

Chemical Compatibility Testing of Injected Fluids with Umbilical Liners

The Challenge

Umbilical lines of synthetic polymer material are used extensively in the offshore oil and gas industry to pump production control and treatment chemicals from the platform to the subsea wellhead. Before commissioning a particular umbilical and chemical combination, it is essential to carry out tests for compatibility by subjecting hose samples to elevated pressure and temperatures, while exposing them to the chemical fluids to be carried in service. These tests can run for several weeks or months, during which time the integrity of the umbilical hose liner is monitored at regular intervals. Key properties of the hose material samples are measured periodically throughout the tests to determine whether any deterioration has occurred as a result of chemical attack or physical degradation.



Analytical Approach

The combination of three instrumental techniques provides a powerful analytical tool to undertake this type of work:

- Fourier Transform Infrared (FTIR) Spectroscopy is used to determine if the umbilical liner has been chemically attacked by the test fluid (e.g. leaching of the polymer material plasticizer).
- Gas Chromatography (GC) is used to quantify the leached plasticizer in the test chemical
- Scanning Electron Microscopy (SEM) is used to ascertain the physical condition of the liner e.g. the presence of surface micro-cracks.

FTIR Analysis

Infrared spectra of the control and aged chemical fluids are recorded using a Fourier Transform Infrared (FTIR) spectrometer fitted with a diamond attenuated total reflectance

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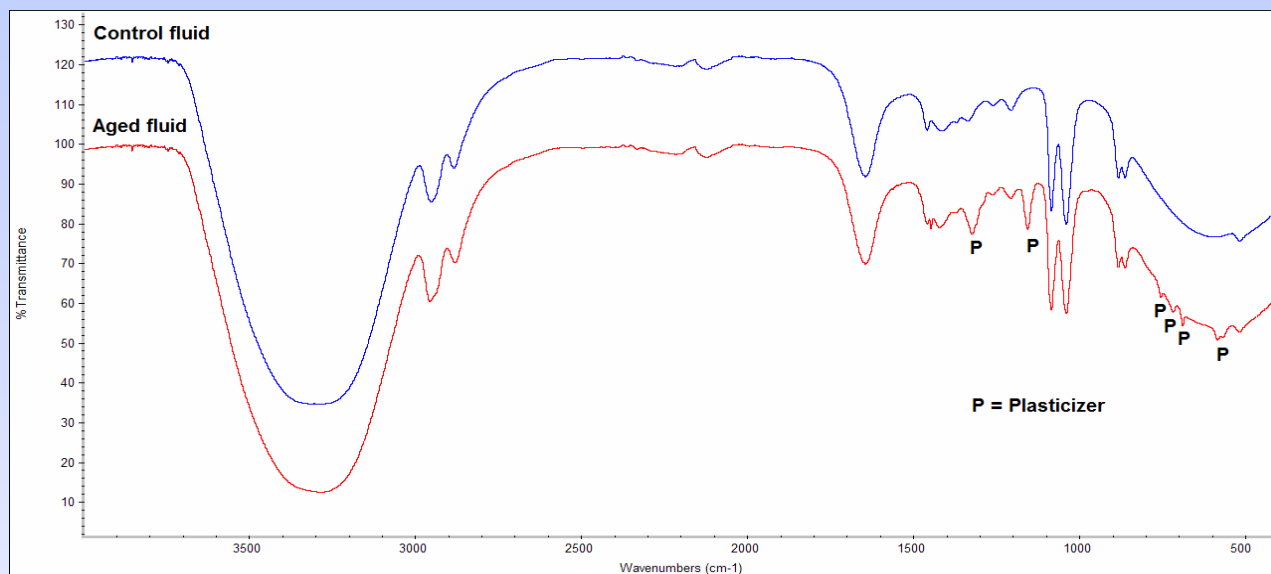
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(DATR) accessory. Comparison of the two IR spectra allows the qualitative detection of any additional contaminants (plasticizer) in the aged fluid which have been leached from the umbilical liner, with as little as 1% w/v of a contaminant being detectable.

