MUD DISSOLVING ACID
(HCl/HF) MDA

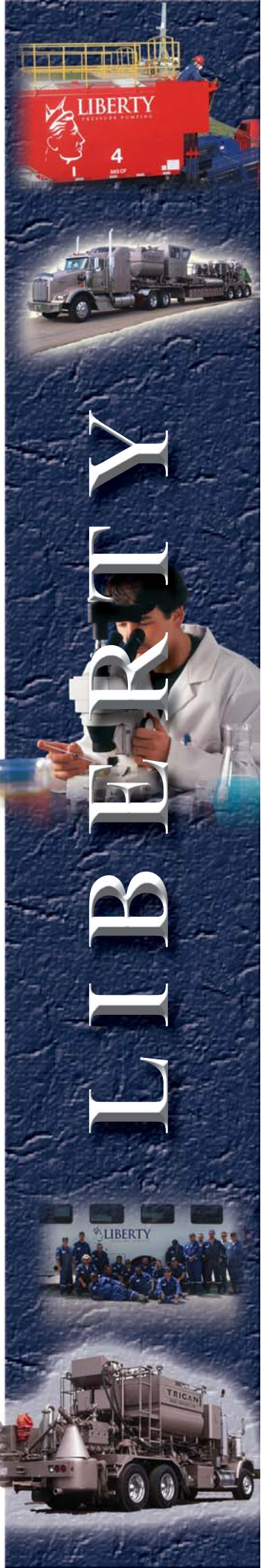
Applications:

Mud Dissolving Acid is a blend of surfactants, inhibitors, iron control agents in hydrochloric acid and hydrofluoric acid. The mixture is used to stimulate sandstone formations by dissolving gel chem type drilling muds (bentonite), clay damage in the near well bore area and is capable of dissolving silicate materials such as cement, feldspars and shales.

Ammonium bifluoride is added to hydrochloric acid to generate hydrofluoric (HF) acid. To generate the following commonly used HCl/HF mixtures Ammonium bifluoride is added at the suggested loadings:

HCl/HF ACID MIXTURE	STARTING HCl STRENGTH	AMMONIUM BIFLUORIDE (lbs/1000 gal)
6% HCl / 1.5% HF	7.5% HCl	208.5
12% HCl / 3% HF	15% HCl	417
14% HCl / 6% HF	20% HCl	834
25% HCl / 3% HF	28% HCl	417

Typically Mud Dissolving Acid mixtures are capable of dissolving small amounts of clays and fines. They also dislodge larger amounts of clays and fines by partially dissolving the agglomeration. The remaining material must be flushed out of the well bore with the spent acid. To disperse and suspend the solids a mutual solvent is incorporated into the acid blend. Liberty MS-1 is added at loadings from 2% to 10% by volume of acid, replacing mix water as to not dilute the overall acid strength. Liberty S-1 is a strong water wetting agent and also helps to disperse and suspend undissolved solids for removal when flowing back spent acid.



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REACTION OF HF WITH SILICA AND SILICATES

Silica		Hydrofluoric Acid		Water		Fluosilicic Acid
SiO_2	+	6HF	→	$2H_2O$	+	H_2SiF_6

For best results when stimulating with Mud Dissolving Acid the following guidelines should be used to limit some of the negative side reactions that can happen when using MDA. See the disadvantages section for the side reactions.

MATRIX STIMULATION

1. Stimulate the formation with no less than 12.6 bbls of MDA per 3.3 feet of perforations. Small volumes serve only to dislodge the fines with no stimulation.

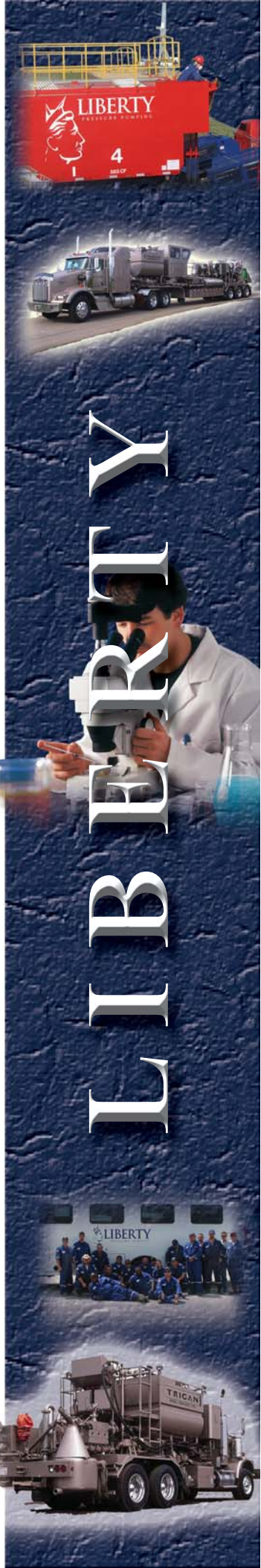
2. A preflush of HCL of 6.3 bbls per 3.3 feet of perforations should be pumped ahead of the MDA to dissolve any calcareous material (ie. scales, limestone, dolomite, calcium silicate cement, or lime based mud), and displace formation brines.

3. The displacement fluid should not be formation water. Crude oil, fresh water with 3% ammonium chloride solution, fresh water with clay stabilizing agent, compressed air or nitrogen can be used.

4. Spent acid should be recovered from the formation or displaced from the near well bore area within one to two hours. This will allow the dissolved silica to stay in solution and the suspended materials to be flushed out of the newly restored permeability.

Advantages:

- Mud Dissolving Acid will dissolve silicate materials that hydrochloric acid alone will not dissolve (i.e. clays, shales, feldspars and cements).
- Removal of filter cake from gel-chem (bentonite) type muds.



