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Nonionic Surfactants Derived from Higher Alcohol,
Having High Detergency and Emulsifiability

NAROACTY CL Products

Preface

NAROACTY CL products were developed by using our new original synthetic technique called Narrow Range Ethoxylation, to produce alternative products of nonionic surfactants derived from alkylphenol. This technique allows alkylene oxide adducts to have a narrow molecular distribution, i.e. nonionic surfactants derived from higher alcohol having high detergency and emulsifiability.

These products have excellent surface tension lowering properties, detergency and emulsifiability. They can be used as various detergent bases for use in the kitchen, laundry and household, as well as base materials for other detergents, emulsifiers, dispersants and wetting agents for the textile, pulp and paper, synthetic resin, metal industries, etc.

The cloud point or phenol index in NAROACTY CL products are the same as those with the same product number in the NONIPOL line of products, which are Sanyo Chemical's nonionic surfactant derived from nonylphenol. We recommend that you consider not only the same product number but also the products with similar product numbers because there are some differences in their performance.

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We offer a wide range of NAROACTY CL products as follows:

Product Name	Appearance (20±5 °C)	HLB	Phenol Index or Cloud Point (°C)	pH *4	Freezing Point or Melting Point °C
NAROACTY CL-20	Colorless to pale yellow liquid	5.7 *1	3.8 *2	6.5	18 *5
NAROACTY CL-40		8.9 *1	7.1 *2	6.5	11 *5
NAROACTY CL-50		10.0	8.7 *2	6.5	10 *5
NAROACTY CL-70		11.7	11.2 *2	6.5	-7 *5
NAROACTY CL-85		12.6	41 *3	6.5	2 *5
NAROACTY CL-95		13.1	54 *3	6.5	8 *5
NAROACTY CL-100		13.3	64 *3	6.5	12 *5
NAROACTY CL-120	Colorless to pale yellow liquid or solid	14.1	80 *3	6.5	22 *5
NAROACTY CL-140	White solid	14.7	93 *3	6.5	31 *5
NAROACTY CL-160		15.2	99 *3	6.5	36 *6
NAROACTY CL-200		16.0	> 100 *3	6.5	42 *6
NAROACTY CL-400	White flake	17.8	> 100 *3	6.5	52 *6

*1 Water insoluble
*2 Phenol index: the amount (mL) of 5 wt % aqueous phenol solutions required to make a mixture of the NAROACTY CL product (1 g) and methanol (10 mL) become white turbid at 20 °C.
*3 Cloud point measured using 2 wt % aqueous solution.
*4 Measured using the 1 wt % aqueous solution.
*5 Freezing point: According to JIS K 0065, each sample in a test tube with a thermometer was cooled while being stirred using a mixing bar. The temperature (freezing point) was measured when the sample solution begins to form a crystal and also the temperature was constant.
*6 Melting point: Measured using OECD 102.

Notice: There is a possibility that these products in liquid may precipitate at low temperatures. In that case, they should be used after being heated between 30 and 40 °C to make a uniform solution. The values are representative.

1. Surface Tension Lowering Property

Figure 1 shows the surface tension lowering properties of NAROACTY CL products in water. Figures 2 and 3 show surface tension lowering properties of NAROACTY CL-50 and NAROACTY CL-100 in water in comparison with their equivalents (conventional nonionic surfactants with the same phenol index or the same cloud point). NAROACTY CL products have excellent surface tension lowering properties in water.

