HIGH-OIL EMULSIONS FOR MWFs BASED ON HEAVY NAPHTHENIC BASE OILS

TRACK OR CATEGORY
Metalworking Fluids III

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INTRODUCTION

In this study, a novel range of high-oil emulsions based on high viscosity naphthenic base oils have been created, for the purpose of building a better understanding of the properties of heavy high-oil emulsions. The naphthenic base oils utilized were Nynas T 110, Nynas T 400, Nynas T 600 and a paraffinic SN 500 (Group 1). Two emulsion systems were employed. One was a commercial Non-ionic surfactant pair from Solvay Novecare, used around HLB 8.5. A second approach utilized a "generic" non-ionic emulsifier system based on readily available sorbitan-derived emulsifiers. Emulsifier blends covering a range of HLB values were utilized to prepare a number of model emulsion systems. The emulsion particle size, and the emulsion stability as a function of time, was determined by static light scattering experiments utilizing a Malvern 3000E MasterSizer equipment. Application were heavy emulsion can be utilized are for example heavy metal forming operations and metal hot rolling.

Experimental setup

A Malvern Mastersizer 3000E static light scattering was used for the investigation of the emulsion Droplet Size Distribution (DSD). The DSD is determined by light scattering at high dilution, thus we can monitor DSD changes over time. Coalescence and Oswald ripening can be detected, and emulsion stability over time can be measured.
For the *screening* study, the samples were shaken by hand and visually inspected for emulsions stability and creaming tendency.

For the HLB-dependence emulsion stability study, an Ultra-Turrax was used for blending the emulsions.

Table 1. Base oils utilized in the study.

Base Oil	T 110	T 400	T 600	SN 500
Characteristics				
Viscosity, 40°C (cSt)	112	369	560	104
Viscosity, 100°C (cSt)	9.1	19.5	21.1	11.5
Aniline Point	**89**	**98**	**89**	**115**
Density, 15°C (kg/dm^3)	0.915	0.922	0.931	0.882
Pour Point (°C)	-30	-21	-12	-12
Appearance	Clear & Bright	Clear & Bright	Clear & Bright	Clear & Bright

Emulsifier selection

For the initial screening study, an emulsifier pair from Solvay Novecare (Rhodasurf) with improved foam control and environmental labelling was selected.

Standard formulations for the screening study

- Concentrate for a HLB 8.5 emulsion
- 50-50 oil with emulsifier – water
- Shaken by hand for 30 seconds

Base Oil	75%
Rhodasurf LF 5	20%
Rhodasurf LF 21	5%

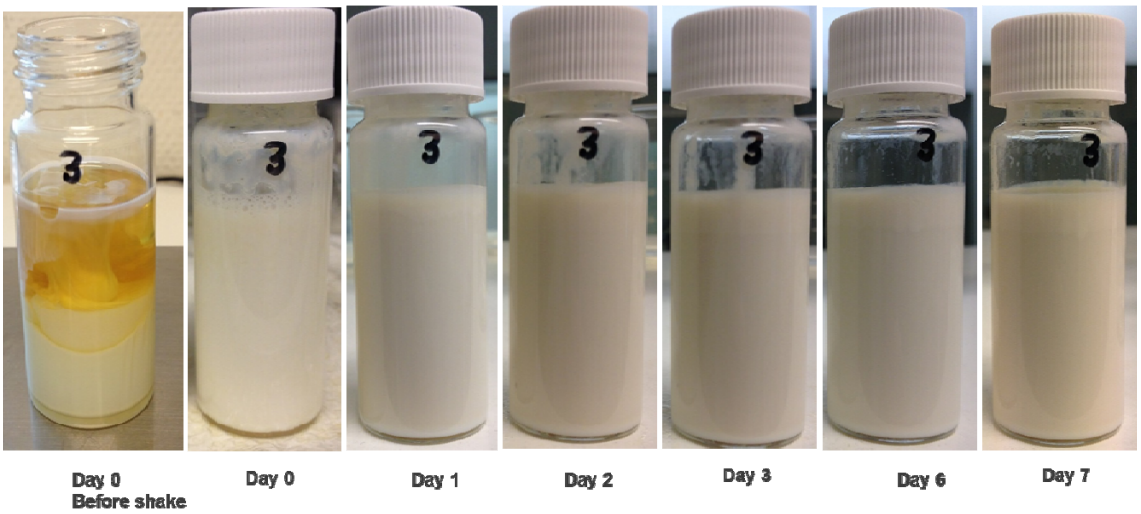


Figure 1. Nynas T 600 with the Solvay emulsifiers.

Stability differences are visible across the four base oils. The Aniline Point of T 110 and T 600 is the same, 89 °C, which give them emulsions with similar properties. These are the more stable emulsions at HLP 8.5 in this system, see Figure 1 for an example. The Aniline Point of T 400 is higher, 98 °C, so the emulsion is less ideal at this HLB. Some creaming observed towards the end of the week. The Group I SN 500 show very clear phase separation already after Day 1.

