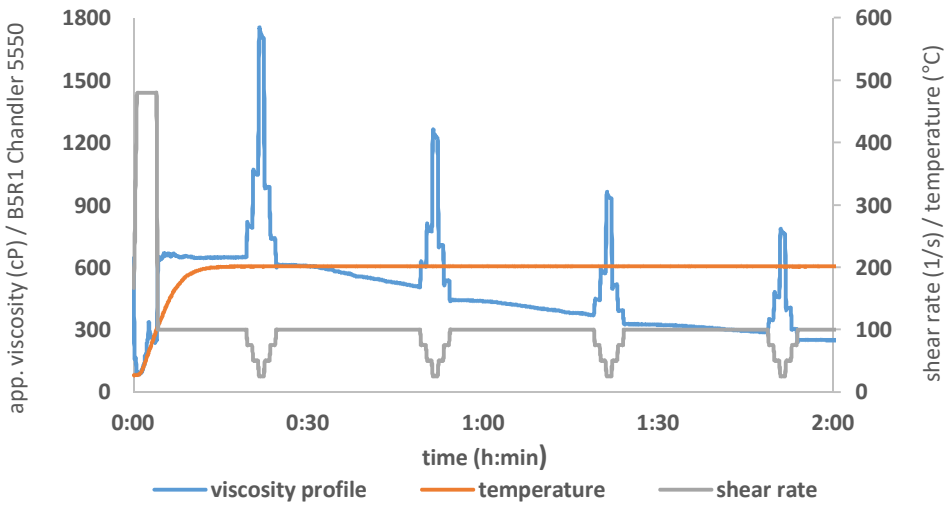
TouGas EP-1F for Hydraulic Fracturing

Key Features of EP-1F gellant:

- Versatile gelling agent for well stimulation based on high-molecular weight acrylamide co-polymer with friction reduction properties
- Performs in a broad temperature range up to ultra-high temperatures
- Compatible with a broad range of water qualities as base fluids
- Leaves no residue and provides high regained conductivity
- Easily crosslinked with common metal crosslinkers (Zr, Ti)
- Superior shear stability and shear response
- Reduced operational costs and improved well productivity

High-Temperature Stability

TouGas EP-1F gellant delivers a superior viscosity profile up to Ultra-High-Temperature conditions. No cool-down is required for demanding wells with high bottom-hole temperature, which directly translates into less water consumption. The viscosity profile can be easily adjusted to specific customer needs.



Fluid with 22 gpt EP-1F gellant (50 lb/Mgal), zirconium crosslinker and clay stabilizer in tap water at 204 °C / 400 °F.

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TOUGAS Oilfield Solutions

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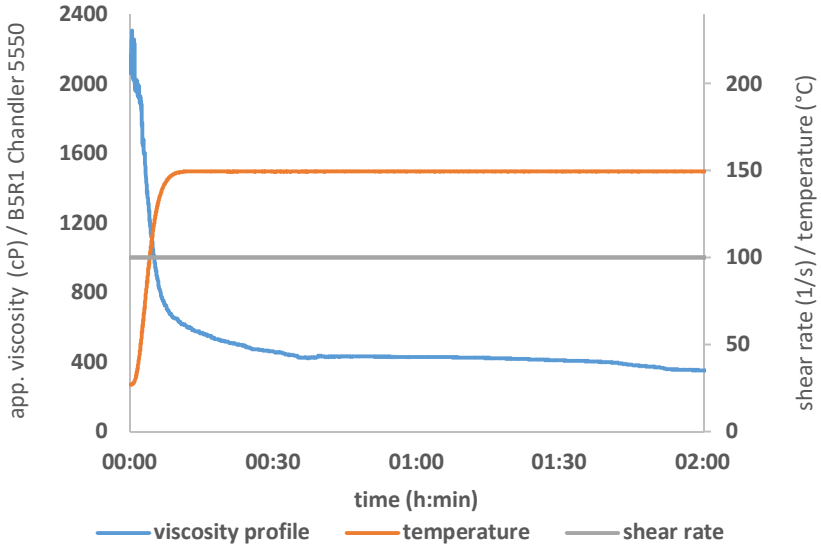
Flexible Water Sources

TouGas EP-1F gellant is compatible with a broad range of water qualities, e.g. formation water, seawater or produced water. This simplifies water sourcing and significantly reduces water related costs.

Salt Water Composition:

