hour	20 hour	25 hour	50 hours
Breaker Type						
No breaker	4.1	3.2	4.3	17.7	31%	
no breaker (repeat test)	8.5	11.5	7.1	6.2	23%	
0.1 ppt AP + 1 ppt Encap AP HP	3	1.8	1.6	5.3	15%	
2 ppt Encap AP HP	3.6	4	6	10.6	12%	
4 gpt Magnesium Peroxide	1.4	1.2	1.7	5.1	8%	
4 gpt Magnesium Peroxide (diesel)	1.4	1.4	1.9	4.1	6%	
1 gpt Calcium Peroxide	1.6	1.4	1.2	3	12%	
2 gpt Calcium Peroxide	3.1	3.2	4.1	9.2	15%	
1 gpt Verenium Enzyme (10%) + 1 ppt Encap AP (200°F) 2013	2.5	9.2	9.9	12.2	17.9%	54.5%
5 ppt Vicon HT @ \$14.00/Lbs?	1.1	1.4	1.4	2.3	16%	
5 ppt Vicon HT (repeat test)	1.1	1.4	1.4	2.3	15%	
10 ppt Vicon HT**	1.2	0.9	3.2	7.3	31%	
1 gpt Hallux Talon Enzyme HT	16.87	17.84	15.4	12.7	67.3%	80.44%

**Generic Borate @ 250°F, 4000 psi Closure
Proppant Consortium 2007-2010 Comparison Data**

**10 ppt of Vicon HT is an amount that is actually not “pumpable”, since it basically has no viscosity (<20 cps @ 40s-1) left within 16 minutes at a Temperature of 230°F.

Filter-Cake Degradation Test

Breaker Efficiency Comparison



Test ID: 13-0282	Test ID: 13-0304	Test ID: 13-0355	Test ID: 13-0298
Shut-In Temp: 210°F	Shut-In Temp: 210°F	Shut-In Temp: 210°F	Shut-In Temp: 210°F
Shut-In Time: 16:55	Shut-In Time: 18:33	Shut-In Time: 18:06	Shut-In Time: 18:34
Breaker: None (Baseline)	3 gpt Sodium Chlorite 8%	10 gpt Sodium Chlorite 8%	Breaker: 2 gpt AES Enzyme HT
0 % Clean-Up	(Vicon HT)	(Vicon HT)	HT
100% Damage	46.5 % Clean-Up	77.4 % Clean-Up	99.4 % Clean-Up
	53.5% Damage	22.6 % Damage	0.6 % Damage

Typical Regained Conductivity Procedure

**30# Crosslinked Guar @ 180°F, 2000 psi closure + 2 lbs/ft²
Independent Lab Testing**

Liquid Flow Rate after shut-in	0.5 ml/min	2 ml/min	5 ml/min	20-40 ml/min	10 ml/min	After Gas flow 10 ml/min
Hours at Closure and Temperature	0 hour	5 hour	10 hour	24 hour	50 hours	60 hours
Breaker Type						
No Breaker 180°F	0.5	4.07	12.2	12.5	12.7	N/A
1 gpt Hallux Talon Enzyme HT 180°F	25.8	33.3	37.8	81.7%	84.3%	96.8%



Generic Borate @ 180°F, 4000 psi Closure Proppant Consortium 2007-2010 Comparison Data

Liquid Flow Rate after shut-in	0.5-2 ml/min	2 ml/min	2 ml/min	2-10 ml/min	25 ml/min	After Gas flow*
Breaker Type @ Closure and Temperature	1 hour	2 hour	5 hour	20 hour	25 hour	50 hours
No breaker	6.7	6.4	7.8	11	17%	
0.1 ppt AP (Ammonium Persulfate)	13.4	12.2	11	9.4	18%	
0.2 ppt AP (Ammonium Persulfate)	4.6	4.6	6.7	7.1	22%	
1 gpt Verenium Enzyme (10%) + 1 ppt Encap AP (200°F) 2013	2.5	9.2	9.9	12.2%	17.9%	54.5%
0.1 ppt AP + 5 ppt Encap AP HP	12	19.1	17	19.3	30%	
1 gpt Hallux Talon Enzyme HT	22.89	18.45	24.06	62.10%	56.10%	95.56%

Generic Borate @ 250°F, 4000 psi Closure Proppant Consortium 2007-2010 Comparison Data

