COMPLETE GROUP

TECHNICAL BULLETIN

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# TUBULAR CORROSION – BRINE DRILLING FLUIDS

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## Background

Complete Group has observed a potential trend within the industry regarding increased frequency of downhole corrosion in brine-based fluid systems. Regarding drilling tubulars in particular, our observations indicate increased pitting being experienced by contractors, operators, rental companies, and service companies alike, generally irrespective of material or product selection. This bulletin attempts to shed light on some (but not all) factors that could be considered when deploying tubulars in brines.

## Disclaimer

The content herein is provided in good-faith for informational and awareness purposes only based on industry observation. Complete Group *does not* recommend, sell, consult on, or otherwise advise on downhole fluid systems of any kind, but remains committed to preserving and enhancing the performance of drill string tubulars deployed by our customers. Drilling tubulars are constructed to industry-standard materials and processes therefore the corrosion characteristics of brine-based fluid systems are typically not addressable at the product level. Instead, corrosion control needs to be tackled at the operational level thus to maximize the life of your drill string **it is strongly advised that a fluid system specialist be actively engaged in deploying any brine-based fluid systems.**

## Brines

For the purposes of this notice, the term "brine" is being used in the most general sense to describe a fluid with a high concentration of salt-based additives in solution. Despite this simplification, within the descriptor of "brines" there exists a multitude of combinations of families, types, and compatibilities. It is critical that the hazards/benefits of various fluids and additives be discussed in detail with a qualified drilling fluid specialist to determine appropriate fluid chemistries and compatibility for a given well and/or equipment. There is a wide range of benefits and consequences for drilling performance, formation effect, and corrosion concerns when considering halide vs formate brines, monovalent vs divalent, concentrations, buffers, and so forth.

## Corrosion Factors

Within the scope of this notice there are too many factors to consider in each specific corrosion concern, however there are a number of considerations which increase corrosion concerns in a broad sense, and can be particularly amplified in brines.

High Temperature High Pressure (HPHT) conditions in general accelerate corrosion of almost all types. These conditions often create an ideal environment for corrosion and tend to increase the likelihood of undesirable corrosive gasses to be present.



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The presence of gasses including (but not limited to) oxygen ($O_2$), carbon dioxide ($CO_2$), and hydrogen sulfide ($H_2S$) alone or in combination may uniquely react with brines and substrate materials in various ways and can produce incredibly corrosive effects in a short period of time. Depending on the fluid system, various buffers, inhibitors, and scavengers may or may not be effective in controlling corrosion rates. $O_2$ is of particular note, being very difficult to mitigate due to the inevitable aeration of drilling fluids at surface.

pH can be a doubly important factor of concern for both brine related corrosion as well as $H_2S$-related sulfide stress cracking (SSC). Depending on the brine type, alkaline (pH 9-11) and acidic (pH 2-6) environments are both plausible realities.

*Drill Pipe Tube Pitting*

### Corrosion Dangers

Speaking to drilling tubulars in particular, generalized corrosion (ie: rust) appears to be more visually evident than ever in brine-based fluid systems. However, the more dangerous forms of corrosion further this generalized corrosion in two localized forms: **pitting** and **stress corrosion cracking** (SCC).

Pitting typically develops in micro- or macro-scopic defects on the surface of the steel. The chemistry of the mechanism can vary, but practically speaking the result is narrow and potentially deep pockets of weakened and/or removed material. These "pits" generally promote further acidification of the local fluid solution, causing self-acceleration of corrosion rates. Left unchecked, pitting can result in excessively thin walls leading to premature failure due to perforation or compromised strength. **Preventing aggressive slip cuts and tong marks** on thin walls (ie: drill pipe tube bodies) is imperative in brines as these local asperities give rise to pitting action almost immediately.

*Pitting Washout*







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*Pitted Hardband*

*Stress Corrosion Cracking*

Stress corrosion cracking is among the most catastrophic failure mechanisms encountered in drilling. Specific brine chemistries, combined with the presence of corrosive gasses, and *tensile stress states* can invite the propagation of potentially rapid and catastrophic cracking through a steel body, even well below typical yield or ultimate material strengths. This is particularly of concern in drilling as most drilling tubulars are either perpetually in tension, or are subjected to fully reversed tension/compression cycles; both of these stress states are ideal for the creation and/or propagation of SCC.

It is outside the scope of this bulletin, but also worth noting that Corrosion Resistant Alloys (CRA's) such as various stainless steels or nickel/cobalt based superalloys (among others) **are not immune to the corrosion mechanisms discussed herein**. The environment that the combination of brine-based fluids and corrosive gasses creates can rapidly destroy far more exotic materials than common drilling tubulars.




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