Technical Bulletin
SGA-21

DESCRIPTION

Hydrochloric acid systems of 15 to 28% concentration viscosified with acid gelling agent SGA-21 provide stable, viscous acids for use in limestone or dolomite formations. The SGA-21 concentration can be varied to provide the desired viscosity for a specific application. A viscous acid has the advantage of reducing fluid loss to the formation and producing wider fractures, both of which result in deeper penetration of unreacted acid into the fracture. Acid gelled with SGA-21 does not experience a reduction in viscosity as the acid spends; however, some thinning will occur at higher temperatures.

The temperature range fluids prepared using SGA-21 is 75° to 300°F (24° to 149°C).

APPLICATION

Fluid Design

Stimulation response is typically limited by acid penetration when fracture acidizing in carbonate formations. The depth of live acid penetration is determined by the fluid loss and the rate of acid spending.

Fluid Loss

Acid fluid loss is reduced by gelling the acid. However, the major fluid-loss problem in fracture acidizing is the development of wormholes. Wormholes can be easily created in the fracture face and increase the reactive surface area. Once wormholes develop, much of the acid enters a few large wormholes that penetrate deep into the fracture face. The acid travels down and extends these wormholes until, as a result of reaction with wormhole walls, it eventually spends. The viscosified acid does not significantly reduce the fluid-loss volume into the wormhole or reduce the number of wormholes created.

Acid penetration is also limited by fluid leakoff to naturally vugular or fractured rock. The effects of fluid leakoff to wormholes or natural voids can be minimized by adding inert fluid-loss additive to the acid. These particles will fill and bridge the wormholes and natural fractures, and improve fluid efficiency.

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Rate of Acid Spending

Viscosifying the acid also accomplishes the following.

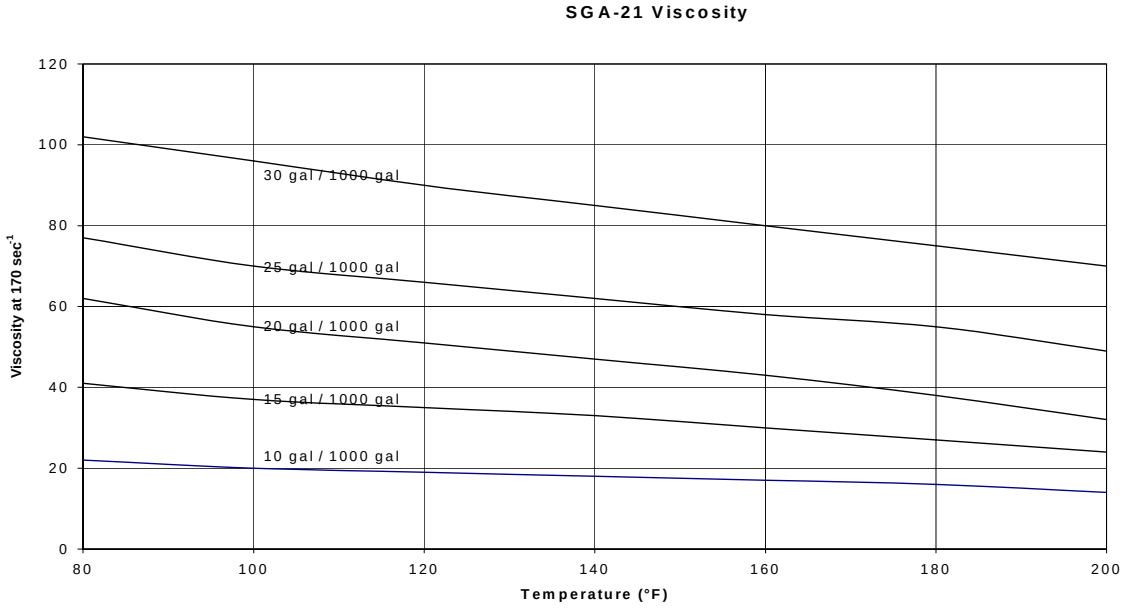
- The relatively high acid viscosity provides increased fracture width, which reduces the area-to-volume ratio and increases the spending time.
- The reduced fluid loss extends the spending time by decreasing the rate of acid migration to the fracture face.

Table 1: SGA-21 Concentration

Temperature (°F[°C])	Range (gals/1000 gals)
<125 [<52]	10 – 20
125 to 200 [52 to 93]	20
>200 [>93]	25 - 30

The concentration should be chosen based on computer simulation, well conditions and economics. The input rheology data for computer simulation should be the rheology at the fluid temperature in the fracture at 50 to 75% penetration. Because of cooldown, reduced fluid-loss requirements and more shallow acid penetration, the required acid viscosity in the later stages of a large fracture acidizing treatment is less than the required viscosity in early stages. The SGA-21 concentration can be reduced for the last 25% to 33% of the acid volume.

