Solutions for flow assurance

High performance asphaltene and wax control using FlowSolve™

Cargill®

The problem

Maintaining flow in the production and transportation of crude oil is a critical challenge in both onshore and offshore environments. Deposition problems related to wax, asphaltene, scale, naphthenates and hydrates can obstruct flow and hence restrict oil and gas production. Flow assurance methods have been used in the oil and gas industry for a number of decades and can be implemented in the form of thermal, mechanical and/or chemical treatments to maintain the successful flow of reservoir fluids from the reservoir to refinery. Flow assurance is becoming more challenging due to the recovery of oil from remote environments (e.g. deepwater) introducing long tie backs, conditions of high pressure, low temperature and long residence times. Also, the increase in production of heavy, highly viscous crudes has added to today's flow assurance challenges.

Our solution

We have invested significantly in developing a range of FlowSolve™ flow assurance additives for the treatment of asphaltene and wax related problems in global crude oils. As a speciality chemical supplier for niche applications, we maintain widespread synthesis expertise within the business to ensure that optimum molecular design provides specific effects. We have gained an understanding of the mode of action in our additives through manipulating molecular structure and the use of numerous evaluation methods. As such, we understand that successful employment of flow assurance additives is regional and crude oil specific and therefore we endeavour to offer a range of flow assurance additives to suit different crude oil types.

Benefits

Industry proven

Very positive industry reputation with over 10 years of successful field applications in Canada, USA, Mexico, North Sea, North Africa and Middle East

Highly effective

Broad spectrum of performance in variable crude oils – onshore, offshore and deepwater. Effective performance at low dosage. Excellent high temperature stability up to 300°C

Easy flow

Ideal physical properties for oilfield deployment; liquid products at room temperature, low product pour points, low product viscosity, good handleability at supplied concentration and/or field ready concentrations

Global regulatory compliance

The majority of our additives have global chemical industry compliance (i.e. REACH, TSCA, DSL etc.) and some grades have achieved OSPAR (EU) offshore industry compliance

Additional features

Low foaming, low emulsion tendency, compatible with oil soluble materials, suitable for blending/diluting

Solutions for asphaltene control

Asphaltenes are organic solids containing polyaromatic structures, aliphatic chains, heteratoms (S, N, O) and trace metals. Asphaltenes are one of the heaviest fractions of crude defined as being insoluble in light aliphatic hydrocarbons, but soluble in aromatic solvents. Flow assurance problems occur when the crude oil solubility of asphaltenes is destabilized by pressure changes and mixing of incompatible fluids. Destabilized asphaltenes can agglomerate and deposit causing expensive blockages in both upstream and downstream pipelines and facilities.

Asphaltene inhibitors:

Asphaltene inhibitors are chemical additives which shift the onset of asphaltene precipitation by keeping the asphaltenes solubilized within the oil, hence delaying their flocculation.

Asphaltene dispersants:

Asphaltene dispersants interact with the asphaltenes after they have flocculated by reducing their particle size and keeping the asphaltenes suspended in the oil, preventing further agglomeration and therefore maintaining crude oil flow. In some heavy crude oils, our flow assurance products have shown effectiveness at reducing viscosity.

Anti-foulants:

Anti-foulants are chemical additives that inhibit the accumulation of deposits on equipment (heat exchangers, condensers, furnaces) in refinery and petrochemical plants. Typically anti-foulants are formulated around a high temperature stable asphaltene dispersant.

Demulsifier synergists:

In crude oil emulsions, asphaltenes can adsorb at the oil-water interface forming viscoelastic films thereby stabilizing the water-in-crude oil (w/o) emulsions. Asphaltene control additives can therefore be used in conjunction with demulsifier formulations to aid the separation of crude oil emulsions.

Fuel oil stabilizers:

When asphaltene containing heavy fuel oil is blended with more paraffinic grades of fuel (e.g. marine gas oil), either to reduce sulphur content or during a switching phase, the asphaltenes will be destabilized and can agglomerate. They then precipitate out causing problems in the engine, fuel filtration systems and storage equipment. An asphaltene inhibitor and/or dispersant could be used to ensure asphaltenes stay stabilized or dispersed and reach the engine to be burnt.

Our asphaltene control testing capabilities

Asphaltene Inhibitor testing is carried out using a FT5 Flocculation Titrimeter from PSL Systemtechnik. Measurements carried out follow the same principle as ASTM D6703 (Automated Heithaus Titrimetry).

The performance testing conducted at our state of the art Houston site utilizes industry recognized techniques generating data in a format that is familiar to our customers. For performance verification or the use of more complex instrumentation, we have access to a number of well-established third party testing houses that will provide independent, credible data.

