

# OPTiFrac® - Low Guar Borate Crosslinked Fracturing Fluids

## 1. System Description and Benefits

OPTiFrac is one of the most robust and cost-effective water-based fracturing fluid systems in oilfield service industry. It is mainly composed of guar and organo-borate crosslinker. The viscoelastic properties of the OPTiFrac system come from the microstructures created by the hydrogen-bonding of the borate crosslinker to the guar polymer. The table below summarizes the characteristics and benefits of OPTiFrac systems.

Characteristics	Benefits
Robust crosslink chemistry at high pH	Simple, easy field mixing, less operational risks and cost-effective
Fast hydration rate and low polymer loading for less damage	
Not shear sensitive, stable rheological properties for better proppant carrying capacity	Effective stimulation and maximum reservoir production
Superior leak-off control for high fluid efficiency and wide fractures	
Delayed Crosslink for friction reduction and controllable breaking mechanism	
Stable at temperature up to 325°F	Applicable in variety of wells and formations
Low surface tension and interfacial tension	

## 2. OPTiFrac Additives

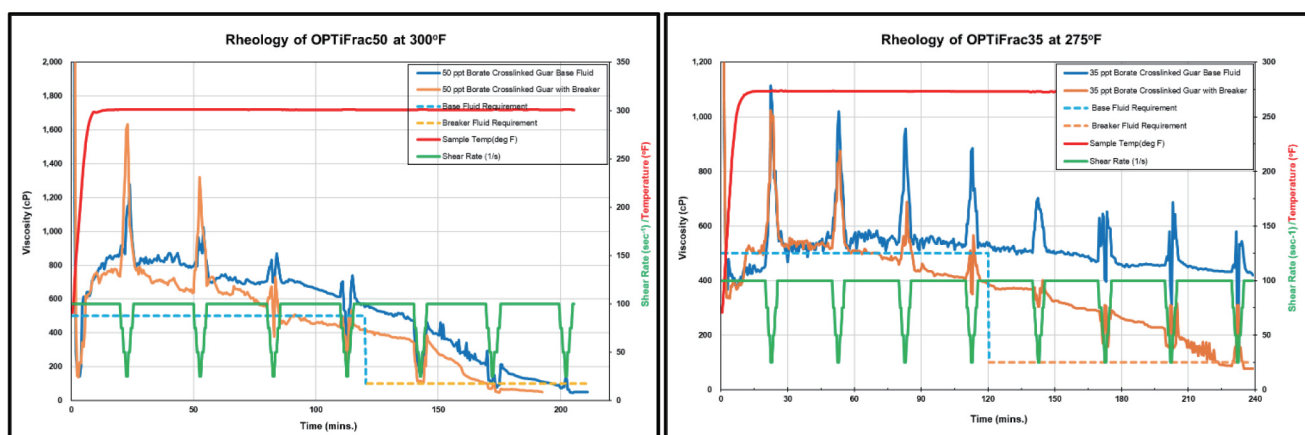
Additive	OPT Code	Color and Form
Guar Gelling Agent	KHF021	White Power
Guar Slurry	KHF021L	Amber Liquid
Clay Stabilizer	KHF002L	Colorless Liquid
Clay Stabilizer	KHF002C	Colorless Liquid
Clay Stabilizer	KHF002	White Crystals
Biocide	KHF003	Colorless to Yellowish Liquid
Biocide	KHF003G	Colorless to Light Yellow Liquid
Stabilizer Aid	KHF004	Colorless to Light Yellow
Stabilizer	KHF005	White Granules
Antifoaming Agent	KHF006	Colorless Liquid
Flowback Additive	KHF007	Light Yellow Liquid
Flowback Additive	KHF007S	Light Yellow Liquid
Borate Crosslinker	KHFX0610, KHFX1030	Light Yellow Liquid
Low Temperature Breaker	KHF011	White Crystals
Medium Temperature Encapsulated Breaker	KHF012	White to Tan Granules
High Temperature Breaker	KHF013	White Granules
High Temperature Encapsulated Breaker	KHF014	Light Yellow Granules

### 3. Typical Properties and Field Applications

OPTiFrac technology was commercialized in 2011 successfully and has been applied in various oil and gas fields in the world. It has been proved to be effective in treatment of tight sandstone and carbonate reservoirs with the following conditions:

Temperature: BHST 70-325°F (21-163°C)  
 Formation: Various sandstone and carbonate formations  
 Mix-water: Fresh water, brines, or seawater

Further information about field applications is described in documented "Case History of OPTiFrac Technology". Typical rheological properties of OPTiFrac fluids are shown in the following Figures.



