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Formulating Soluble Oil Metalworking Fluids with Paraffinic Base Oil and Aristonate Sulfonates

Aristonates, manufacturing by Pilot Chemical are the leading synthetic sulfonate in the US industrial lubricant market. The primary base oil used in US industrial applications is naphthenic. Therefore, most of the formulation work with the Aristonates has been done with naphthenic base oils. This bulletin demonstrates that the use of Aristonates in formulations with paraffinic base oils is both possible and desirable. Some general guidelines are given and some preliminary test results demonstrate the superior stability of Aristonate based emulsions vs those based on a typical US natural sulfonate emulsifier.

Formulation Guidelines:

In this work, two samples of 100 N paraffinic oil typical of those used in Asia and a sample of 110 N oil from the USA were used. A number of soluble oils were formulated containing the following ingredients in the indicated percentage ranges.

Component	Function	Composition Range %
Sulfonate	Primary Emulsifier	12.6-16.5
Low Rosin Acid content Tall Oil Fatty Acid[1]	Anionic Co-emulsifier	8.4-11.0
Triethanolamine	Neutralizing Base	4.2-5.5
Monoethanolamine	Neutralizing Base	1.8-2.4
Water Soluble Amide[2]	Nonionic Co-emulsifier	4.5-5.9
Linear Alcohol Ethoxylate*	Nonionic Co-emulsifier	8.5-11.2
Parrafinic Oil	Diluent	60.0-47.5

*Note on the Linear Alcohol Ethoxylate: For this work, a C_{12-16} linear alcohol ethoxylate with an average degree of ethoxylation of 1.6 was used. This ethoxylate has an HLB value of 5 and is more suited to the formation of stable macro-emusions (particle size >1 micron) than the higher HLB ethoxylates of HLB 8 or more, which should be used to formulate micro-emulsion type systems (particle size < 0.05 microns). The HLB 5 ethoxylate used in this work was Genapol 26L-1.6 from Hoechst.

The soluble oils formulated according to the above guidelines were all stable and clear. They were then evaluated in an emulsion stability test according to the institute of Petroleum (IP 263) protocol. The emulsions so formed, at dilution levels 20:1 and 30:1 with 400 ppm water were “milky white” in appearance, indicative of macro-emulsions with a particle size of over 1 micron. By contrast, when similar soluble oils are prepared

[1] 40% Rosin acid content Tall Oil Fatty Acid is recommended. Higher Rosin acid content will decrease emulsion stability.
[2] EM-980 from Ferro Corp., Keil Chemicals Division.

using a higher HLB ethoxylate (e.g. Alfonic 1214GC40 from Condea Vista, with an HLB of 8), the emulsions so produced are transparent, indicative of micro-emulsions with particle size of <0.05 microns.

Stability of Soluble Oils and Emulsions:

This part of the work evaluated the stability of the soluble oils and the emulsions formed from them as the content of diluent in the soluble oils was increased. It is typically more difficult to form a stable emulsion as diluent oil content increases. The performance of Aristonate H-LF was compared to that of the corresponding natural sulfonate in terms of soluble oil and emulsion stability. A 100 N neutral paraffinic oil typical of that in use in Asia was used in this part of the work.

The exact formulations used were as follows:

Component	Formula 1%	Formula 2% (increased diluent oil)
Sulfonate*	16.5	12.6
Low rosin acid content Tall Oil Fatty Acid	11.0	8.4
Triethanolamine	5.5	4.2
Monoethanolamine	2.4	1.8
Water soluble amide	5.9	4.5
HLB 5 ethoxylate	11.2	8.5
Paraffinic diluent oil	47.5	60.0

Aristonate H-LF or natural sulfonate equivalent

A total of four formulations were therefore prepared and evaluated in the IP 263 emulsion test. These were Formula 1 (Aristonate), Formula 1 (natural), Formula 2 (Aristonate) and Formula 2 (natural).

All four soluble oils as prepared above were observed to be clear and stable. However, on dilution with water to levels of 20:1 and 30:1 according to the IP 263 protocol, the resulting emulsions showed some differences in stability between the Aristonate and natural sulfonate based products as noted in the table below.

Formulation	Sulfonate	Diluent Oil Content%	20:1 Emulsion	30:1 Emulsion
1	Aristonate H-LF	47.5%	Stable	Stable
1	Natural sulfonate	47.5%	0.5 ml darker layer	Slight discoloration
2	Aristonate H-LF	60.0%	Stable	Stable
2	Natural sulfonate	60.0%	Discoloration in neck of flask	Slight discoloration

Continuing work at Pilot has yielded stable emulsion from paraffinic oil based soluble oils with up to 70% diluent oil content, based on Aristonates.

Conclusions:

Our work to date shows that stable soluble oils with superior emulsion performance can be prepared using Aristonate sulfonate. The stability and performance of the soluble oils can be affected greatly by the surfactants used in the formulation work, particularly the HLB value of the nonionic co-emulsifier used (in this study the alcohol ethoxylate). Specifically, the formation of a clear micro-emulsion or milky macro-emulsion in use can be influenced by the choice of co-emulsifier.