The residual viscosity after spending is an important factor of fluid design. The effects that residual viscosity will have depend on the viscosity and reservoir pressure. Generally, the SGA-21 concentration should be chosen to provide less than 50 cp (at 170 sec-1) at bottomhole static temperature. Energizing the gelled acid with nitrogen or carbon dioxide will lessen the effects of residual viscosity. The use of pad fluids will also reduce the effects of residual viscosity by diluting the acid.



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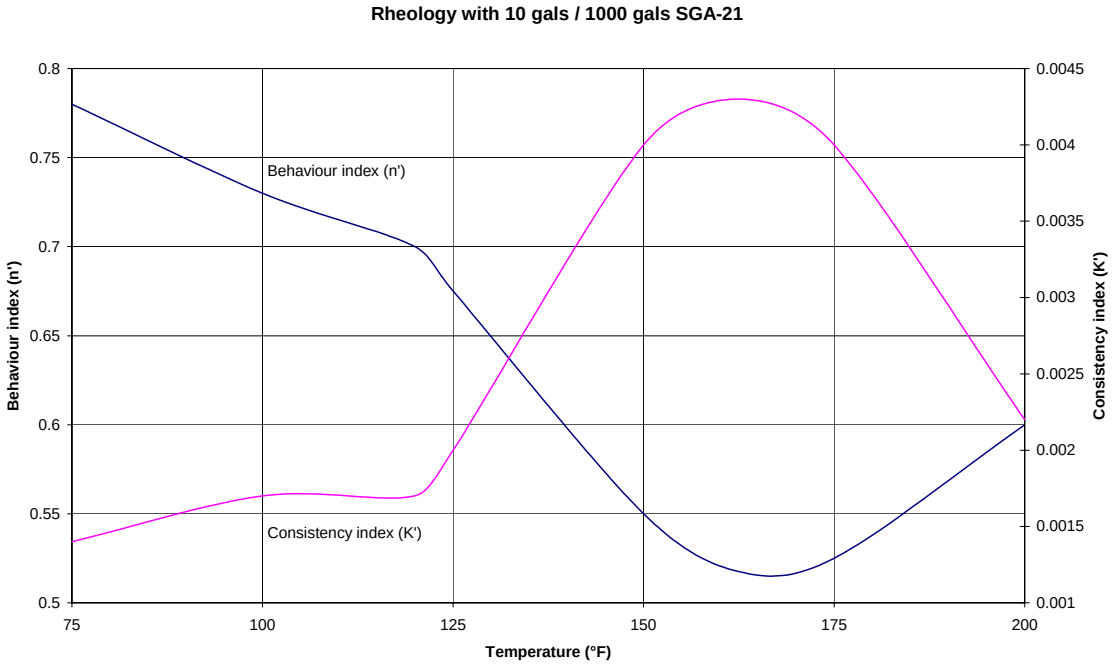
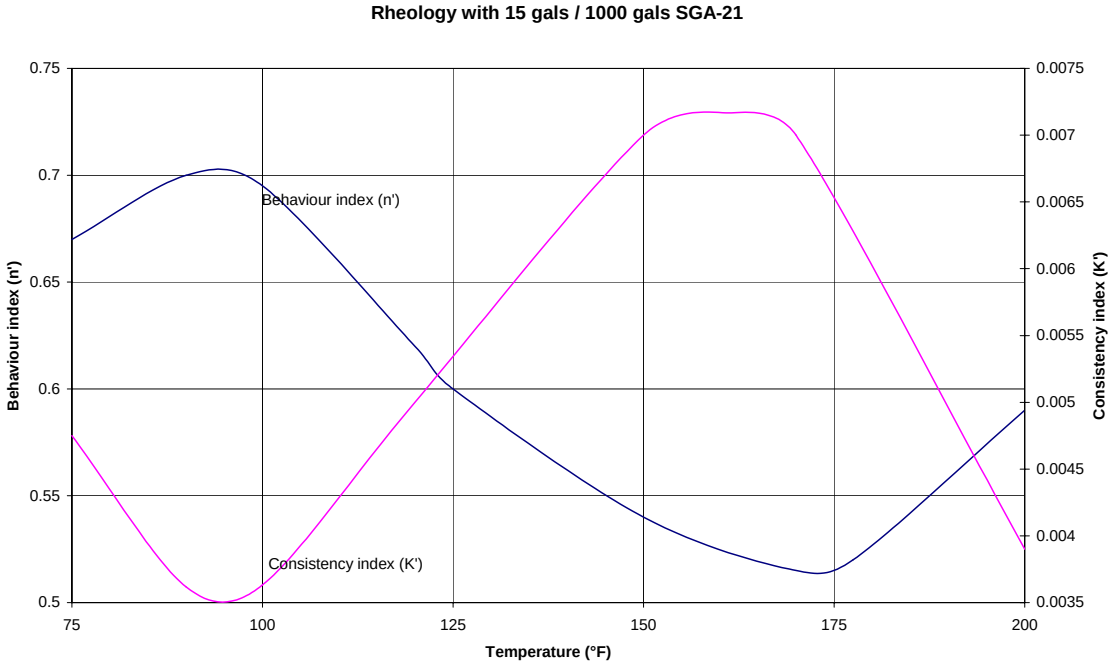
Rheology of SGA-21 in Acid