### 4. Precautions and HSE Considerations

Guar (KHF021 and KHF021L), Delayed borate crosslinker (KHF0610 and KHF01030) and breaker (KHF011, KHF012, KHF013 and KHF014) in OPTiFrac systems play the most important role in fracturing treatment. In addition, clay stabilizer (KHF002, KHF002L and KHF002C), biocide (KHF003 and KHF003G), stabilizer aid (KHF004), stabilizer (KHF005), antifoaming agent (KHF006) and flowback additive (KHF007 and KHF007S) are also used in OPTiFrac systems.

The laboratory procedures, quality assurance program and guidelines for field mixing and handling of OPTiFrac systems are described in OPTiFrac fluid manual.

Refer to the technical sheet and SDS of the respective product for the health, safety and environmental information of each product.

# Clay Stabilizer KHF002

## 1. Introduction

The clay stabilizer KHF002 is used to prepare the salt water for mixing fracturing fluids. The additive can also stabilize the clays in the formation during fracturing and flowback operations.

## 2. Physical Properties and Hazards

Additives	Form	S.G.	Water Solubility	Health Hazard	Physical Hazard	pH
KHF002	White crystals	1.88-2.08	Soluble	Eyes, skin	None	6.0-8.0 (2 wt.%)

## 3. Chemical Properties and Application

KHF002 is an inorganic salt. The cations presented in KHF002 aqueous solution will inhibit swelling and dispersing of reactive clays in most sandstone formations.

KHF002 can be used for wide temperature ranges because of its inorganic nature.

KHF002 is compatible with most additives used in guar-based fracturing fluids.

## 4. Treatment

1-6 wt.% of KHF002 is generally used to prepare the salt water in mixing fracturing fluids.

## 5. Packaging

KHF002 is supplied in plastic-lined bags with net weight of 25 kg/bag. It should be stored in shaded areas with good ventilation.

# Clay Stabilizer KHF002C

## 1. Introduction

Clay stabilizers are routinely added to aqueous-based fracturing fluids to help prevent damage to the formation caused by clay migration and swelling. These clay stabilizers are either a temporary or permanent type, and they are often used in combination.

The clay stabilizer KHF002C is a KCl substitute and can be used with Guar, HPG, CMHPG and Friction Reducer-based frac fluids. KHF002C is a temporary clay stabilizer that helps to prevent clay particles from swelling and plugging of reactive clays in water-sensitive formations during fracturing and flowback operations.

## 2. Physical Properties and Hazards

Additives	Form	S.G.	Water Solubility	Health Hazard	Physical Hazard	pH
KHF002C	Colorless liquid	1.02-1.07	Soluble	Moderate-Eyes	None	6.5-8.0

## 3. Chemical Properties and Application

Temporary Clay Stabilizer KHF002C is an organic liquid clay stabilizer. It is NOT a solution of KCl, but it can be substituted for KCl in most oilfield applications.

KHF002C has been used at temperatures up to 350°F without any adverse effect on fluid rheology.

KHF002C can be batch mixed, or continuously mixed into the fracturing fluid using a liquid-additive system. This eliminates the time-consuming step of batch mixing dry KCl in the base fluid. KHF002C can be used in most aqueous-based fracturing fluids and is compatible with most additives used in the fracturing fluid systems.

KHF002C is highly recommended for systems that are sensitive to high salt concentrations.

## 4. Treatment

The recommended KHF002C concentration is 0.5 to 2 Gal/1,000 Gal (0.5 to 2 L/m<sup>3</sup>). For specific formations such as high reactive clay content, the KHF002C concentration can be further optimized using laboratory core tests.

## 5. Packaging

KHF002C is supplied in 55 gallons high density polyethylene (HDPE) drums or 265 gallons HDPE totes. Keep it away from extreme conditions such as places near flames or direct sunlight.

# Clay Stabilizer KHF002L

## 1. Introduction

Clay stabilizers are routinely added to aqueous-based fracturing fluids to help prevent damage to the formation caused by clay migration and swelling. These clay stabilizers are either a temporary or permanent type, and they are often used in combination.

The clay stabilizer KHF002L is a KCl substitute for KHF002 which can be used to prepare the salt water for mixing fracturing fluid. The additive can also stabilize the reactive clays in the formation temporarily during fracturing and flowback operations.

