



TouGas CMHPG/T-AD Fluid

for Hydraulic Fracturing

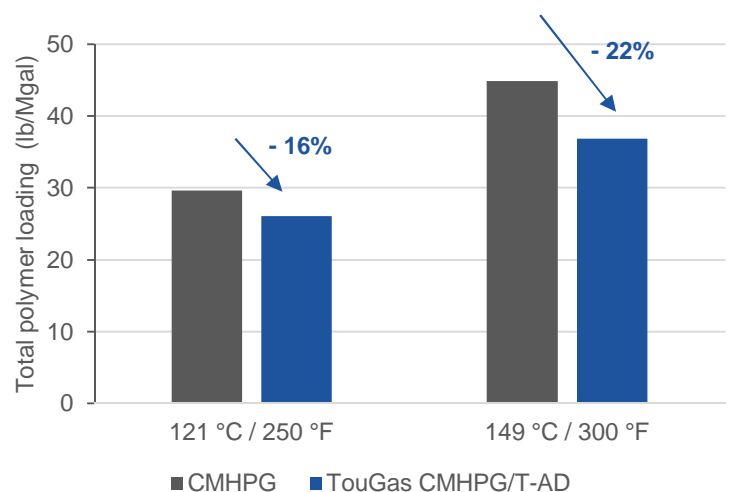
TouGas CMHPG/T-AD combines the benefits of a traditional CMHPG fracturing fluid with those of TouGas' proprietary stabilizing additive T-AD. Key benefits of this innovative fluid design are:

- Increased fluid stability, especially at high temperatures up to 176 °C / 350 °F
- Lowers costs and improves fracture clean-up by allowing reduced polymer loadings
- More uniform proppant placement with reduced settling due to higher proppant carrying capability
- Improved shear stability reduces screen-out risk in deep and challenging environments

Reduced Polymer Loading

By adding small amounts of TouGas proprietary additive T-AD to zirconium crosslinked TouGas CMHPG fracturing fluids, the stability of the fluid can be enhanced significantly as shown in the performance graph on the next page. This allows to reduce the total polymer loading up to 22 % while maintaining the performance of the fluid. At higher temperatures this stabilizing effect is even stronger.

Lower polymer loading leads to reduced costs, less formation damage and improved well productivity.

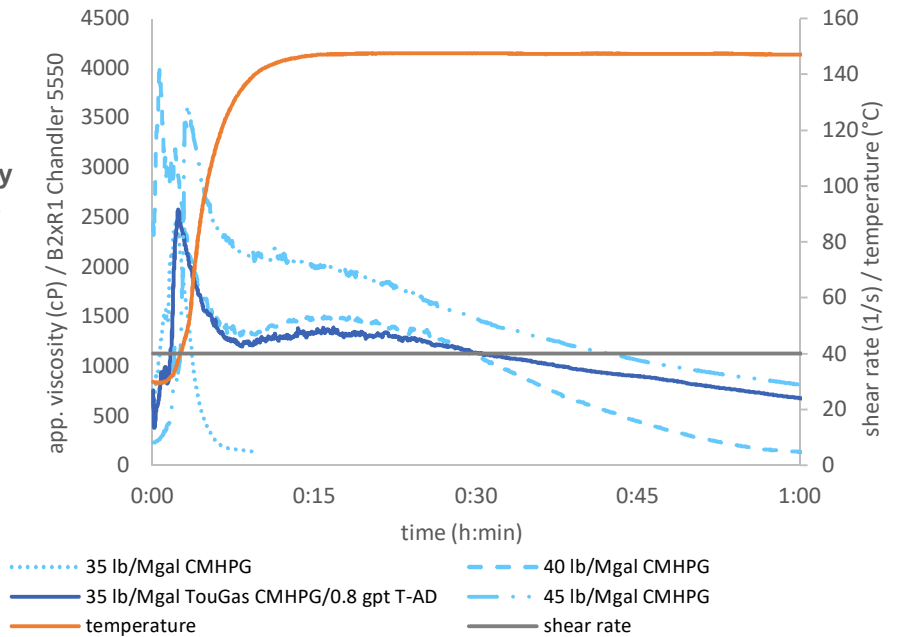


TouGas CMHPG/T-AD

TouGas CMHPG/T-AD Fluid Performance at 149 °C / 300 °F

Addition of TouGas T-AD to CMHPG fluid significantly improves the fluid performance. A 35 lb/Mgal TouGas CMHPG/T-AD fluid delivers 700 cp viscosity after 60 min. Without the addition of TouGas T-AD a significantly higher CMHPG loading of 45 lb/Mgal is required to achieve a similar performance.

Fluids were prepared with 2 wt-% KCl water. pH was adjusted to 5 for hydration. Crosslinking with 2.5 gpt zirconium crosslinker solution at pH 8-9.



Higher Proppant Carrier Capability of TouGas CMHPG/T-AD

Static settling tests with linear fluids demonstrate the higher proppant carrier capability of TouGas CMHPG /T-AD. Enhanced proppant carrier capability translates into improved proppant placement.