The rheology of the acid is determined primarily by the concentration of SGA-21. Rheology data is provided below:





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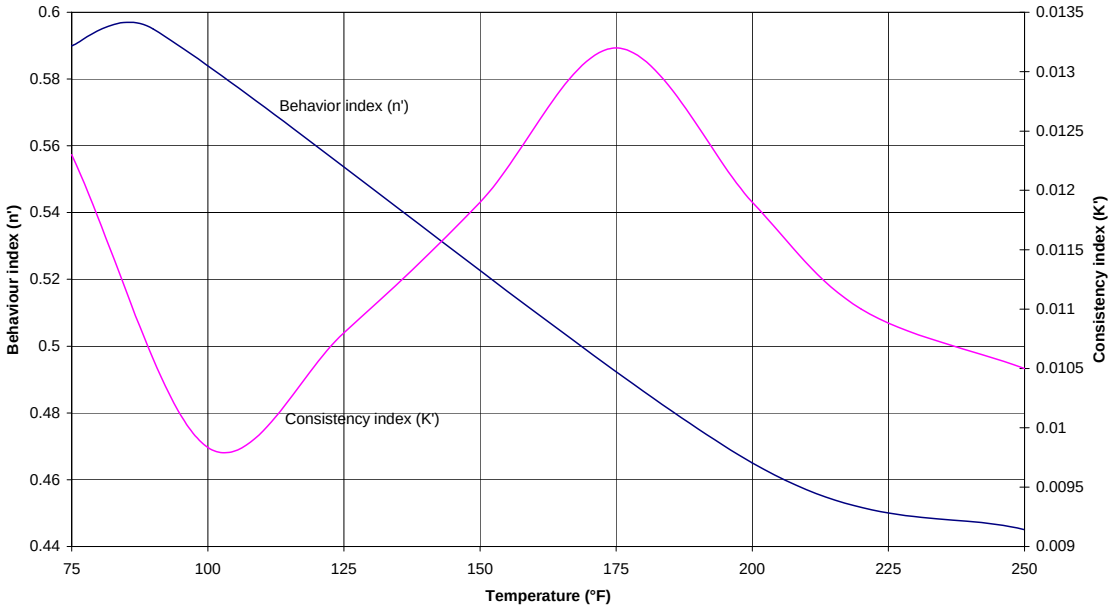
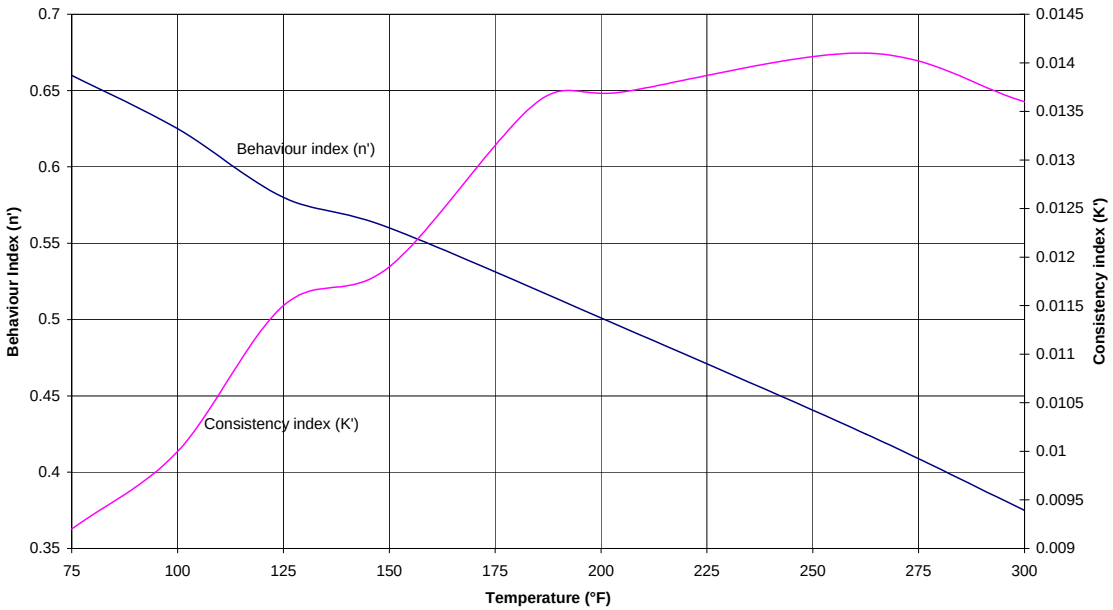
Rheology with 20 gals / 1000 gals SGA-21



