BYK

TECHNICAL INFORMATION
CRUDE OIL DEMULSIFIERS

Contents

High-performance demulsifiers for oilfield applications

In the production of crude oil, emulsified water (or brine) is one of the most significant problems encountered in oilfield operations. Most crude produced globally contains emulsified water. Water becomes emulsified and stabilized in crude oil, not in the reservoir, but by the agitation/shear of the production process and equipment. The presence of natural surfactants, resins, asphaltenes and paraffin, and oil-wet inorganic fines such as silt and clay present at the oil/water interface stabilize the emulsions produced. Lower temperatures and additives applied at the well head can have the side effect to stabilize emulsified water. These additives comprise corrosion inhibitors, biocides, or scale and wax inhibitors.

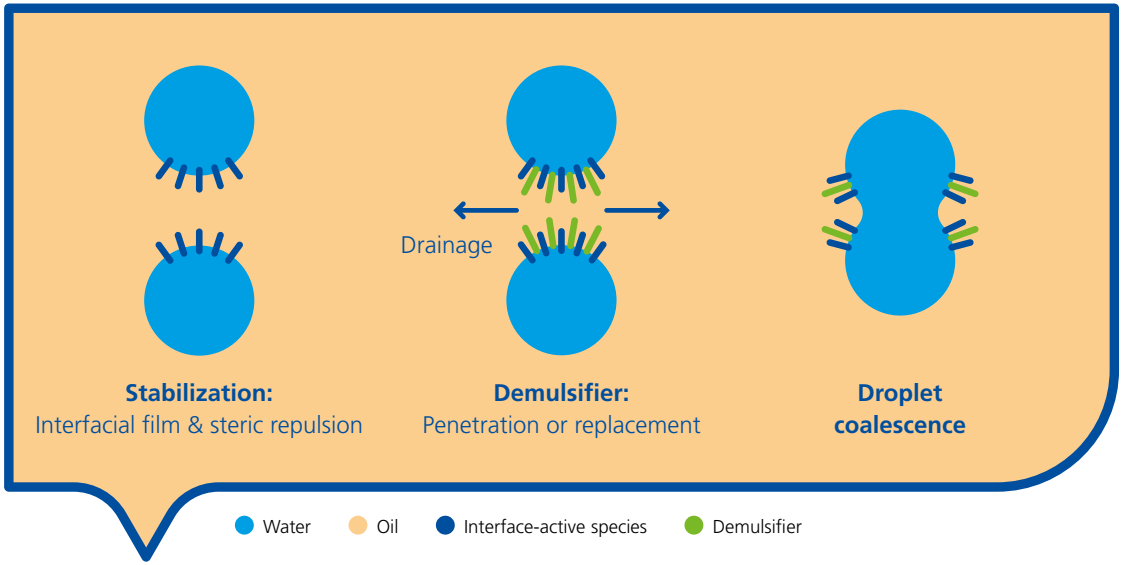
At times, the water content of produced crude can be in excess of 80 %. The emulsified water in crude, which typically contains salt, can cause high viscosities making pumping difficult and can cause corrosion problems in pipelines and production equipment. These issues can drastically increase oilfield operation costs. There are several ways to break crude oil emulsions including heating, electrical methods, and mechanical separation. However, treatment with chemical emulsion breakers is easy in the field or refinery and typically has a better cost-to-performance ratio compared to other emulsion breaking methods.