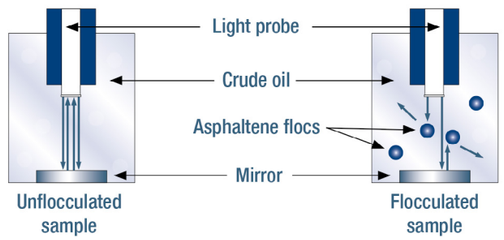


Figure 1: Schematic diagram of the FT5 flocculation titrimeter principle

The FT5 Flocculation Titrimeter titrates an asphaltenic crude oil sample with a light aliphatic hydrocarbon to destabilize the asphaltenes. The onset of asphaltene flocculation is determined via the decrease in translucency of the solution. A successful asphaltene inhibitor will delay this onset point, such that a larger volume of aliphatic hydrocarbon titrant is needed to destabilize the asphaltenes.

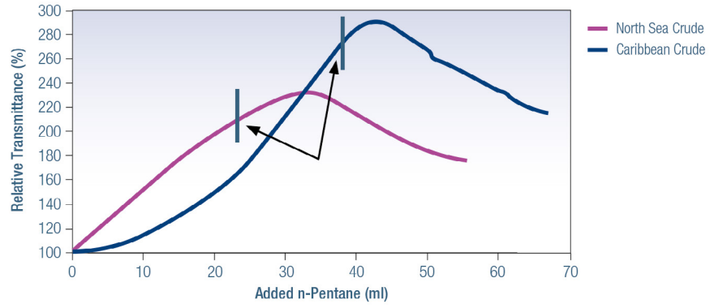


Figure 2: Example of asphaltene flocculation onset

Asphaltene dispersant testing is carried out following ASTM D7061 (Measuring n-Heptane Induced Phase Separation of Asphaltene-Containing Oils as Separability Number by using the Turbiscan). The Turbiscan functions by monitoring the transmission of light at varying levels through a sample vial to determine if asphaltene particles are remaining dispersed, or if they are sedimenting.

Figure 3: Turbiscan instrument

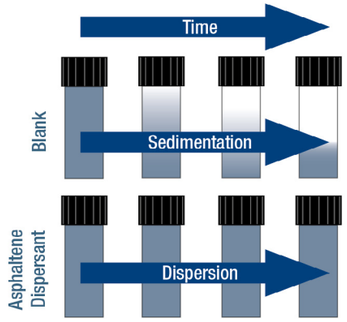


Figure 4: Principle of Turbiscan measurements

We have developed a dynamic deposition system to study asphaltene deposition issues at closer to field conditions.

Solutions for wax control

Paraffin waxes in crude oil can exist as normal, branched or cyclic alkanes with carbon chain lengths between C15 and >C100. It is the normal alkanes (n-paraffin waxes) which are mostly responsible for crude oil flow problems relating to wax. Wax problems in the well or pipeline occur when there is a drop in temperature or pressure, such that the waxes begin to precipitate or lose solubility. This can result in wax gelling in the main body of the oil, or wax deposition on cooler surfaces or in regions of lower oil velocity; both of which can lead to a deterioration in crude oil flow. Chemical treatments include our pour point depressants and wax inhibitors which function as wax crystal modifiers and so are deployed above the wax appearance temperature (WAT) of the crude oil.

Pour point depressants and viscosity reducers:

Pour point depressants are chemical additives used to mitigate the gelling of wax within an oil. On cooling, the waxes can precipitate from the oil as plate-like crystals which interact to form a gel matrix in which liquid oil is trapped. This can cause increased oil viscosity and eventually a gel structure that is strong enough to prevent the crude oil from flowing; this is called the pour point of the oil. A pour point depressant modifies the structure of the wax crystals on formation so that they are less likely to interact, therefore lowering the pour point and viscosity of the crude, enabling it to flow at lower temperatures. Pour point depressants also assist in pipeline restart after periods of pipeline shut-in.

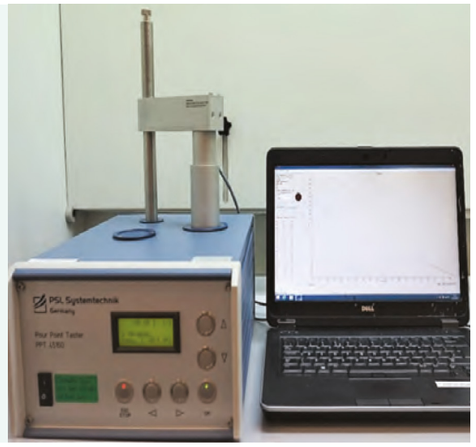
Wax inhibitors:

Wax Inhibitors are chemical additives used to treat a wax deposition problem. These additives modify the morphology and distribution of the wax crystals such that they are less likely to migrate through the oil and deposit on a surface. Wax inhibitors can also change the consistency of wax deposited on a surface. A softer wax deposit enables less frequent and more efficient mechanical pigging of the pipeline.