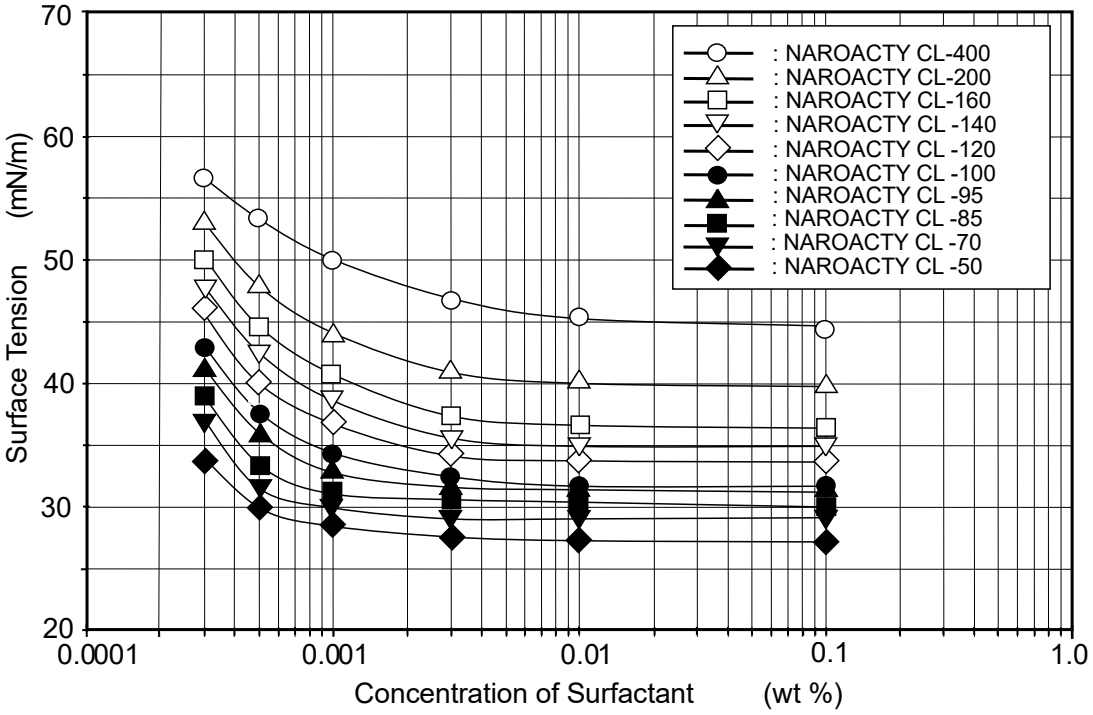

Figure 1. Surface Tension Lowering Property

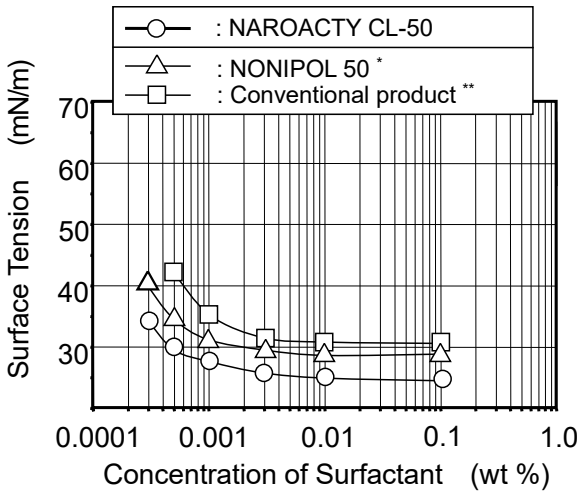

Figure 2. Comparison of NAROACTY CL-50 with Conventional Nonionic Surfactants

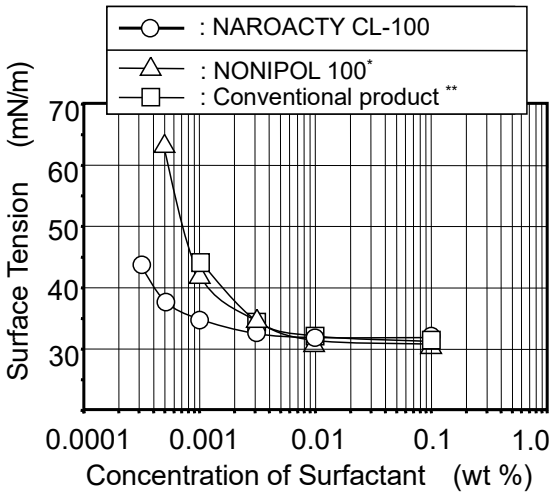

Figure 3. Comparison of NAROACTY CL-100 with Conventional Nonionic Surfactants

* Sanyo Chemical's nonionic surfactant derived from nonylphenol
** Nonionic surfactant derived from higher alcohol, manufactured using a Sanyo Chemical's conventional synthetic technique

Testing Method:
Measured using the Wilhelmy method at 30 °C.

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2. Foaming Property

Figure 4 shows foaming properties of aqueous solutions containing NAROACTY CL products. Figures 5 and 6 show foaming properties of aqueous solutions containing NAROACTY CL-50 and NAROACTY CL-100 in comparison with their equivalent aqueous solutions (conventional nonionic surfactants with the same phenol index or the same cloud point).

Compared to their equivalent aqueous solutions, aqueous solutions containing NAROACTY CL products have slightly lower foaming properties.