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Limitations:

1. The first limitation of hydrofluoric acid is that calcium salts precipitate the HF as a relatively insoluble material, calcium fluoride. Calcium salts result from the reaction of HCl or HF on calcareous materials (i.e. Scales, limestone, dolomite, calcium silicate cement, or lime based mud). The reaction is as follows:

Calcium Salt				Calcium Fluoride (insoluble)		
$CaCl_2$	+	2HF	→	CaF_2	+	2HCl

The calcium fluoride formed not only destroys the silica dissolving power of the HF, but also, the CaF_2 formed represents a pore plugging material. CaF_2 has a slight solubility in HCl so that a small amount of calcium (as in cement reactions) can be tolerated. For these reasons MDA acid should always be preceded by a HCl preflush and should never be used on formations with greater than 20% calcareous material except in perforation washes where thick mud filter cakes are present.

2. The second characteristic of HF is a more serious consideration in the use of MDA. When HF spends on silica, the fluosilicic acid formed is soluble in the acid solution. If the fluosilicic acid is mixed with potassium, sodium, magnesium, or calcium the corresponding fluosilicate salt will precipitate. This material is insoluble and has a gelatinous texture which tends to irreversibly plug permeable flow channels.

Fluosilicic Acid		Salt		Insoluble fluosilicate	
H_2SiF_6	+	2KCl	→	K_2SiF_6	+ 2HCl
H_2SiF_6	+	2NaCl	→	Na_2SiF_6	+ 2HCl
H_2SiF_6	+	$2CaCL_2$	→	$CaSiF_6$	+ 2HCl

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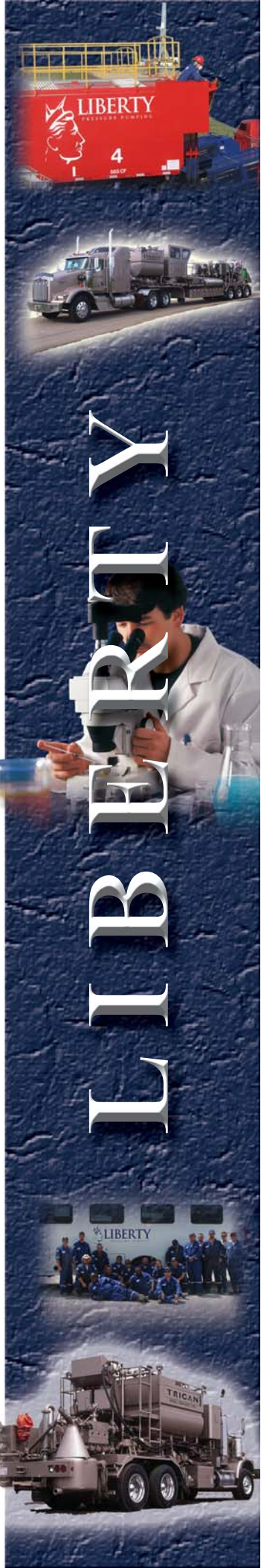

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Again the importance of the HCl acid preflush to displace the formation brine and avoid intermixing of spent acid with salt water. In the case of a water injection well the need for a compatible spacer such as weak HCl or ammonium chloride solution made with fresh water is important.

3. The third characteristic of HF acids involves the effect of dilution on spent HF. If diluted spent HF is allowed to remain in the pore spaces, gelatinous silica can be reprecipitated according to the equation:

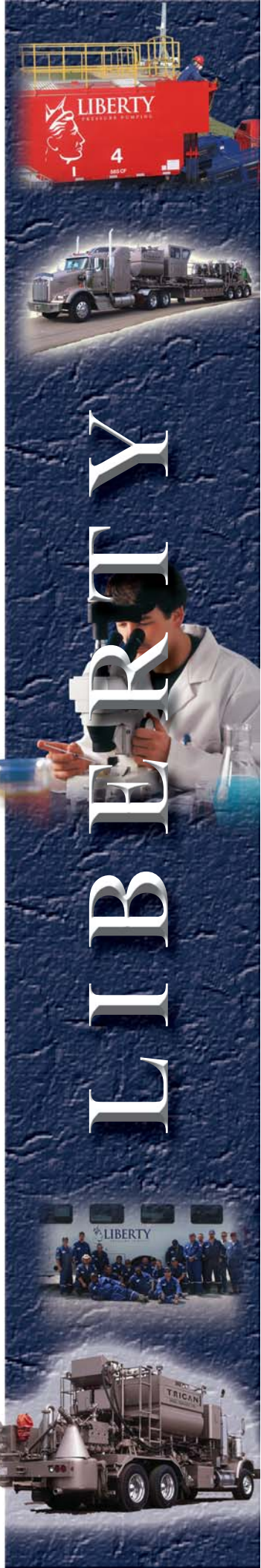
   $H_2SiF_6 + 2H_2O \rightarrow 6H+ +F- + SiO_2$

   In reduced acid strength or dilution

   This is another reason for HCl spacers and rapid flowback of stimulation fluids.

4. The fourth disadvantage of HF blends is that they generate a significant amount of insoluble fines. It is therefore important to pump enough volume to improve permeability and to allow the fines to flow out of the zone.

Handling Precautions: Acidic liquid may cause serious burns to flesh and eyes if not flushed immediately. User should wear protective gloves, clothing, safety goggles, and face shield when handling. See Material Safety Data Sheet. If irritation persists take material safety data sheet and consult nearest physician. If the fluoride ion is not flushed away immediately it can migrate towards the bone causing painful burns.



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