Chemical Compatibility Considerations

Production chemicals that are used in the process system offshore vary in configuration, carrier solvents, type, viscosity and performance. These can be based on a range of inorganic, organic, simple, complex and polymeric chemicals. As such, they have different fluid characteristics and respond differently to pressure and temperature. The compatibility of these chemicals, both with each other and with the production system as a whole, is a critical consideration when selecting fit for purpose products to support production operations.

It is generally most cost effective and efficient to resolve any issues related to chemical, material, performance and process compatibility as early as possible, with this typically occurring prior to or during detailed design.

There are three main compatibility issues that need to be addressed in the early stages of every project. These compatibility issues are:

- Fluid and Chemical Compatibility
    - Chemical—Chemical Compatibility
    - Chemical—Fluid Compatibility
- Material Compatibility
    - Metallic Material Compatibility
    - Non Metallic Compatibility
- Performance Compatibility

Chemical Compatibility

Chemical compatibility testing is important from the standpoint of selecting chemicals that are compatible with the production, fracturing, completion, storage and hydrotest fluids that they may encounter, as well as other production chemicals that they may contact in direct or dilute form. Chemical incompatibility can result in the formation of solids, gels and deposits that can plug injection lines and valves or reduce product effectiveness.

Some key lessons learned through multiple offshore projects have been that:

- Some chemicals, depending on the main ingredient and carrier solvents (such as certain scale inhibitors) are incompatible with spacer fluids, as a result one or more buffer solutions are required when flushing umbilicals and injection lines e.g. EGMBE, HAN.
- Installation of a subsea methanol injection location close to a scale/corrosion cocktail inhibitor can lead to scaling and eventual plugging of the line. Hence, determining the appropriate chemical injection location is extremely important.
- A common area of incompatibility is between kinetic hydrate inhibitors and corrosion inhibitors. This can significantly restrict the choice of appropriate products in some applications.
- THPS (Tetrakis Hydroxymethyl Phosphonium Sulfate) and glutaraldehyde biocides can interact with oxygen scavengers and render them inactive.
- Selecting the right chemical mix ratio plays an important role in compatibility testing and chemical selection. Generally 50:50 and 90:10 mixes are preferred.
- Chemical vendors need to strictly follow the functional requirements of each of the specified chemicals and provide detailed results for screening and selecting chemicals using different laboratory tests.

is published for the benefit of our friends and clients. If you have any questions about this article please contact us at
281-398-5781
info@gatellc.com

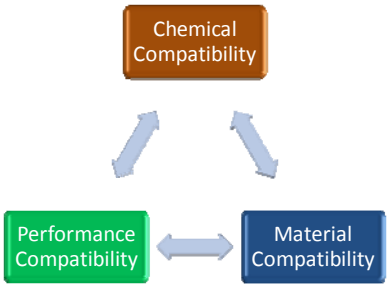

Figure 1:
Compatibility Issues Summary

	MeoH	LDHI	Asphaltene Inhibitor	Paraffin Inhibitor	Corrosion Inhibitor	Scale Inhibitor
MeoH	Yes	Yes	No	No	No	No
LDHI	Yes	Yes	No	No	Yes	No
Asphaltene Inhibitor	No	No	Yes	Yes	No	No
Paraffin Inhibitor	No	No	Yes	Yes	No	No
Corrosion Inhibitor	No	Yes	No	No	Yes	No
Scale Inhibitor	No	No	No	No	No	Yes

Table 1:
Chemical—Chemical Compatibility Example

	Viton A	PTFE	HDPE	HNBR	Chemraz	PEEK
LDHI	No	Yes	Yes	No	Yes	Yes
Asphaltene Inhibitor	Yes	Yes	Yes	No	Yes	Yes
Paraffin Inhibitor	No	No	Yes	Yes	No	No
Corrosion Inhibitor	No	Yes	No	No	Yes	No
Scale Inhibitor	Yes	Yes	Yes	No	No	Yes

Table 2:
Chemical - Material (Elastomers) Compatibility Example

Upstream engineering for offshore oil and gas specializing in:

- Chemical Systems Engineering
- Materials & Corrosion
- Flow Assurance
- Waterflood
- Commissioning & Startup

Material Compatibility

Chemical-material compatibility testing is important to determine if the production chemicals are compatible with the materials of construction of the chemical storage, chemical delivery and production systems. This includes both metallic and non–metallic materials. Chemicals such as those with low pH can increase corrosion risks, whereas others can promote vapor phase corrosion or elastomer degradation. Hence, choosing a chemical solely based on its performance in the process system is not a feasible option.

Some key lessons learned with respect to materials compatibility issues are:

- Along with metallic material compatibility tests, detailed tests involving elastomers are necessary. The selection of the right type of test to replicate the field conditions is crucial. Although unrestrained testing in concentrated product is generally suitable, this may be overly conservative for actual components depending on their exposure conditions and whether they are providing primary, secondary, static or dynamic sealing. This can require the undertaking of detailed risk assessments for subsea production systems, where elastomer performance and selection can be critical.
- Proper testing procedures should be followed during testing. If only immersed testing is undertaken then issues such as the potential for vapor phase corrosion of 316L stainless steel storage tanks by DBNPA (dibromonitrilpropionamide) biocides can be overlooked.
- LDHI (low dosage hydrate inhibitor) is often incompatible with HNBR and Viton.
- Corrosion Inhibitor is usually incompatible with Viton at temperatures exceeding 140°F. Also, corrosion inhibitors that contain amines are usually incompatible with certain Viton grades.
- Methanol, paraffin inhibitors and demulsifiers can permeate some polymers and elastomers.
- It is necessary to keep a record of all the materials used for a given production system from the detailed design phase of the project onwards. Any change in the material of construction of the system should be noted and testing of chemicals for material compatibility should be performed.

Performance Compatibility

Performance compatibility issues need to be addressed through chemical testing. There can be many variations of performance compatibility, where one of the most widely studied is the relationships between various kinetic hydrate inhibitors and corrosion inhibitors. Although it is not feasible to test every combination of product prior to field production, it is strongly recommended that chemical vendors are consulted regarding potential incompatibilities between their products and that testing is undertaken to identify the implications of this.

Incompatibility Mitigation

Undertaking a structured chemical qualification program significantly reduces the risk that incompatibility issues will impact subsequent production operations. Some additional best practices include:

- Establishing field start-up procedures that consider chemical-chemical incompatibilities, particularly for high-risk systems such as subsea umbilicals and downhole injection lines.
- Avoid using the same dosing line for dissimilar chemicals. Samples of any deposits or other unusual materials should be recovered and analyzed.
- Change-out of chemicals during the field life should include chemical, material and performance compatibility testing prior to change-out as part of a specified management of change process. Many problems occur when products are switched without addressing potential compatibility issues.