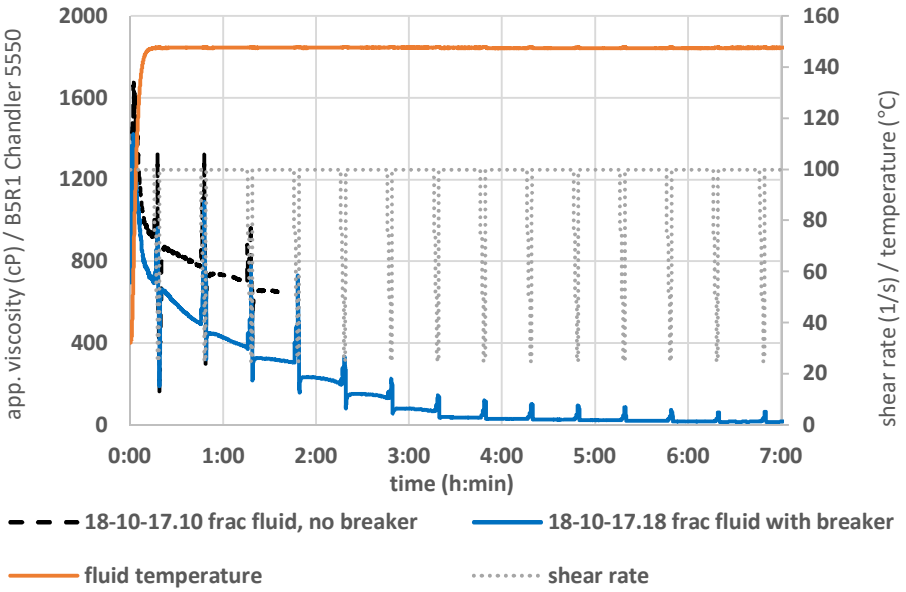
Ions	ppm
Calcium	10,020
Sodium	66,873
Magnesium	740
Chloride	123,018
TDS	**200,651**



Fluid with 21 gpt EP-1F gellant (47 lb/Mgal), zirconium crosslinker in high TDS salt water at 150 °C / 302 °F.

Reliable Breaking

TouGas EP-1F gellant is reliably broken down with oxidizers to water-like viscosity. Breaker schedule can be adjusted to job requirements. Incorporated additives assure very low surface tension of the broken fluid. This leads to excellent flowback behavior and high regained conductivity ultimately resulting in improved well productivity.



Fluid with 22 gpt EP-1F gellant (50 lb/Mgal), zirconium crosslinker, encapsulated bromate (8 lb/Mgal active breaker) in synthetic seawater with 55,000 ppm TDS.

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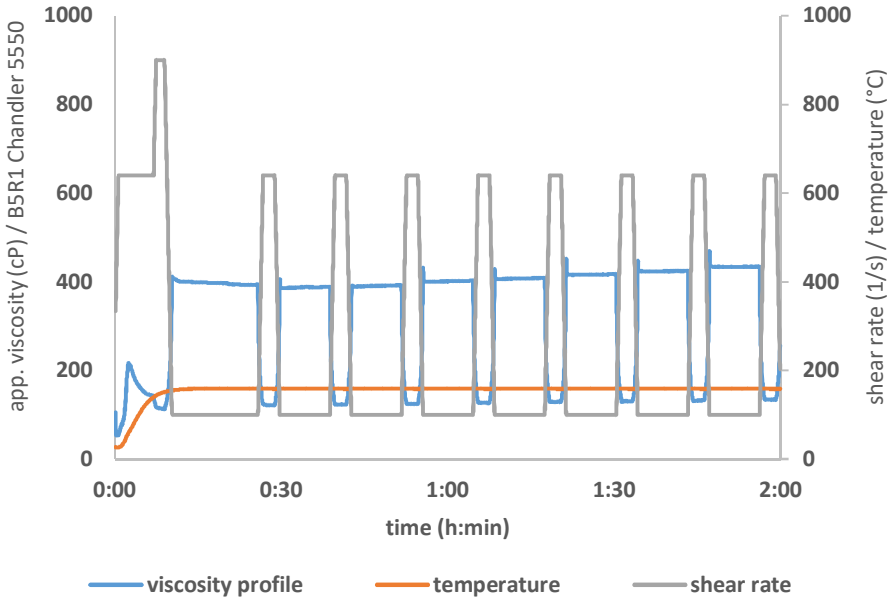
Superior Shear Response

Innovative polymer design leads to a superior shear response behavior of zirconium crosslinked EP-1F gellant. This results in easier frac job design and stable proppant placement.

Fluid with 22 gpt EP-1F gellant (50 lb/Mgal). Measurement at 160 °C / 320 °F with shear rate of 640 1/s, 900 1/s and switches between 640 1/s and 100 1/s.



Favorable Environmental Safety Profile

Ecotoxicology data: non toxic

Fish toxicity of polymer in TouGas EP-1F gellant	Algal growth inhibition of polymer in TouGas EP-1F gellant	Crustacean toxicity of polymer in TouGas EP-1F gellant
96 h LC_{50} >500 mg/l (cyprinodon variegates, sheepshead minnow)	**72 h EC_{50}** >1000 mg/l (Growth inhibition of *Skeletonema costatum*; ISO 10253; 2006)	**48 h LC_{50}** 1127 mg/l (Lethality test with Acartia tonsa (Dana); ISO 14669; 1999)

Biodegradability of TouGas EP-1F

TouGas EP-1F gellant	polymer in TouGas EP-1F gellant	organic solvent in TouGas EP-1F gellant	surfactants in TouGas EP-1F gellant
after 28 days: **28 %** after 60 days: **40 %** (seawater, Marine BODIS; OSPAR Ringtest; 1995)	after 28 days: **7 %** (seawater, Marine BODIS; OSPAR Ringtest; 1995)	after 28 days: **100 %** (seawater, Marine BODIS; OSPAR Ringtest; 1995)	A) DOC-removal: **96 %** (OECD 301C) B) Biodegradability: **99%** (static)

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