Note

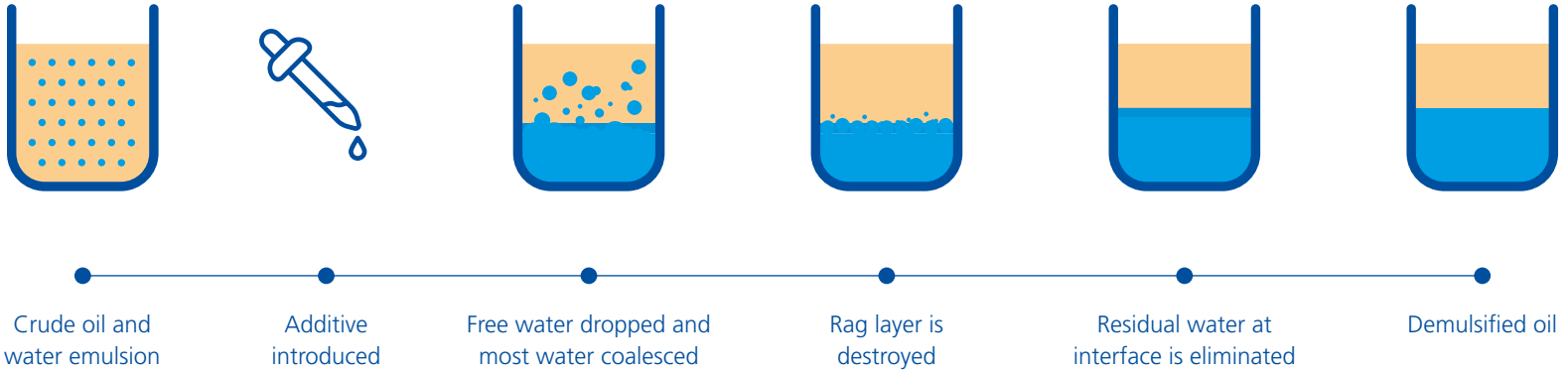
To ensure the best appearance and full functionality, please open in Adobe Acrobat.

Functions of demulsifiers

Oilfield demulsifier chemistries provide three primary functions when applied to crude oil containing emulsified water. The functions are typically considered chemistry dependent and can be broken down into Water Droppers, Polishers and Interface Enhancers (G.01). It is important to note that a single chemistry can provide several functionalities, so there is not a clearly defined line as to what functions each additive provides. The stability of emulsified water varies from well to well. A typical emulsion breaking package will be comprised of products with different chemistries designed to treat that particular well.



The demulsification process



G.01

Desalters

Crude oil that has been separated from water may still contain a significant amount of salts. These salts cause corrosion issues in the downstream process as well as the possible deactivation of refinery catalysts. To remove the salt, water and demulsifiers are added to the crude and heated. The salt and other dissolvable impurities dissolve into the water. Over time, the demulsifier helps settle the water with the dissolved salt and impurities to the bottom of the tank leaving dry uncontaminated crude oil on top. Desalting may be performed initially in the field and later at the refinery site to bring the crude into full specification.

Water droppers

Products in this class coalesce emulsified water in crude oils and release water that is in the free state. They rupture the emulsifying film at the oil/water interface and allow the water droplets to coalesce into much larger water droplets. These larger droplets have less surface tension than smaller droplets, which allows them to "drop" out as a separate phase.

Interface enhancers

Products with this functionality are used to create sharp interfaces between the oil and water phases for easier separation. These products work synergistically with those used for flocculation and coalescence to help eliminate any residual water remaining emulsified at the oil/water interface.

Additionally, products with chemistries that are favored as interface enhancers can be used as desalters and wetting agents.

Wetting agents

Oil-wet fine solids present in crude oil emulsions at the oil/water interface can have a stabilizing effect on the emulsion. When products that act as wetting agents are added to demulsifier blends, they water-wet the solids present and allow them to be removed with the emulsified water.

Polishers

These products flocculate and concentrate the sub-micron water droplets that are present at the base of the oil column prior to coalescence. The crude oil above the settling level of the flocs is considered dehydrated. Dehydrated crude oil appears "polished" due to the absence of emulsified water, which refracts light and creates a dull appearance.

Chemistry of BYK demulsifiers

Resin Alkoxylates Alkoxylated alkyl phenol formaldehyde resins	The alkyl group can be butyl, amyl, nonyl, or a mixture of the three. The interfacial activity is controlled by the amounts of the ethylene oxide (EO) and propylene oxide (PO) attached to the polar ends. Resins are primary water droppers and perform well in lower treating temperatures. Resins are also used in desalting applications.
Polyols Polyether polyols	Derived from PO and EO. Demulsifiers based on polyether polyols are more environmentally friendly than resin-based demulsifiers. They are used to break emulsions in high gravity crudes, improve the oil/water interface, and improve water clarity. These are commonly used in combination with resin demulsifiers. Polyether polyols can also provide water wetting of solids.
Esters Alkoxylated maleic ester resins	The reaction product of alkoxylated resin and an organic acid. Provide water dropping properties as well as enhancing the oil/water interface. They are also used for desalting crude oil and natural gas condensates. These are commonly used as performance enhancers for resin demulsifiers.
Amines Nonionic amine alkoxylates	Effective as water droppers and desalters in mid to high-gravity API crudes. Provide good interface characteristics and water clarity. These are commonly used with resin demulsifiers.
Diepoxides Nonionic modified polyols	Excellent water droppers if used alone, or they can be used to enhance the performance of resin and amine demulsifiers. These generally help provide low BS&W and are excellent polishers.
Polyethyleneimines (PEI) Alkoxylated polyethyleneimines	Typically used in combination with resin demulsifiers. PEI demulsifiers are used for polishing of low to mid gravity API crudes.
Other Chemistries • Modified phosphate esters • High concentration sulfonates • Quaternary ammonium chloride compounds • Tallow diamine ethoxylates	Sulfonates are typically used as slugging compounds and also as demulsifiers in enhanced oil recovery. Chemistries in this category can also be used as non-emulsifiers in acid stimulation, for asphaltene and paraffin dispersants, and also for corrosion inhibition.

