

Acidizing Fluid Additives and Total Fluids Packages

ChampionX additives are vital components for acidizing operations in every part of the world, supporting the primary goal of improving well productivity. The four main applications of acids in oil and gas well stimulations are acid fracturing, matrix acidizing, fracturing spearhead and remedial acidizing. In general, acid is used to increase the surface area of the flow paths to the production wellbore by dissolving portions of an acid-soluble formation or to remove acid-soluble formation face damage.

Commonly, hydrochloric acid or a combination of hydrochloric and hydrofluoric acids are used. Organic acids such as formic and acetic are typically used when a slower reaction with the formation is desired. For example, in very high temperature formations, in which the reaction of mineral acids with the formation may be too rapid to produce desirable results, organic acids may be used effectively.

Additives for acidizing fluids have been developed to control acid corrosion, to prevent acid-induced emulsion and sludge, to retard the reaction rate of acids and to improve the performance of the acidizing fluid. An acidizing fluid is a complex mixture of chemicals that may include components listed below. Any product must be checked for compatibility with the other additives in the acidizing fluid system.

ChampionX offers total fluid packages specifically to improve efficiency by shifting from line item additives. The fluid packages that are offered are: our Single Phase Retarded Acid system, Emulsified Acid System, and our Straight Acid package.

The following is a catalogue of acidizing additives and fluid packages by application. Please consult your ChampionX sales engineer for current updates to this catalogue.

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Acid Corrosion Inhibitors

Acid corrosion inhibitors are used to control the corrosion of tubulars that are caused due to usage of concentrated acids. Corrosion inhibitors developed for HCl and mud acid are different from inhibitors developed for organic acids, both in chemistry and in mode of action. In general, both types of inhibitors work by forming a hydrophobic film on the surface of metals.

The dosage of any acid corrosion inhibitor depends on eight factors: 1) the expected length of time that a metal is exposed to acid; 2) the type of acid and the strength; 3) the temperature; 4) the type of additives present in the fluid and their dosages; 5) the pressure; 6) the presence of H₂S; 7) the metal to be protected; and 8) any limitations imposed upon the makeup of the fluid.

Surface active additives in the acidizing fluid have been shown to have a potentially significant effect on the dosage of inhibitor or intensifier required to achieve good protection against corrosion. For example, the use of non-emulsifiers or foaming agents have been shown to require the dosage of intensifier to be doubled for N80. The use of mutual solvents and antisludge agents have been shown to increase the dosage of intensifier by 400 to 600 percent. Whenever possible, the dosage of acid corrosion inhibitor should be determined by corrosion testing in the lab using all the components of the acidizing fluid.

Product code	Form	Description
AIM1015	liquid	Inhibits HCl and mud acid corrosion Low to medium temperature conditions Economical option
AIM1025	liquid	Inhibits HCl and mud acid corrosion For low to high temperature conditions
AIM1026	liquid	Inhibits HCl and mud acid corrosion For low to high temperature conditions Also inhibits organic acid corrosion
AIM1017	liquid	High temperature acid corrosion inhibitor Used primarily in well stimulation projects. Can be batch mixed or added on the fly
AIM1023	liquid	Mid temperature acid corrosion inhibitor Can be batch mixed or added on the fly Highly dispersible in acid
AOR1152	liquid	Inhibits organic acid corrosion For low to high temperature conditions
X-CORR HT	liquid	Inhibits HCl up to 300F in 15% HCl. Applicable to other HCl concentrations

Acid Corrosion Inhibitor Intensifiers

Intensifiers are additives used to aid in acid corrosion protection when HCl or mud acid is used. Intensifiers are normally not needed when organic acids are used. Intensifiers are used to improve the cost-effectiveness of corrosion control in four situations: 1) at temperatures above 250°F (121°C); 2) when other additives are used in the fluid; 3) when needed for specific applications such as pitting or hard-to-inhibit metals; and 4) when testing indicates that adding more acid corrosion inhibitor will not be as cost effective as adding an intensifier.

