

### Infrared Spectroscopy as a means of identifying Naphthenates which can form undesirable flow line and separator deposits

#### The Challenge

We were approached by an oil company client with a request to provide an appropriate analytical technique capable of detecting naphthenates in oil pipe deposits. Under certain conditions, the naphthenic acids present in acidic crude oil will precipitate with  $\text{Ca}^{2+}$ -ions that are present in produced water and form calcium naphthenate and, to a lesser extent, other metal naphthenates. This precipitation accumulates predominantly in oil/water separators and de-salters, but



naphthenates can also deposit in pipelines. When the crude oil is being processed offshore the pressure decreases which leads to degassing of carbon dioxide from the formation water and hence an increase in pH. When the pH of the water increases, the concentration of dissociated acid also increases which favours the formation of calcium naphthenate. These deposits can cause separator fouling and flow-assurance problems which can be extremely costly for the oil company since oil production may be shut down hence early identification of naphthenates is essential to allow appropriate remedial treatment to be commenced.

#### Analytical Approach

To deal with the client's request we have developed a relatively rapid analytical procedure involving the use of FTIR for the identification of naphthenic acid salts. Since the sludge-like deposits are invariably mixtures of solids and hydrocarbons, organic solvent extraction is required to remove the hydrocarbons and concentrate any naphthenic acid salts. Infrared spectra of the solids are then recorded using a Fourier Transform Infrared (FTIR) spectrometer fitted with a diamond attenuated total reflectance (DATR) accessory which involves minimal sample handling and requires only milligram quantities of samples. The IR spectrum represents a qualitative chemical fingerprint of the solids which can be interpreted by means of functional group analysis and use of search software to compare the spectrum of the unknown sample with a library of in-house reference IR spectra.



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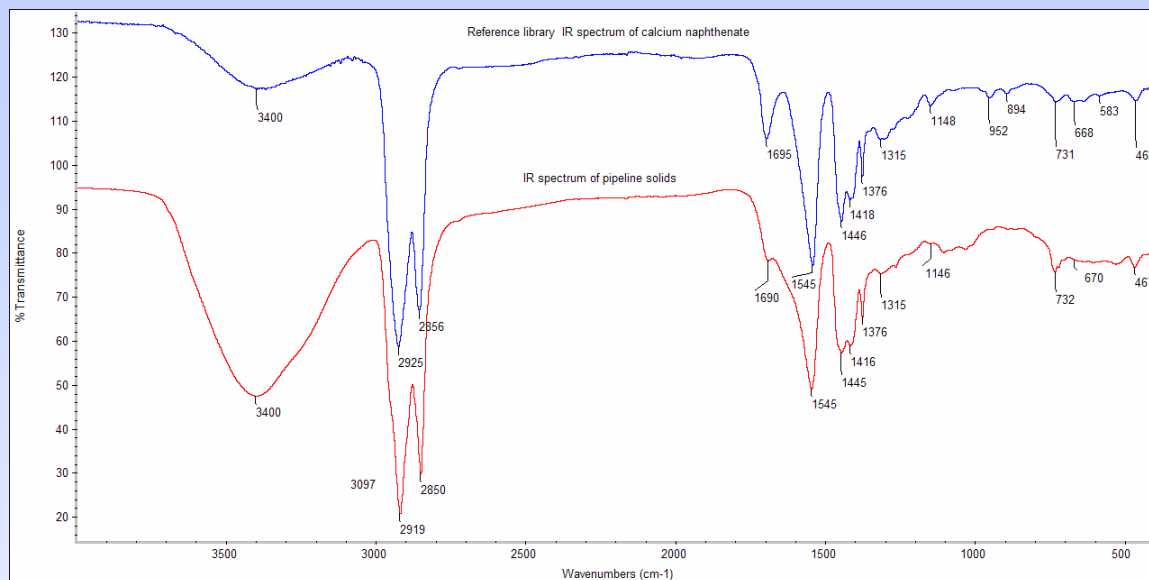
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## Analytical Data

Comparison of IR spectrum of pipeline solids and reference library IR spectrum of calcium naphthenate



## The Cost-Saving Outcome

The results of the FTIR analysis of the pipeline solids clearly show that calcium naphthenate-type material is the dominant component present in the solids which allows the client to initiate an appropriate chemical treatment to prevent the formation of naphthenate salts and reduce costly shutdown time.

Most other methods for the detection of naphthenates involve a mixed organic solvent extraction procedure which is likely to be less specific than the FTIR method hence FTIR analysis is ideal for the rapid, unambiguous detection of naphthenates.

As well as the detection of naphthenates, FTIR analysis can also be applied to the characterization/identification of a range of oil industry problem samples relating to scale inhibitors, corrosion inhibitors, drilling muds, hydrogen sulphide scavengers, emulsifiers etc.

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