Rheology with 25 gals / 1000 gals SGA-21



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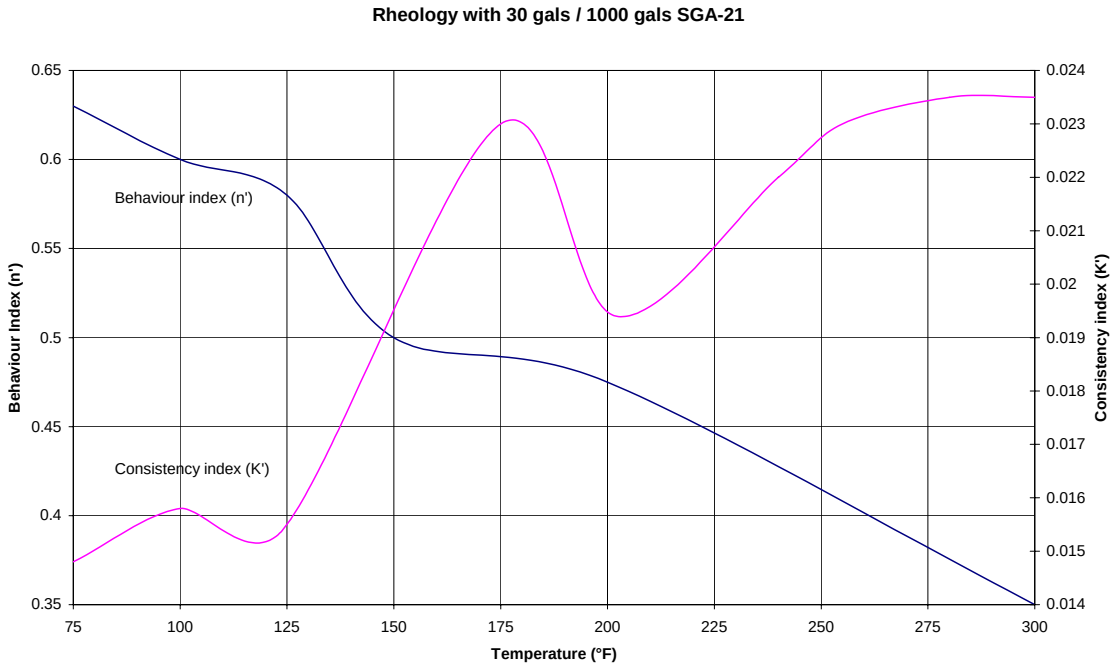

Compatibility With Other Additives

Table 2: compatible additives and allowable concentrations.

Additive	Concentration (gal / 1000 gal
SS-20	2
SS-25	5
SS-28	3

Clay Stabilizer SCS-142 is ***not*** compatible with gelled acid prepared with SGA-21:

The use of additives not provided in the table or use at higher concentrations requires compatibility testing. Tests should include testing for viscosity reduction and residue formation after spending.

Corrosion Inhibition

Acids prepared with SGA-21 are inhibited with Corrosion Inhibitor SAI-05 and Inhibitor Aid SAI-02. Table 3 provides the required concentrations of SAI-05 and SAI-02 for gelled acid containing SGA-21 at 10 gal/1000 gal. Table 4 provides the required concentrations of SAI-05 and SAI-02 for gelled acid containing SGA-21 at 20 gal/1000 gal. Table 5 provides the required concentrations of SAI-05 and SAI-02 for Gelled Acid containing SGA-21 at 30 gal/1000 gal. All fluids contain 10 lb Iron Stabilizer SFS-05/1000 gal.