Product code	Form	Description
ASP811 (Formic Acid)	liquid	Aids in HCl and mud acid corrosion inhibition For temperatures greater than 250°F (121°C)
AIN1186	solid	Aids in HCl and mud acid corrosion inhibition For temperatures greater than 250°F (121°C)

Acid Non-Emulsifiers

The use of concentrated acids can contribute to the formation of water-in-oil emulsions in many types of hydrocarbon liquids. Emulsions created in the producing formation can increase hydrocarbon viscosity and decrease or block the flow of hydrocarbons to the producing well. Acid non-emulsifiers are used in acidizing fluids to prevent the formation of such emulsions. Non-emulsifiers are specially designed surfactants that prevent the formation of water-in-oil emulsions by reducing the surface tension at the interface of water and oil. Non-emulsifiers are formulated to leave the producing formation water wet, to allow the free flow of hydrocarbon fluids to the wellbore. In the lab or in the field, API RP-42 tests can be conducted to select the best non-emulsifier for a particular hydrocarbon emulsion.

Product code	Form	Description
ASP301	liquid	Broad spectrum non-emulsifier Environmentally responsible
ANE1251	liquid	Broad spectrum non-emulsifier Winterized – been rebranded

Antisludge Agents and Iron Control

In formations producing asphaltenic crude oil, the use of mineral acid in stimulation work can cause the precipitation of thick deposits, commonly called sludge. An acid-induced sludge can significantly reduce production. Removal of sludge from the formation is difficult and expensive. In addition to acid, the presence of ferric iron (Fe³⁺) in the fluid has been shown to be a factor in sludge formation. A good sludge prevention program includes not only additives to keep asphaltenes dispersed in the crude oil but also additives that eliminate or control ferric iron. Reducing agents keep ferric iron reduced to ferrous iron. They reduce sludge problems, and prevent the formation of ferric hydroxide, which can precipitate from spent acid at a pH of 2. Chelating, or sequestering, agents form soluble complexes with iron and help keep it in solution. Surfactant systems have been developed to handle severe sludge applications, including those formed in the presence of 28% HCl.

Product code	Form	Description
ASA1303	liquid	Inhibits acid sludge formation
AIC100D	solid	Dry citric acid
		Iron control
AIC100L	liquid	Citric acid solution Iron control
AIC1450	liquid	EDTA iron control
AIC1452	liquid	Iron chelating agent

Acid Viscosity Modifiers and Retarders

The viscosity of acid and rate of reaction with the formation can be modified to produce a more effective acid stimulation. Additives can be used to increase the viscosity of acid, to create a foam in acid, to emulsify acid in a hydrocarbon and to chemically retard the rate at which acid reacts with the formation.

All these methods will provide some reduction in the reaction rate of the acid because of physical interference with the movement of acid to the formation surface.

Product code	Form	Description
AFR1418	liquid	Acid gellant - builds viscosity in acid
ACR1702	liquid	Acid retarder Slows the contact of acid with the formation
AIE1772	liquid	Acid emulsion stabilizer
AIE1770	liquid	Acid oil phase emulsifier

Hydrogen Sulfide Scavengers

H₂S can be present in the well because of bacterial activity or created by the reaction of mineral acid with iron sulfide deposits. The presence of small amounts of H₂S can result in needing to increase the dosage of acid corrosion inhibitor required. Greater amounts of H₂S can be removed with a flush containing a hydrogen sulfide scavenger.

Product code	Form	Description
AHS1500	liquid	Removes H ₂ S to improve acid corrosion inhibition. Reduces personnel exposure to H ₂ S.
AHS1501	liquid	Removes H ₂ S to improve acid corrosion inhibition.