Sorbitan Emulsions, seven-day study

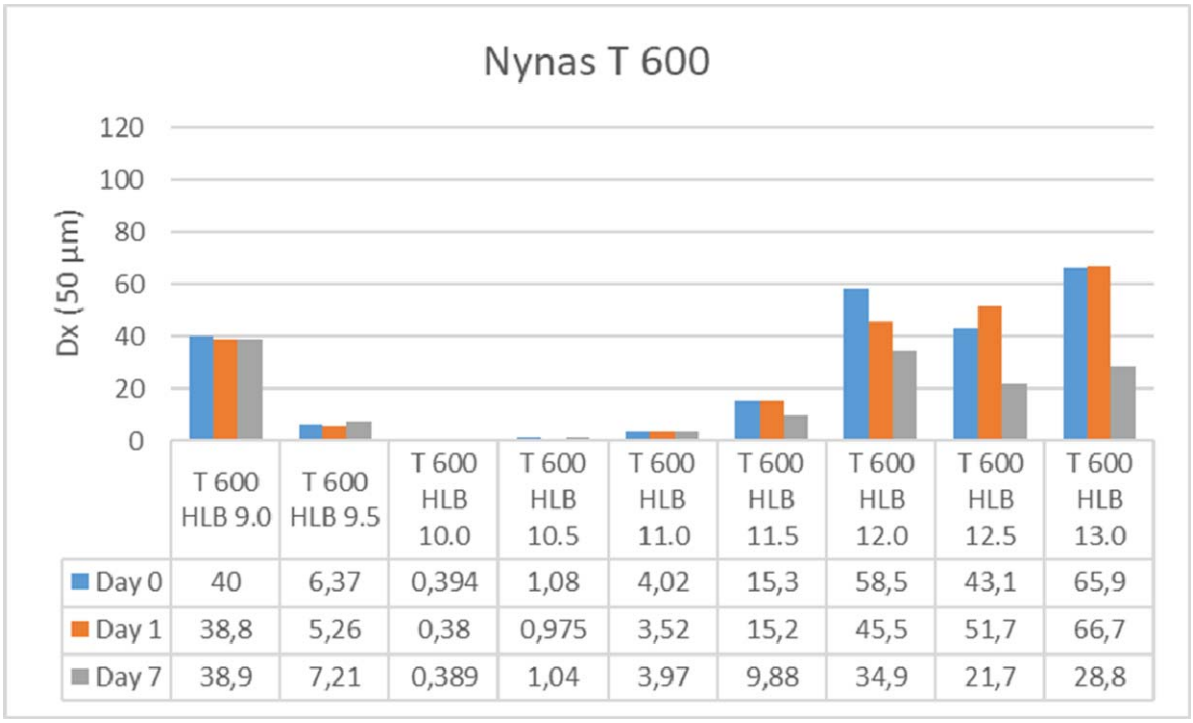
Concentrates for a Sorbitan-based emulsion with nine different HLBs were prepared. They were then applied 50-50 blends of oil with emulsifier and hard water (20°dH). High-shear blending utilizing the Ultra-Turrax was employed. The HLB was varied in half-unit steps from 9 to 13. The research challenge was to find the optimum HLB value giving the best emulsion stability.

Table 2. Blends of Span and Tween (%) to create the different HLBs.

HLB	**9.0**	**9.5**	**10.0**	**10.5**	**11.0**	**11.5**	**12.0**	**12.5**	**13.0**
Span 80 (%)	56.1	51.4	46.7	42.1	37.4	32.7	28.0	23.4	18.7
Tween 80 (%)	43.9	48.6	53.3	57.3	62.6	67.3	72.0	76.6	81.3

Figure 2. Optimal emulsion stability for T 600 was found at HLB 10.0 and 10.5.

The droplet size distribution (DSD) was determined for all systems. In Figure 3, the DSD minimum where emulsion stability is the best can be observed at HLB 10.0. A wide "sweet spot", from 9.5 to 11 demonstrates the ruggedness of the emulsion system.



	T 600 HLB 9.0	T 600 HLB 9.5	T 600 HLB 10.0	T 600 HLB 10.5	T 600 HLB 11.0	T 600 HLB 11.5	T 600 HLB 12.0	T 600 HLB 12.5	T 600 HLB 13.0
Day 0	40	6,37	0,394	1,08	4,02	15,3	58,5	43,1	65,9
Day 1	38,8	5,26	0,38	0,975	3,52	15,2	45,5	51,7	66,7
Day 7	38,9	7,21	0,389	1,04	3,97	9,88	34,9	21,7	28,8

Figure 3. DSD for T 600, best stability at HLB 10.0.

KEYWORDS
Base Stocks: Mineral Base Stocks, Metalworking: Stability, Metalworking: Forming.