Measurements were conducted in a graduated cylinder with a 20 lb/Mgal CMHPG linear fluid and a 20 lb/Mgal TouGas CMHPG/T-AD linear fluid. Brown sand proppants (20/40-mesh) were used in the test at a concentration of 1.5 lb/gal at 20 °C / 68 °F. For the fluid without TouGas T-AD additive proppant settling starts immediately and is almost complete after 30 s. The fluid with TouGas T-AD still keeps proppants suspended even after 30 s.

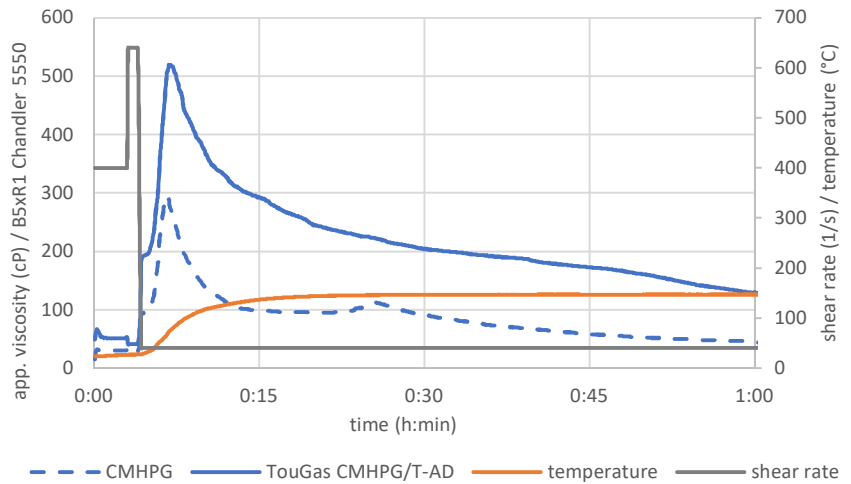
Settling time	20 lb/Mgal linear CMHPG fluid	20 lb/Mgal linear TouGas CMHPG/T-AD fluid with 0.5 gpt T-AD
After 4 seconds		
After 30 seconds		

TouGas CMHPG/T-AD

Improved Shear Stability

Improved shear stability leads to a more robust performance in regard to crosslink delay time for TouGas CMHPG /T-AD. This reduces the risk for screenouts and related operational interruptions and ultimately lowers operational costs.

35 lb/Mgal TouGas CMHPG/T-AD fluid and 35 lb/Mgal CMHPG fluid were exposed to a shear history simulation with 400 1/s for 3 min, 640 1/s for 1 min and 40 1/s for 60 min. Fluids were heated to 149 °C / 300 °F.

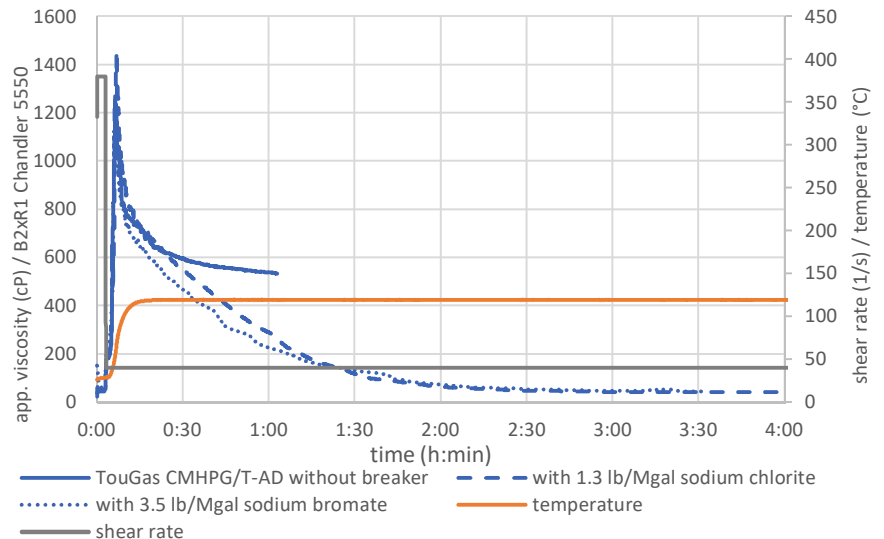


Reliable Breaking

Common oxidizing breakers reliably break TouGas CMHPG/T-AD fluids. The breaking profile can be designed specifically to the job requirements. Static breaking tests confirmed clean breaking of these gels down to water like viscosity. This leads to high fluid recovery and cleanup.

Dynamic breaking tests of a 35 lb/Mgal TouGas CMHPG/T-AD fluid were conducted at 121 °C / 250 °F with live sodium chlorite and live sodium bromate. Viscosity after breaking was shown to be below 5 cp with Ubbelohde viscometer. Breaking profile can be controlled by adjusting the breaker amount.

Static breaking tests were performed with the same breaker types and loadings at 121 °C / 250 °F for 18 h in pressurized cells. Viscosities after breaking were below 10 cp. (not shown here)





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