## 2. Physical Properties and Hazards

Additives	Form	S.G.	Water Solubility	Health Hazard	Physical Hazard	pH
KHF002L	Colorless liquid	1.08-1.13	Soluble	Moderate- Eyes	None	7.0-8.0

## 3. Chemical Properties and Application

Temporary Clay Stabilizer KHF002L is an organic efficient liquid clay stabilizer. It is NOT liquid KCl, but it can be substituted for KCl in most applications.

KHF002L has been used at temperatures up to 350°F without any adverse effect on fluid rheology.

KHF002L can be batch mixed, or continuously mixed into the fracturing fluid using a liquid-additive system. This eliminates the time-consuming step of batch mixing dry KCl in the base fluid. KHF002L can be used in most aqueous-based fracturing fluids and is compatible with most additives used in the fracturing fluid systems.

## 4. Treatment

The recommended KHF002L concentration is 2 Gal/1,000 Gal (2 L/m<sup>3</sup>). For specific formations such as high reactive clay content, the KHF002L concentration can be further optimized using laboratory core tests.

## 5. Packaging

KHF002L is supplied in 55 gallons high density polyethylene (HDPE) drums or 265 gallons HDPE totes. Keep it away from extreme conditions such as places near flames or direct sunlight.

# Biocide KHF003

## 1. Introduction

The mixing water for the preparation of fracture fluid should be free of bacteria and enzymes. Either can cause degradation of the polymer and premature viscosity break. They can also prevent viscosity development. Bacteria produce enzymes to which most guar or guar derivative polymers are particularly sensitive.

## 2. Physical Properties and Hazards

Additives	Form	S.G.	Water Solubility	Health Hazard	Physical Hazard	pH
KHF003	Colorless to yellowish liquid	0.95-1.00	Soluble	Eyes, skin, inhalation	Flammable	7.0-8.0

## 3. Chemical Properties and Application

The biocide KHF003 is added to the mix-water as early as possible before the bacterial problem develops. It can be continuously mixed during the treatment to prevent bacterial growth in the reservoir, but it will be of little or no benefit to the stability of the fracturing fluid if added by continuous mix. This product will kill bacteria but cannot remove enzymes.

When using polymer-free systems (such as SurFrac), biocides or bactericides are NOT required because KHF003 may interfere with rheological properties of SurFrac fluids.

KHF003 is compatible with most additives used in crosslinked guar based fracturing fluids, but certain additives such as scale inhibitors, demulsifiers especially enzyme breakers might not be compatible with KHF003. Laboratory testing is required before using these additives together in fluid systems.

## 4. Treatment

The recommended concentration for KHF003 is 0.25-0.75 Gal/1,000 Gal of mixing water.

## 5. Packaging

This product is supplied in 55 gallons high density polyethylene (HDPE) or steel drums. Keep it away from extreme conditions such as places near flames or direct sunlight.

# Biocide KHF003G

## 1. Introduction

The mixing water for the preparation of fracture fluid should be free of bacteria and enzymes. Either can cause degradation of the polymer and premature viscosity break. They can also prevent viscosity development. Bacteria produce enzymes to which most guar or guar derivative polymers are particularly sensitive.

## 2. Physical Properties and Hazards

Additives	Form	S.G.	Water Solubility	Health Hazard	Physical Hazard	pH
KHF003G	Colorless to light yellow liquid	1.10-1.15	Soluble	Eyes, skin, inhalation	Flammable	3.5-5.0

## 3. Chemical Properties and Application

KHF003G is added to the mix water as early as possible, and preferably put into tanks before the water is added. Before using, the tanks should be thoroughly cleaned. No residual fluids should remain in the tanks. Tanks containing residual fluid provide an ideal environment for bacteria to grow. When the tanks are used again, the bacteria count can be so elevated that the gelling agent will be rapidly degraded.

It can be continuously mixed during the treatment to prevent bacterial growth in the reservoir, but it will be of little or no benefit to the stability of the fracturing fluid if added by continuous mix. This product will kill bacteria but cannot remove enzymes.

KHF003G will not affect the rheology of most crosslinked guar based fracturing fluids, and it is also compatible with most additives used in OPTiFrac and EZFrac. Laboratory testing is required before using these additives together in fluid systems.

## 4. Treatment

The recommended concentration for KHF003G is 0.25-0.75 Gal/1,000 Gal of mixing water.

## 5. Packaging

This product is supplied in 55 gallons high density polyethylene (HDPE) or steel drums. Keep it away from extreme conditions such as places near flames or direct sunlight.

# Stabilizer Aid KHF004

## 1. Introduction

Iron ions present in mix-water or fracturing fluids can affect the fluid properties adversely. A stabilizer must be added whenever the dissolved iron concentration is greater than 10 ppm. KHF004 is one of the effective stabilizers used in guar-based fracturing fluids to prevent the adverse effect of iron on fluid properties.