T. 01

Demulsifier testing

A demulsifier bottle test method is used to screen demulsifiers for performance in crude oil emulsions. The bottle test is designed to simulate production conditions as closely as possible. A "live" crude oil sample that is free of additives must be collected for testing. If the demulsifier is to be injected at a point that contains crude from several wells, a blend of those crudes in the appropriate ratio should be used for the bottle test. If heat will be available to the demulsification process, such as in a refinery, a water bath should be used at the appropriate temperature to simulate the heated reaction environment. If the demulsification process will take place in the field under ambient temperature, the heat can be omitted in the testing. The duration and magnitude of agitation in bottle testing should mimic as closely as possible the conditions in the field.

Demulsifier samples should be diluted in solvent for testing at 5–10 % concentration for solubilization prior to testing. Solubility of BYK demulsifiers in common solvents can be found in Table T. 02. Bottle testing will show the most effective demulsifier intermediates. Based on intermediate performance, a blend can be created to most effectively demulsify the target crude oil.

The test results that are important to determining the demulsifier performance are as follows:
- Visual inspection of separated water quality
- Visual inspection of treated oil quality
- Interface sharpness
- Water content of the treated top oil
- Water content of the interface zone
- Salt content in the top oil

Demulsifer bottle testing is a critical process that requires understanding and experience. It is beyond the scope of this brochure to provide a bottle test method and guidelines. Specifics on the bottle testing method can be found in industry literature and online resources.

BYK demulsifier product details (1/3)

Product	Chemistry	RSN	Activity (%)	Viscosity at 77 °F (mPas)	Water	Methanol	Aromatic Solvent	Kerosene	Fast Dropper	Polisher	Clean Interface	Desalter	Wetting Agent	Corrosion Inhibitor
BYK GS-54	Alkoxylated amylphenol formaldehyde resin	11.3	65	200	D	S	S	D	●			○		
BYK GS-54A	Alkoxylated amylphenol formaldehyde resin	11	73	2,000	D	S	S	I	●			○		
BYK GS-55	Alkoxylated amylphenol formaldehyde resin	14.5	70	1,500	D	S	D	I	●			○		
BYK GS-58	Alkoxylated amylphenol formaldehyde resin	16	88	1,000	I	S	S	I	●					
BYK GS-32	Butyl resin alkoxylate polymer	15	85	8,000	I	S	D	I	●					
BYK GS-42	Butyl resin alkoxylate polymer	9.5	66	8,000	D	S	S	S	●					
BYK GS-45	Butyl resin alkoxylate polymer	9	75	8,000	D	S	S	S	●					
BYK GS-34	Alkoxylated nonylphenol formaldehyde resin	15	76	7,000	I	S	S	I	●			○		
BYK GS-35	Alkoxylated nonylphenol formaldehyde resin	16.5	86	6,000	D	S	S	D	●			○		
BYK GS-46	Alkoxylated nonylphenol formaldehyde resin	16.5	91	3,000	D	S	S	I	●					
BYK GS-47	Alkoxylated nonylphenol formaldehyde resin	13.5	91	2,000	D	S	S	I	●					
BYK GS-68	Alkoxylated nonylphenol formaldehyde resin	21	80	17,000	I	S	S	I	●			○		
BYK A-GS-3545	Nonyl/Butyl resin alkoxylate polymer	12	74	8,000	D	S	S	I	●					
BYK A-GS-615	Polyether polyol	18	80	300	S	S	I	S			●		●	
BYK GS-11	Polyether polyol	10.8	100	1,000	D	S	S	S			●			
BYK GS-13	Polyether polyol	22	100	7,000	I	S	S	I	●		○			
BYK GS-38	Polyether polyol	9.9	100	1,000	D	S	S	S			●			
BYK GS-61	Polyether polyol	13.5	100	500	D	S	S	S			●			