Liquid Flow Rate after shut-in	0.5-2 ml/min	2 ml/min	2 ml/min	2-10 ml/min	25 ml/min	After Gas flow*
At Closure and Temp	1 hour	2 hour	5 hour	20 hour	25 hour	50 hours
Breaker Type						
No breaker	4.1	3.2	4.3	17.7	31%	
no breaker (repeat test)	8.5	11.5	7.1	6.2	23%	
0.1 ppt AP + 1 ppt Encap AP HP	3	1.8	1.6	5.3	15%	
2 ppt Encap AP HP	3.6	4	6	10.6	12%	
4 gpt Magnesium Peroxide	1.4	1.2	1.7	5.1	8%	
4 gpt Magnesium Peroxide (diesel)	1.4	1.4	1.9	4.1	6%	
1 gpt Calcium Peroxide	1.6	1.4	1.2	3	12%	
2 gpt Calcium Peroxide	3.1	3.2	4.1	9.2	15%	
1 gpt Verenium Enzyme (10%) + 1 ppt Encap AP (200°F) 2013	2.5	9.2	9.9	12.2	17.9%	54.5%
5 ppt Vicon HT @ \$14.00/Lbs?	1.1	1.4	1.4	2.3	16%	
5 ppt Vicon HT (repeat test)	1.1	1.4	1.4	2.3	15%	
10 ppt Vicon HT**	1.2	0.9	3.2	7.3	31%	
1 gpt Hallux Talon Enzyme HT	16.87	17.84	15.4	12.7	67.3%	80.44%

Hallux Talon Flowback Aid Family

- **General Information:**

- Hallux Talon Flowback Aid Family are liquid, non-emulsion type, synthetic zwitterionic, medium strength surfactants to enhance polymer load or fluid recovery in Oilfield applications. Any of the Hallux Talon Flowback Aid chemical formulations are environmentally friendly products that can be custom designed to have any particular Contact Angle or Surface Tension property. The main zwitterionic chemical compound of any of these formulations is compatible with other cationic, anionic and nonionic surfactants.

- **Physical and Chemical Properties:**

- Main Molecular Formula: C₁₉H₃₈N₂O₃
- Density: 8.7-10.00 lb/gal (1.05-1.2 Kg/L) (depending on the needed properties)
- pH: 3.5-8.0 (depending on the needed properties)
- Solubility in water: Soluble
- Solubility in Hydrocarbons: Insoluble
- Appearance: Clear to light amber liquid
- Odor: Soapy 'wax" odor
- Boiling Point: > 221°F (105°C)
- Freezing Point: - 10°F (-23°C)
- Flashpoint: > 230°F

- **Recommended Loadings:**

- Hallux Talon Flowback Aid formulations are typically applied in concentrations ranges from 1.0 to 2.0 gpt (L/M3) of the base fluid to provide excellent fluid recovery.

- **Shipping and Handling:**

- Hallux Talon Flowback Aid products are packaged in 275 gallon or 330 gallon IBC Totes. All products in this family are not DOT regulated and can be shipped worldwide. MSDS and Pricing available upon request.



Hallux Talon Green KCl Substitute

- **General Information:**
 - Hallux Talon KCL Substitute is a liquid substitute for potassium chloride (KCl) in Oilfield applications. AES KCl substitute is an environmentally friendly, Feed Grade, highly concentrated organic salt.
- **Physical and Chemical Properties:**
 - Molecular Formula: C5H14ClNO
 - Density: 9.00 lb/gal (1.08-1.09 Kg/L)
 - pH: 6.5-8.0
 - Solubility in water: Soluble
 - Solubility in Hydrocarbons: Insoluble
 - Appearance: Clear to light amber liquid
 - Odor: Amine "Fishy" odor
 - Boiling Point: 257°F (125°C)
 - Freezing Point: - 10°F (-23°C)
 - Flashpoint: > 200°F
- **Recommended Loadings:**
 - Hallux Talon KCl substitute typical concentration ranges from 0.7 to 1.5 gpt (L/M3) of the base fluid to give an equivalent temporary clay stabilization of 2% potassium chloride or 1 to 2 gpt (L/M3) equivalent of TMAC (50%). Higher loadings are recommended if clay sensitivity poses an issue with regards to formation damage.
- **Shipping and Handling:**
 - Hallux Talon KCl substitute is packaged in 275 gallon or 330 gallon IBC Totes. Bulk storage can be arranged. Product is not DOT regulated and can be shipped worldwide. MSDS and Pricing available upon request.