## 2. Physical Properties and Hazards

Additives	Form	S.G.	Water Solubility	Health Hazard	Physical Hazard	pH
KHF004	Colorless to light yellow liquid	1.12-1.18	Soluble	Eyes, skin	None	9.0-11.0 (1%)

## 3. Chemical Properties and Application

High concentration of dissolved iron in mix-water or fracturing fluids can severely affect fluid viscosity especially at elevated shear and temperature. Stabilizer Aid KHF004 is an organic-based iron stabilizer which can be used to minimize the adverse effect of dissolved iron and to enhance fluid properties at elevated temperature and shearing. If dissolved iron concentration is low (less than 2 ppm) and temperature is less than 220°F, KHF004 is generally NOT required for stabilization. However, KHF004 MUST be used if fluid temperature is greater than 250°F no matter the concentration of dissolved iron.

KHF004 is compatible with most additives used in guar-based fracturing fluids, but it may interfere with some oxidizing breakers if the fluid is not properly designed.

## 4. Treatment

The recommended concentration for KHF004 is 1-3 Gal/1,000 Gal of mixing water.

## 5. Packaging

KHF004 is supplied in 55 gallons high density polyethylene (HDPE) drums. Keep it away from extreme conditions such as places near flames or direct sunlight.

# Stabilizer KHF005

## 1. Introduction

Guar or derivative products tend to degrade at elevated temperature. The rheological properties of guar-based fracturing fluids will deteriorate at high temperature. Stabilizer KHF005 is specifically designed to be used to prevent degradation of fracture fluids at temperatures greater than 250°F (121°C).

## 2. Physical Properties and Hazards

Additives	Form	S.G.	Water Solubility	Health Hazard	Physical Hazard	pH
KHF005	White granules	1.75-1.95	Soluble	Eyes, skin	None	7.5-8.5 (1%)

## 3. Chemical Properties and Application

Fracturing fluids will pick up oxygen either at surface or pumping down hole. The oxygen dissolved in fracturing fluids will degrade polymers presented in fluids and reduce fluid viscosity, especially at elevated temperature. KHF005 acts as an oxygen scavenger and prevent the rapid degradation of gelling agents caused by dissolved oxygen in fracturing fluids and improve fluid rheological properties significantly at high temperature applications (typically when bottom hole static temperature is greater than 250°F).

KHF005 is compatible with additives used in guar-based fracturing fluids, but it has to be added in either linear gel or dissolved in water and pumped through liquid additive line. It cannot be added into crosslinker solution.

## 4. Treatment

5-30 lbs/Mgal KHF005 is generally good enough to stabilize fluid properties at high temperature.

## 5. Packaging

KHF005 is supplied in plastic-lining bags with net weight of 25 kg/sack. It should be stored in shaded areas with good ventilation.

# Antifoaming Agent KHF006

## 1. Introduction

Foams formed while mixing fracturing fluids cause many problems such as lower and wrong density reading, poor wetting and hydration efficiency, and pumping difficulties due to pump cavitation and loss of suction. KHF006 antifoam agent is often required in mixing fracturing fluids to prevent foaming tendency and avoid problems described above.

## 2. Physical Properties and Hazards

Additives	Form	S.G.	Water Solubility	Health Hazard	Physical Hazard	pH
KHF006	Colorless liquid	0.97-1.02	Soluble	Moderate-Eyes	None	7.0-9.0 (10% methanol solution)

## 3. Chemical Properties and Application

KHF006 is an effective antifoam agent in most fracturing fluids that do not have high salt concentrations. It is NOT a foam breaker. Therefore, KHF006 should be always added into mixing water before any foam forms. Higher agitation is required in cold weather for better dispersion.

## 4. Treatment

The recommended concentration for KHF006 is 0.1-0.5 Gal/1,000 Gal of mixing water.

## 5. Packaging

KHF006 is supplied in 5 gallons high density polyethylene (HDPE) pails. Keep it away from extreme conditions such as places near flames or direct sunlight.

# Flowback Additive KHF007

## 1. Introduction

Surface active reagents were generally used in aqueous-based stimulation fluids to lower the interfacial tension that restricts fluid flow in the rock matrix. KHF007 surfactant lowers the capillary pressure by both improving the wettability of the pore throat and reducing the interfacial tension.

Both laboratory testing and field results have shown that KHF007 can provide superior cleanup due to the wetting properties and surface tension reduction that leads to lower capillary pressures. The use of KHF007 results in less swabbing time, faster cleanup and more complete recovery of stimulation fluids.