S = Soluble D = Dispersible I = Insoluble ● Primary function ○ Secondary function

T. 02

BYK demulsifier product details (2/3)

Product	Chemistry	RSN	Activity (%)	Viscosity at 77 °F (mPas)	Water	Methanol	Aromatic Solvent	Kerosene	Fast Dropper	Polisher	Clean Interface	Desalter	Wetting Agent	Corrosion Inhibitor
BYK GS-64	Polyether polyol	17.5	100	1,100	S	S	S	S			●		●	
BYK GS-84	Polyether polyol	20	100	5,000	I	S	S	I			●	●	●	
BYK A-GS-300C	Alkoxylated maleic ester resin	8	51	900					●	●	●	●	●	
BYK GS-18	Alkoxylated maleic ester resin	7.5	56	900	D	D	S	I	●	○				
BYK GS-30	Alkoxylated maleic ester resin	8	60	900	I	D	S	I	●	○				
BYK GS-37	Alkoxylated maleic ester resin	7.7	56	1,000	I	S	S	I	●	○				
BYK GS-69	Alkoxylated maleic ester resin	8		9,000	D	S	S	I	●	○				
BYK GS-15	Nonionic modified polyol	6.5	90	500	D	S	S	S		●				
BYK GS-26	Nonionic modified polyol	7	82	1,200	D	S	D	D	●					
BYK GS-28	Nonionic modified polyol	6.5	85	3,000	D	S	S	S		●				
BYK GS-57	Nonionic modified polyol	7	95	2,500	I	S	S	D	●	○				
BYK GS-X-245	Nonionic modified polyol	8	85	2,500	D	S	D	D	●					
BYK GS-51	Nonionic amine alkoxylate	10	100	2,000	D	S	S	I	●		○			
BYK GS-904	Nonionic amine alkoxylate	12.5	100	1,100	D	S	S	I	●		○			
BYK GS-905	Nonionic amine alkoxylate	16.5	95	400	I	S	S	I	●		○			
BYK GS-39	Alkoxylated amine	9.9	90	700 @ 50 °C	I	S	S	S	○	●				
BYK GS-393	Alkoxylated amine	6	90	1,750	I	S	S	S	○	●				
BYK A-GS-446	High concentration sulfonate	12.6	38	200	D	S	S	D	●				○	

S = Soluble D = Dispersible I = Insoluble ● Primary function ○ Secondary function

T. 02

BYK demulsifier product details (3/3)

Product	Chemistry	RSN	Activity (%)	Viscosity at 77 °F (mPas)	Water	Methanol	Aromatic Solvent	Kerosene	Fast Dropper	Polisher	Clean Interface	Desalter	Wetting Agent	Corrosion Inhibitor
BYK A-GS-449	High concentration sulfonate	10	56	1,000	D	S	S	S	●				○	
BYK A-GS-AA-91	Modified phosphate ester	19.6	65	300	S	S	S	S					●	
BYK A-GS-PD-16	High concentration sulfonate	17.7	69	700	D	S	S	I					●	
BYK A-GS-PD-16N	High concentration sulfonate	18.3	70	1,900	D	S	S	S					●	
BYK A-NE-104	Amine sulfonate	18.6	42	200	S	S	I	I			●		●	
BYK CI-1010	Amine ethoxylate	23.8	100	600	S	S	S	S						●
BYK GS-448	High concentration sulfonate	9.8	53	500	D	S	S	I	●				○	
BYK GS-WA-152	Quaternary ammonium chloride compound	19.8	84	300	S	S	I	I					●	

S = Soluble D = Dispersible I = Insoluble ● Primary function ○ Secondary function

T. 02

Our capabilities

BYK is committed to providing high performance additives to the oil and gas industry along with the technical support required to help our customers use the products in the most efficient and cost-effective way possible. BYK's technical staff can provide product recommendations, technical service support work, and also participate in collaborative development projects with our customers. BYK maintains fully staffed and equipped oilfield laboratories in Texas, USA.

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