

Choline Product for Clay Stabilization

Clay Stabilization

Clays pose challenges as they are well known for swelling in the presence of water. Within their crystalline layers, clays contain cations, typically sodium, which occupy 'base exchange positions or sites.' Upon contact with water, these cations are solubilized resulting in clay instability and often swelling. When clay swells, the ability of the clay-containing land to permit the passage of liquids, drilling or fracturing fluids as well as hydrocarbons, is diminished, impeding production. In particular, in the North Sea and US gulf argillaceous sediment (Gumbo Shale) is common and is notorious for swelling.

Clay stabilizers reduce clay swelling. They function through ion exchange, where the clay stabilizer provides a cation to replace the native, solubilized clay cation such as sodium. Potassium chloride (KCl) is commonly used to reduce clay swelling, where the potassium ion is effective at preventing swelling. It presents certain challenges. Potassium chloride is often used at high levels (2–4%) and requires handling at the site of use to prepare a solution. In addition, potassium chloride can be incompatible with other materials, negatively impacting other aspects of fracturing fluids such as gelation.

Choline chloride (75%) and choline bicarbonate (75%) offer an attractive alternative. They serve as an effective temporary clay stabilizer / KCl substitute for the smectite, illite and mixed layer clay minerals, those commonly found in formations. The advantages choline salts offer over KCl include:

- **Superior performance and use at much lower levels** (0.3–1% vs 2% for KCl, depending upon the mineralogy of the formation). This is particularly useful for offshore uses, reducing the amount of clay stabilizer to be shipped.
- **Compatibility with brine, calcium chloride, KCl solutions as well as all known fracturing fluids, cross-linkers and breakers** (Note: with acids, choline bicarbonate is neutralized generating carbon dioxide. All lines previously used for acids should be flushed with water prior to use).
- **Minimal chemical handling.** Choline chloride and choline bicarbonate are non-toxic, low viscosity liquids, readily available to be used directly at the site of use. This ready-to-use availability eliminates time for pre-mixing and any saltwater disposal costs.
- **Flexibility.** Choline chloride and choline bicarbonate are high active, clay stabilizer liquids with an activity of 75%. This highly soluble material can be used in all environments and does not suffer from crystallization issues when used in a brine solution in cold climates (KCl has a limiting 24% activity and can crystallize in cold climates).
- **Environmentally friendly.** Use of choline chloride can reduce the amount of chloride present by up to 75% vs. KCl. Choline bicarbonate is chloride-free. Both are environmentally positive (biodegradable and do not pose a negative impact on organisms). Not more than (NMT) 3% KCl can be in the Gulf owing to a negative impact on shrimp.

Table 1. Filtration Time Tests / Capillary Suction Time

Additive	Amount per 100ml	Filtration Time (seconds)
No additive	—	10512
KCl	0.76	205
Choline Chloride	1.4	35
Choline Bicarbonate	1.85	44

Table 1. Test method: Aqueous solutions of the above additives were prepared and 5g of A.P.I. bentonite was subsequently added and then thoroughly mixed for five minutes in a blender. Using a Capillary Suction Time (CST) instrument, the time required for the solution to radially travel a fixed distance along Whatman No.17 chromatography filter paper was determined.

For the same number of cations (0.1M), the clay stabilizers choline chloride and choline bicarbonate had less swelling impact on bentonite as evidenced by shorter filtration times.

Table 2: Clay Stabilizer Summary

	KCl	Choline Bicarbonate	Choline Chloride
Activity	Powder	75% liquid	75% liquid
Typical use levels	2 – 4%	0.3 – 1%	0.3 – 1%
Chloride Content	—	0% (chloride-free)	Up to 75% reduction relative to KCl
Use	Require on-site solubilization	Ready to use	Ready to use
Compatibility	Incompatible with some fracture fluids. Premature crystallization.	Compatible with all known water based fracture fluids, cross-linkers and breakers (except acids).	Compatible with all known water based fracture fluids, cross-linkers and breakers.

Specifications

Specific gravity = 1.1

pH = 7 – 9 (Choline Chloride), 9 – 11.5 (Choline Bicarbonate)

CAS # 65-48-1; CAS # 78-73-9

Activity = 75 – 78%.

Shipping and Handling

500 lbs. in a 55 gallon polyethylene drum

2500 lbs. in a 275 gallon IBC