## 2. Physical Properties and Hazards

Additives	Form	S.G.	Water Solubility	Health Hazard	Physical Hazard	pH
KHF007	Light yellow liquid	1.00-1.05	Soluble	Eyes, skin, inhalation	Fire	N/A

## 3. Chemical Properties and Application

KHF007 promotes fracturing fluid cleanup of the proppant pack and the invaded rock matrix because the contact angles resulting from the use of KHF007 are higher than those for other conventional cleanup surfactants. In addition, the surface and interfacial tension values from the use of KHF007 are also lower than most conventional surfactants used. This leads to significantly lower capillary pressures which reduces the force required to initiate flow of the stimulation fluid and therefore, KHF007 should provide better and quicker fluid recovery following a stimulation treatment.

KHF007 are compatible with all additives used in Guar-based fracturing fluids such as OPTiFrac. Lab testing indicates that KHF007 can be used for temperature applications up to 350°F.

KHF007 can reduce the surface tension to as low as 19 Dynes/cm.

## 4. Treatment

The CMC value for KHF007 is low. However, 1-2 Gal/1,000 Gal is the generally recommended concentration for most fracturing fluids.

## 5. Packaging

KHF007 is supplied in 55 gallons high density polyethylene (HDPE) drums or 265 gallons HDPE totes. Keep it away from extreme conditions such as places near flames or direct sunlight.

# Flowback Additive KHF007S

## 1. Introduction

Surface active reagents were generally used in aqueous-based stimulation fluids to lower the interfacial tension that restricts fluid flow in the rock matrix. KHF007S surfactant lowers the capillary pressure by both improving the wettability of the pore throat and reducing the interfacial tension.

Both laboratory testing and field results have shown that KHF007S can provide superior cleanup due to the wetting properties and surface tension reduction that leads to lower capillary pressures. The use of KHF007S results in less swabbing time, faster cleanup and more complete recovery of stimulation fluids.

## 2. Physical Properties and Hazards

Additives	Form	S.G.	Water Solubility	Health Hazard	Physical Hazard	pH
KHF007S	Light yellow liquid	1.00-1.05	Soluble	Eyes, skin, inhalation	Fire	7.0-9.5

## 3. Chemical Properties and Application

KHF007S promotes fracturing fluid cleanup of the proppant pack and the invaded rock matrix because the contact angles resulting from the use of KHF007S are higher than those for other conventional cleanup surfactants. In addition, the surface and interfacial tension values from the use of KHF007S are also lower than most conventional surfactants used. This leads to significantly lower capillary pressures which reduces the force required to initiate flow of the stimulation fluid and therefore, KHF007S should provide better and quicker fluid recovery following a stimulation treatment.

KHF007S are compatible with all additives used in Guar-based fracturing fluids such as OPTiFrac. Lab testing indicates that KHF007S can be used for temperature applications up to 350°F.

KHF007S can reduce the surface tension to as low as 22 Dynes/cm at 30°C.

## 4. Treatment

The CMC value for KHF007S is low. However, 1-2 Gal/1,000 Gal is the generally recommended concentration for most fracturing fluids.

## 5. Packaging

KHF007S is supplied in 55 gallons high density polyethylene (HDPE) drums or 265 gallons HDPE totes. Keep it away from extreme conditions such as places near flames or direct sunlight.

# Low Temperature Breaker KHF011

## 1. Introduction

Proppant-pack permeability can be severely damaged by gelling agents such as guar or its derivatives. The amount of damage increases as polymer concentration increases. Breakers are generally used to reduce the viscosity of the fracturing fluids by degrading the polymer that is concentrated in the proppant pack. KHF011 is an oxidizer breaker used in most guar or guar derivative based fracturing fluids.

## 2. Physical Properties and Hazards

Additives	Form	S.G.	Water Solubility	Health Hazard	Physical Hazard	pH
KHF011	White crystals	1.89-2.09	Soluble	Eyes, skin	Oxidizer	3.0-7.0 (5%)

## 3. Chemical Properties and Application

The reactivity of KHF011 is strongly dependent on temperature. Thermal decomposition of KHF011 produces highly reactive radicals that can attack the guar-based polymer backbone.

By itself, KHF011 is effective in the temperature range of 125 to 225°F. KHF011 can be used at fluid temperatures less than 125°F when breaker aid is used together. Encapsulated breaker KHF012 should be used at high temperature greater than 225°F.