Total Fluids Packages

Single-Aqueous Phase Retarded Acid System

HCl acid stimulation of carbonate production requires the retardation of the HCl-carbonate rock reaction to achieve the optimum balance between total fluid used and the enhancement of well production. ChampionX has developed 2 Single- Aqueous-Phase Retarded Acid fluid systems for this purpose: FALCON 1 and FALCON II. These integrated fluid packages enhance operational efficiency as they can be mixed on-the-fly. They are also designed to have relatively low dosage of retarder.

FALCON I

This system will

1. Slow down the reaction of HCl and limestone formation so that HCl will go to deeper formations for better a stimulation job.
2. Provide corrosion protection in 15% HCl up to 260°F.
3. Provide corrosion protection in 20% HCl up to 240°F (tested for 8 hours).
4. Provide H₂S scavenging in acidic conditions.
5. Provide ease of mixing and stable dispersion of all ingredients.

Product code	Description
X-CORR HT	Acid corrosion inhibitor
ASP811 (Formic Acid)	Acid corrosion inhibition intensifier
ACR1702	Acid retarder
AHS1500	H ₂ S scavenger
ANE1251	Non-emulsifier
AIC1453	Iron reducing agent
AIC1452	Iron chelating agent

Note: The exact formulation and concentrations of the fluid package depends on customer needs and criteria.

FALCON II

This system will:

1. Slow down the reaction of HCl and limestone formation at bottom hole temperature.
2. Provide corrosion protection at 280°F in 28% HCl with C95 and N80 coupons (tested for 6 hours).
3. Have good thermal stability at 300°F 28% HCl (tested for 3 hours).
4. Provide H₂S scavenging in acidic condition.

Product	Function
28% HCl*	Acid
AIM1029	Acid corrosion inhibitor
ASP811(Formic Acid)	Corrosion inhibition intensifier
ANE1251	Non-emulsifier
AIC1453	Iron control – reducing agent
AIC1452	Iron control – chelating agent
AHS1502	H ₂ S scavenger
ACR1702	Acid retardation reagent
AXX1977	Surfactant

*ChampionX will not supply the acid.

Note: The exact formulation and concentrations of the fluid package depends on customer needs and criteria.

Emulsified Acid Package

Emulsified Acid Systems are used in fracturing and acidizing operations to improve well productivity by removing formation damage and creating deeper and narrower wormholes. It is used to control fluid loss and achieve deep acid penetration during the stimulation of high temperature carbonate reservoirs.

This emulsified acid package will:

1. Provide emulsion stability at 300°F (tested for 3 hours).
2. Provide H₂S scavenging in acidic condition.
3. Provide iron control.
4. Provide corrosion protection.

Product	Function
31% HCl*	Acid
AIC1453	Iron reducing agent
AIC1452	Iron chelating agent
AIM1024	Acid corrosion inhibitor
AIN1186	Corrosion inhibition intensifier
ASP811 (Formic Acid)	Corrosion inhibition intensifier
AHS1502	H ₂ S scavenger
Diesel*	External phase solvent
AIE1770	Emulsifier
AIE1772	Emulsion stabilizer

*ChampionX will not supply the acid and diesel.

Note: The exact formulation and concentrations of the fluid package depends on customer needs and criteria.

Straight acid package

This system:

1. Will provide corrosion protection for L80 and C95 in 28% HCl at 275°F under pressure of 3000psig (tested for 4 hours).
2. Will provide surface tension less than 30 mN/m in CaCl₂ brine.
3. Has iron control for 3000 ppm of Fe³⁺.
4. Stable in 300°F (tested for 3 hours).

Product	Function
AIM1030	Corrosion Inhibitor
ASP811 (Formic Acid)	Corrosion inhibition intensifier
AXX1977	Surfactant
AHS1500	H ₂ S scavenger
ANE1251	Non-emulsifier
AIC1452	Iron chelator
AIC1453	Iron Reducer

Note: The exact formulation and concentrations of the fluid package depends on customer needs and criteria.