Figure showing comparison of IR spectra

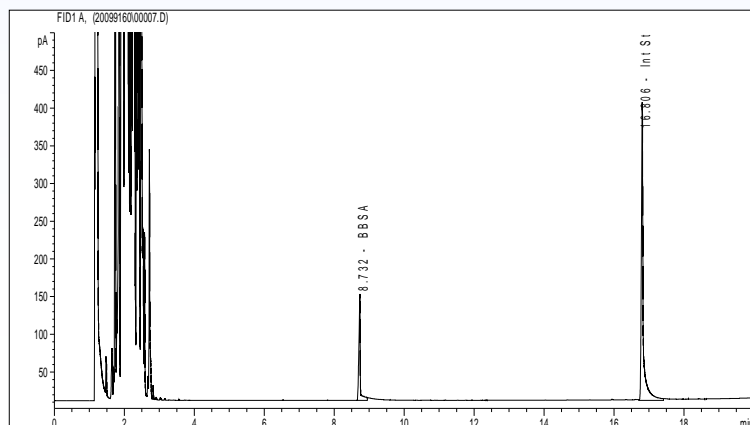


Additional absorption of aged fluid is attributed to leached plasticizer which is then quantified using GC-MS

Gas Chromatography

Butylbenzene sulphonamide (BBSA) plasticizer is analysed by gas chromatography with flame ionisation detection (GC-FID) following sample extraction/dilution in dichloromethane/methanol solvent. The BBSA is quantified with reference to an added internal standard.

Figure showing BBSA plasticizer peak and internal standard peak.

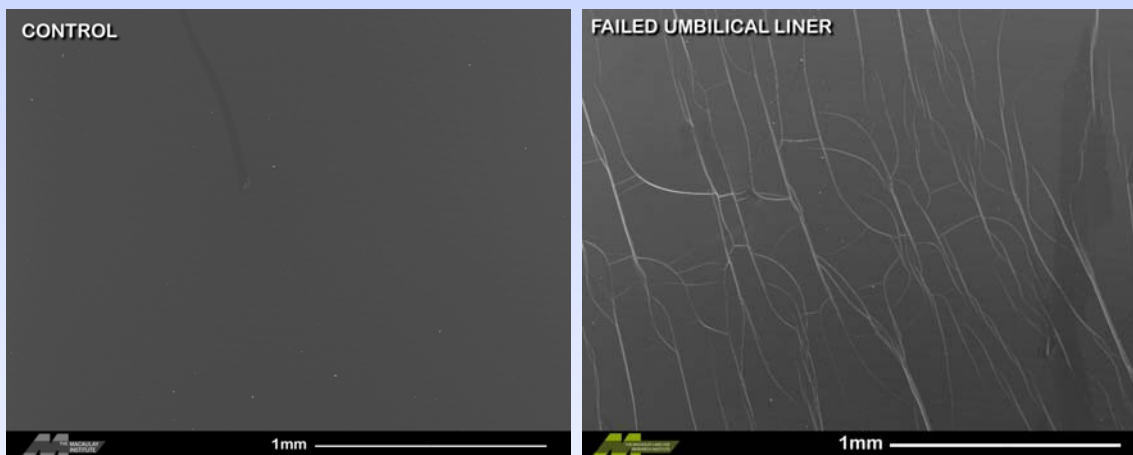


This allows the client to gauge if the concentration of leached plasticizer is within acceptable limits such that the umbilical/chemical fluid combination can be used in service or, if above acceptable limits, allows the selection of an appropriate alternative chemical fluid at the outset, thereby avoiding costly in-service failure (during injection /production operations).

SEM Imaging

Following the failure of an umbilical liner during testing, SEM images are produced to compare the inner surface of the failed liner with an untested (control) specimen. Both the control and the failed liners are sampled using a surgical blade, first cutting along the longitudinal axis of the umbilical, then transversely to try and minimize stress to the material whilst cutting. The resultant high magnification SEM images can provide evidence of any physical/chemical degradation of the umbilical liner.

Comparison of SEM Micrographs of Control and Failed Umbilical Liners



The SEM image of the failed umbilical liner displays micro cracks in its inner surface forming a 'crazy paving'-like pattern, confirming that it has suffered damage during the duration of the test.

The Cost-Saving Outcome

A combination of three analytical techniques, FTIR, GC and SEM, provides a powerful and effective three-pronged approach for testing the compatibility of umbilical liners and chemical fluids in relation to the potential for chemical and physical degradation of the liners during prolonged injection.

The chemical and physical analysis of liners and production chemicals following controlled aging tests provides crucial and definitive information for the client in advance of chemical deployment to determine material compatibility and avoid potentially costly umbilical liner failure during service.

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