KHF011 is not compatible with reducing chemicals and stronger oxidizers. Care should be taken to avoid the use of reducing additives and stronger breakers together with KHF011.

## 4. Treatment

Breaker KHF011 is an oxidative breaker. It can be used in both linear gel and crosslinked fluids. Breaker KHF011 can be batch mixed, continuously mixed or used as a dry material.

Typical concentration of 0.01-2.0 lbs/Mgal is recommended to cover most fracturing operations.

## 5. Packaging

KHF011 is supplied in 55 lbs plastic-lining bags generally in buckets with net weight of 25 kg/package. Keep it away from extreme conditions such as places wet and humid or direct sunlight.

# Medium Temperature Encapsulated Breaker KHF012

## 1. Introduction

Proppant-pack permeability can be severely damaged by gelling agents such as guar or its derivatives. The amount of damage increases as polymer concentration increases. Breakers are used to reduce the viscosity of the fracturing fluid by degrading the polymer that is concentrated in the proppant pack. KHF012 is the encapsulated version of KHF011, which is used for breaking polymers in fracturing fluids.

## 2. Physical Properties and Hazards

Additives	Form	S.G.	Water Solubility	Health Hazard	Physical Hazard	pH
KHF012	White to tan granules	1.76-1.96	N/A	Eyes, skin	Oxidizer	N/A

## 3. Chemical Properties and Application

KHF012 is a particulate material with specific size produced by coating (encapsulating) KHF011 with a water-resistant barrier. Encapsulation of the breaker greatly reduces fracturing fluid exposure to the breaker and enables the use of high concentrations of breaker that, without coating, would rapidly reduce the fluid viscosity. KHF012 cannot leak off and be lost to the formation, KHF012 remains in the fracture where it is needed to degrade concentrated polymers. After fracturing treatment, release of the breaker occurs as the reservoir temperature increases and the fracture closes.

The effective working temperature for KHF012 is in the range of 125-275°F.

KHF012 can be used in most guar and derivative based fracturing fluid systems such as OPTiFrac and UniFrac. It is compatible with most additives used in these systems except for reducers or stronger oxidizers.

## 4. Treatment

Breaker KHF012 is an oxidative breaker. It can be used in both linear gel and crosslink fluids. KHF012 can be used with proppant sizes 16/30 mesh and smaller. As much as 5 times of KHF011 loading (up to 10 lbs/Mgal) can be added into fracturing fluids by using encapsulation technique such as in KHF012.

## 5. Packaging

KHF012 is supplied in 55 lbs plastic-lining bags generally in buckets with net weight of 25 kg/package. Keep it away from extreme conditions such as places wet and humid or direct sunlight.

# High Temperature Breaker KHF013

## 1. Introduction

Proppant-pack permeability can be severely damaged by gelling agents such as guar or its derivatives. The amount of damage increases as polymer concentration increases. Breakers are generally used to reduce the viscosity of the fracturing fluids by degrading the polymer that is concentrated in the proppant pack. KHF013 is an oxidizer designed for breaking guar or guar derivative based fracturing fluids at high temperature applications.

## 2. Physical Properties and Hazards

Additives	Form	S.G.	Water Solubility	Health Hazard	Physical Hazard	pH
KHF013	White granules	3.27-3.47	Soluble	Eyes, Skin	Oxidizer	7.0-8.0 (1%)

## 3. Chemical Properties and Application

The reactivity of KHF013 is strongly dependent on temperature. Thermal decomposition of KHF013 produces highly reactive radicals that attack the guar-based polymer backbone.

KHF013 is effective in the temperature range of 200 to 300°F. KHF011 can be used at fluid temperatures less than 200°F. KHF014 (encapsulated KHF013) should be used at high temperatures greater than 300°F.

KHF013 is a strong oxidizer which is reactive with most chemicals such as acids, salts, and all reducing agents. Toxic or corrosive gases may release from the above reactions. Care should be taken seriously to avoid the use of reducing agents, acids, salts and other oxidizers together with KHF013.

## 4. Treatment

KHF013 concentration depends on factors such as polymer concentration, temperature, break time requirement, and polymer type. Typical concentration of 0.01-2.0 lbs/Mgal is recommended to cover most fracturing operations. Laboratory testing may be required for optimized breaker schedule design.

## 5. Packaging

KHF013 is supplied in 55 lbs plastic-lining bags generally in buckets with net weight of 25 kg/package. Keep it away from extreme conditions such as places wet and humid or direct sunlight.