SAI-05 and SAI-02 at the required concentrations will provide six hours of protection at the specified temperature. Pipe weight loss is less than 0.02 lb/ft2 at temperatures 200°F (93°C) or less. Pipe weight loss is less than 0.05 lb/ft2 at temperatures of 201° to 250°F (94° to 121°C).

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Table 3: Corrosion Inhibitor Loadings (acid with 10 gpt SGA-21)

HCl acid (%)	Temperature (°F[°C])	SAI-05 Concentration (gals/1000 gal)
15	<175 [<79]	1
	176 to 200 [80 to 93]	2
20	<175 [<79]	1
	176 to 200 [80 to 93]	4
28	<150 [<66]	1
	151 to 175 [66 to 79]	3
	176 to 200 [80 to 93]	8

Table 4: Corrosion Inhibitor Loadings (acid with 20 gpt SGA-21)

HCl acid (%)	Temperature (°F[°C])	SAI-05 Concentration (gals/1000 gal)	SAI-02 Concentration (lbs/1000 gal)
15	<175 [<79]	1	--
	176-200 [80-93]	2	--
	201-250 [94-121]	6	10
20	<175 [<79]	1	--
	176-200 [80-93]	4	--
	201-250 [94-121]	10	--
28	<150 [<66]	1	--
	151-175	3	--
	176-200 [80-93]	6	4
	201-250 [94-121]	10	20

Table 5: Corrosion Inhibitor Loadings (acid with 30 gpt SGA-21)

HCl acid (%)	Temperature (°F[°C])	SAI-05 Concentration (gals/1000 gal)	SAI-02 Concentration (lbs/1000 gal)
15	<175 [<79]	1	--
	176-200	4	--
	201-250 [94-121]	8	10
	251-300 [122-149]	10	40
20	<150 [<66]	1	--
	151-175 [66-79]	2	--
	176-200 [80-93]	4	--
	201-250 [94-121]	10	20
	251-300 [122-149]	10	40
28	<150 [<66]	2	--
	151-175 [66-79]	4	--
	176-200 [80-93]	10	--
	201-250 [94-121]	10	20
	251-300 [122-149]	20	60

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Retardation

The acid reaction rate is not retarded by SGA-21.

Iron Control

The presence of ferric iron (Fe^{+++}) in the spent acid may cause precipitation of the polymers in SGA-210. Iron Stabilizer SFS-05 is added at a minimum concentration of 10 lb/1000 gal to prevent precipitation. This minimum concentration is adequate for ferric iron content less than 1500 ppm. If the ferric iron content exceeds 1500 ppm, the SFS-05 concentration should be increased accordingly.

Use in 28% HCl: The SFS-05 will rapidly decompose in 28% HCl at surface temperatures greater than 100°F (38°C). A black color in the acid is evidence of decomposition. If the black color is evident, additional SFS-05 should be mixed in the acid just prior to pumping.

Use in Water Injection Wells: Large amounts of iron scale are sometimes encountered when treating water injection wells. A preflush of ungelled acid containing SFS-05 is recommended to minimize iron contamination of the gelled acid.

Use in Sour Wells: Chelating Agents SFS-03 or SFS-04 should be used to prevent iron (II) sulfide (FeS) precipitation when treating sour wells. These additives are used in conjunction with SFS-05 and cannot be substituted for SFS-05.

Thickening Time: Ferric iron content greater than 200 ppm in the acid will significantly slow the thickening rate. The addition of SS-25 Surfactant at 2 to 5 gal/1000 gal will speed the polymer hydration rate.

FIELD MIXING PROCEDURES

The polymer in SGA-21 may settle to the bottom of the container during storage. Thorough agitation in the container is recommended prior to use.

Batch Mix

The following procedure is a typical batch-mix procedure for these fluids.

1 Mix the dilute acid and additives.

2 Mix the SGA-21 (as close to pump time as practical). Slowly add the SGA-21 while the acid is being agitated. 90% of the maximum viscosity is developed immediately. Continue to agitate until the fluid is completely hydrated (usually 30 to 60 min).

Continuous Mix

The SGA-21 may be continuously mixed if the ferric iron content is less than 200 ppm. Ferric iron content greater than 200 ppm will lengthen the thickening time. The addition of SS-25 at 2 to 5 gal/1000 gal is recommended and will speed the polymer hydration rate.

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PHYSICAL PROPERTIES

Physical Appearance	Off-white liquid
Odour	Slight mineral oil
Boiling Point/Boiling Range (°C)	>100
Flash Point (°C) / Method Used	>100
Specific Gravity	1.1g/cc

PACKAGING

Supplied in 200L drums or 1000L IBCs

ADDITIONAL INFORMATION

None

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