Wax control testing capabilities

Crude oil pour point

The pour point of a liquid is the temperature (on cooling) at which the liquid is no longer able to flow, under the conditions of the test. Crude oil pour point determinations are conducted using an automatic pour point analyser (PPT PSL 45150) in accordance with ASTM D 5985. The detected no-flow temperature is rounded up to the nearest 3°C increment and this value is quoted as the pour point. The testing range is -55°C to 150°C.



Wax inhibition

Wax inhibition is the percentage reduction of wax deposition on a cold surface, under the conditions of the test.

Evaluations are conducted using a Cold Finger Analyser (F5 Technologies), where the individual cold finger temperatures, bath temperature and test duration are adjusted for the properties of each crude oil evaluated.

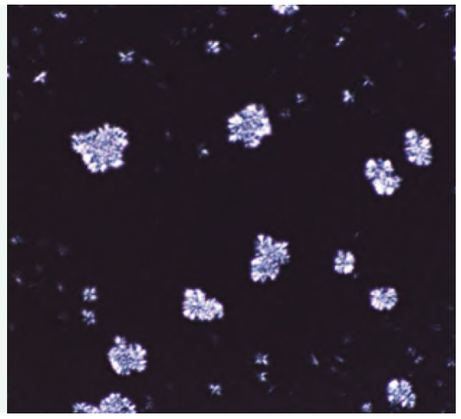
Crude oil viscosity profile

The viscosity of a crude oil is determined whilst cooling at 1°C/minute from its molten state.

A Brookfield DV2T viscometer and cooling bath is used, with Spindle 18 and 10 rpm spindle speed. The testing range is -20°C to 70°C.

Wax crystal morphology by cross polarized microscopy

By using cross polarized microscopy equipped with a temperature controlled stage and camera, it is possible to observe the morphology of wax crystals in crude oil and also to determine the wax appearance temperature of a crude oil sample. Typically a magnification of x20 and cooling rate of 0.2°C/minute is used.



Wax deposition

We have the capability to conduct wax deposition studies at closer to field conditions, by utilizing our wax capillary flow through and flow loop systems.

Our flow assurance products

Our chemical solutions help our global customers improve flow assurance, manage process-cost benefit and achieve operations that do not impact local environments during extraction.

Product name	Active content (%)	Appearance at 25°C	Flash point (°C)	Pour point (°C)
Flowsolve 110LN	50	Clear brown liquid	61	-33
Flowsolve 113LN	50	Clear brown liquid	61	-33
Flowsolve 140	35	Clear to slightly hazy yellow liquid	25	15
Flowsolve 150	50	Clear brown liquid	70	-63
Flowsolve 212LN	50	Clear brown liquid	61	-33
Flowsolve 250 AF	50	Clear brown liquid	130	<-20
Flowsolve 430	48-52	Liquid	>60	18

Treat rates

Typical treat rates of FlowSolve flow assurance products range from 10 ppm to 1000 ppm which is dependent on the crude oil type and the severity of the problem. Laboratory testing should be conducted for individual oils to establish an optimum treatment regime. To assist in the process of product selection and treat rate determination we provide samples of all products in the FlowSolve series.

Contact us to discuss how we can support you with your flow assurance issues, and to request datasheets, brochures, samples and much more.
energy_technologies@cargill.com

Notes

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Notes

Who are we?

The Energy Technologies business in Cargill Bioindustrial creates, makes and sells specialty chemicals and additives for the global energy market. Working in close collaboration with our customers, we apply sustainable concepts and deep scientific expertise so that together we can efficiently power the world of tomorrow.

At our core, we are experts in synthetic ester and polyalkylene glycol chemistries, taking products from lab scale through to full manufacturing. Investing in the development of new chemistries allows us to support our customers in meeting new industry challenges.

For those who dare to imagine a brighter future, we establish long lasting relationships and create bespoke industry solutions through our integrated research & development and global manufacturing capabilities. Being both global and local, you have direct access to our network of technical experts. We look forward to talking to you.

Further information

Cargill Bioindustrial sales and distribution are coordinated through an extensive worldwide network of technical and commercial experts. For further information or guidance please contact us:

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