# High Temperature Encapsulated Breaker KHF014

## 1. Introduction

Proppant-pack permeability can be severely damaged by gelling agents such as guar or its derivatives. The amount of damage increases as polymer concentration increases. Breakers are used to reduce the viscosity of the fracturing fluid by degrading the polymer that is concentrated in the proppant pack. KHF014 is the encapsulated version of KHF013, which is used for breaking polymers in fracturing fluids at high temperatures.

## 2. Physical Properties and Hazards

Additives	Form	S.G.	Water Solubility	Health Hazard	Physical Hazard	pH
KHF014	Light yellow granules	1.92-2.12	N/A	Eyes, Skin	Oxidizer	N/A

## 3. Chemical Properties and Application

KHF014 is a particulate material with specific size produced by coating (encapsulating) KHF013 with a water-resistant barrier. Encapsulation of the breaker greatly reduces fracturing fluid exposure to the breaker and enables the use of high concentrations of breaker that, without coating, would rapidly reduce the fluid viscosity. KHF014 cannot leak off and be lost to the formation, KHF014 remains in the fracture where it is needed to degrade concentrated polymers. After the fracturing treatment, release of the breaker occurs as reservoir temperature increase and the fracture closes.

The effective working temperature for KHF014 is in the range of 200-350°F.

KHF014 can be used in most guar and derivative based fracturing fluid systems such as OPTiFrac and EZFrac. It is compatible with most additives used in these systems except for reducers, acids, salts, and other oxidizers, which require extra care to confirm using them together.

## 4. Treatment

As much as 5 times of KHF013 loading (up to 10 lbs/Mgal) can be added into fracturing fluids by using encapsulation technique such as in KHF014.

## 5. Packaging

KHF014 is supplied in 55 lbs plastic-lining bags generally in buckets with net weight of 25 kg/package. Keep it away from extreme conditions such as places wet and humid or direct sunlight.

# Guar Gelling Agent KHF021

## 1. Introduction

Gelling Agent KHF021 is a high-yielding dry guar product for continuous or batch mixing of fracturing fluids. Its hydration rate is faster compared to conventional guar and is easier to disperse and hydrate in water.

## 2. Physical Properties and Hazards

Additives	Form	S.G.	Water Solubility	Health Hazard	Physical Hazard	pH
KHF021	White powder	1.35-1.55	Soluble	Eyes, nose, throat	Fire, dust, water slick	6.5-7.0 (0.6%)

## 3. Chemical Properties and Application

Slurry based (diesel or other oils) guar products are typically hazardous to environment. KHF021 is a specially treated dry powder of guar that delivers faster hydration rate and higher yielding values after hydration. This higher yield guar generally provides much better crosslinking properties (viscosity) than conventional guar products, allowing much lower gel loading and leads to better fracture conductivity.

Together with crosslinker, activator, and the delaying agent, the gelling agent KHF021 provides wide range of delay time and rheological property at temperature and shear. The delay time can vary from 0~6 minutes and the fluid are stable up to 150°C.

The high temperature stabilizer KHF005 can be used to prevent degradation of fracturing fluids at temperatures greater than 200°F (93°C).

## 4. Treatment

The 20-40 lbs/1,000 gal gel loading is generally required to get enough viscosity to initiate the fracture and transport the proppant into the fracture. The gel loading is dependent on the formation bottom hole temperature. Typically, higher the temperature, higher is the gel loading required to achieve the required viscosity.

## 5. Packaging

KHF021 is supplied in plastic-lining bags with net weight of 25 kg/sack or 900 kg/jumbo bag. It should be stored in shaded areas with good ventilation. Keep it away from high temperature, humidity and direct sunlight.

# Guar Slurry KHF021L

## 1. Introduction

Gelling Agent KHF021L is a high-yielding guar slurry for continuous or batch mixing of fracturing fluids. Its hydration rate is faster compared to guar powder, and is easier to meter, disperse and hydrate in water.

## 2. Physical Properties and Hazards

Additives	Form	S.G.	Water Solubility	Health Hazard	Physical Hazard	pH
KHF021L	Amber liquid	1.06-1.11	Soluble	Eyes, nose, throat	Fire, water slick	N/A

## 3. Chemical Properties and Application

For fracturing applications, specially-treated free-flowing dry guar powder is liked by the operating companies due to the absence of diesel and similar oils. However, its metering and use at the well site are difficult. When mixed with water, these dry guar powder can form fish eyes, and thus many times cannot achieve the desired maximum viscosity on hydration. For this reason, guar powder is slurry in diesel or mineral oils, and provides much better crosslinking properties (viscosity) allowing much lower gel loading and leads to better fracture conductivity.

In addition to proppant carrying in hydraulic fracturing, this slurry can also be used as a pad for both hydraulic and acid fracturing. Together with crosslinker, activator, and the delaying agent, the gelling agent KHF021L provides wide range of delay time and rheological property at temperature and shear. The delay time can vary from 0~3 minutes and the fluid are stable up to 350°F.

The high temperature stabilizer and stabilizer aids can be used to prevent degradation of fracturing fluids at temperatures greater than 200°F (93°C).

## 4. Treatment

Guar Slurry equivalent to 20-40 lbs/1,000 gal guar gel loading is generally required to get enough viscosity to initiate the fracture and transport the proppant in to the fracture. The gel loading is dependent on the formation bottom hole temperature, pumping time, and cool down. Typically, higher the temperature, higher is the gel loading required to achieve the required viscosity.

## 5. Packaging

KHF021L is supplied in 265 gallons high density polyethylene (HDPE) totes. It should be stored in shaded areas with good ventilation. Keep it away from high temperature, fire, humidity and direct sunlight.

# Borate Crosslinker KHFX0610

## 1. Introduction

Crosslinker are generally introduced to polymer-based fracturing to improve the rheological properties of fracturing fluids.

KHFX0610 is a borate crosslinker used in guar based fracturing fluids such as OPTiFrac. Borate-crosslinked guar-based fracturing fluids reach optimum properties when the pH is in the range of 10.5-12.0. Crosslinker KHFX0610 itself contains a pH buffer and delaying agent to optimize crosslinking and improve fluid viscosity and stability.

## 2. Physical Properties and Hazards

Additives	Form	S.G.	Water Solubility	Health Hazard	Physical Hazard	pH
KHFX0610	Light yellow liquid	1.15-1.20	Soluble	Eyes, skin, Inhalation	Corrosive	12.0-14.0 (1%)

## 3. Chemical Properties and Application

KHFX0610 is a borate crosslinker used in guar-based fracturing fluids. It provides the required pH value to crosslink guar or derivatives hydrated in salt or mix-water. Therefore, it is used in most guar or guar derivative-based fracturing fluids to improve fluid rheological properties and temperature stability. The pH value is controlled within the range of 10.5-12.0 under most application conditions.

KHFX0610 molecules contain special groups that delay the crosslink reaction between borate and guar or guar derivative molecules. Depending on the chemical environment such as mix-water, reactant concentrations such as KHFX021, and temperature, crosslink delay time can be controlled in the range of 1-6 minutes.

The optimum KHFX0610 concentration should be designed based on the required crosslink delay time and fluid properties, depending on other additives and their concentrations.

KHFX0610 is compatible with all additives used in OPTiFrac fracturing fluid systems, which are engineered for use up to 325°F.

## 4. Treatment

The concentration of KHFX0610 dependent on the polymer concentration, temperature, mix-water salinity and desired crosslink delay time. Typically, 5-10 Gal/1,000 Gal KHFX0610 are required to cover most applications.

## 5. Packaging

KHFX0610 is supplied in 55 gallons high density polyethylene (HDPE) drums or 265 gallons HDPE totes. Keep it away from extreme conditions such as places near flames or direct sunlight.

# Borate Crosslinker KHFX1030

## 1. Introduction

Crosslinker are generally introduced to polymer-based fracturing to improve the rheological properties of fracturing fluids.

KHFX1030 is a borate crosslinker used in guar based fracturing fluids such as OPTiFrac. Borate-crosslinked guar-based fracturing fluids reach optimum properties when the pH is in the range of 10.5-12.0. Crosslinker KHFX1030 itself contains a pH buffer and delaying agent to optimize crosslinking and improve fluid viscosity and stability.

## 2. Physical Properties and Hazards

Additives	Form	S.G.	Water Solubility	Health Hazard	Physical Hazard	pH
KHFX1030	Light yellow liquid	1.31-1.36	Soluble	Eyes, skin, Inhalation	Corrosive	12.0-14.0 (1%)

## 3. Chemical Properties and Application

KHFX1030 is a borate crosslinker used in guar-based fracturing fluids. It provides the required pH value to crosslink guar or derivatives hydrated in salt or mix-water. Therefore, it is used in most guar or guar derivative-based fracturing fluids to improve fluid rheological properties and temperature stability. The pH value is controlled within the range of 10.5-12.0 under most application conditions.

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The concentration of KHFX1030 dependent on the polymer concentration, temperature, mix-water salinity and desired crosslink delay time. Typically, 5-10 Gal/1,000 Gal KHFX1030 are required to cover most applications.

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