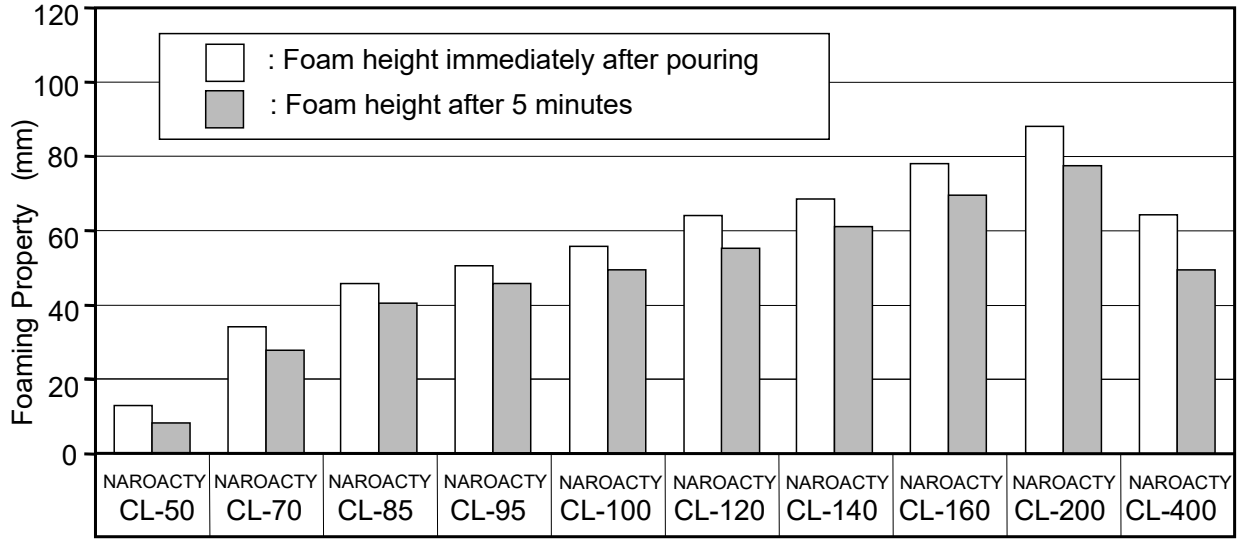

Figure 4. Foaming Property

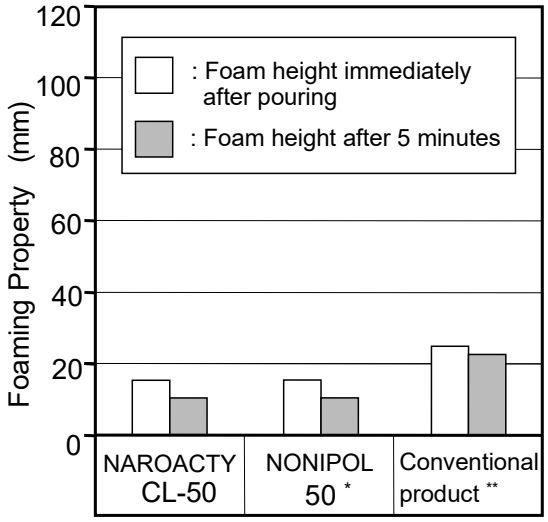

Figure 5. Comparison of NAROACTY CL-50 with Conventional Nonionic Surfactants

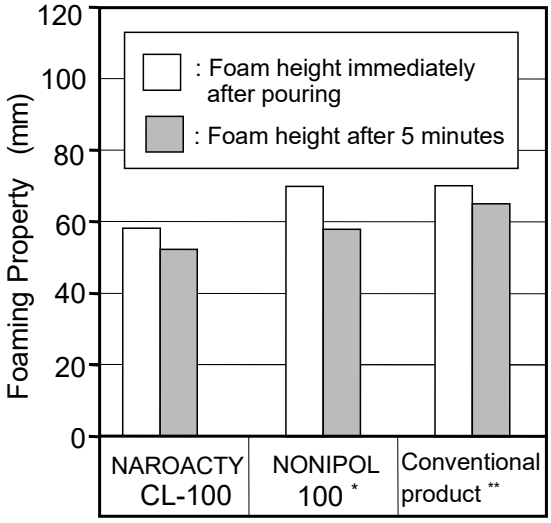

Figure 6. Comparison of NAROACTY CL-100 with Conventional Nonionic Surfactants

* Sanyo Chemical's nonionic surfactant derived from nonylphenol

** Nonionic surfactant derived from higher alcohol, manufactured using a Sanyo Chemical's conventional synthetic technique

Testing Method:

Each 0.02 wt % aqueous surfactant solution was measured using the Ross-Miles method at 20 °C.

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3. Penetrating Property

Figure 7 shows the penetrating properties of aqueous solutions containing NAROACTY CL products measured using the cotton canvas sedimentation method. Figures 8 and 9 show penetrating properties of aqueous solutions containing NAROACTY CL-85 or NAROACTY CL-120 in comparison with their equivalent aqueous solutions (conventional nonionic surfactants with the same cloud point).

Aqueous solutions containing NAROACTY CL products have penetrating properties identical to or better than their equivalent aqueous solutions. Samples were prepared by diluting surfactants with water to achieve 0.01 wt % aqueous solution.

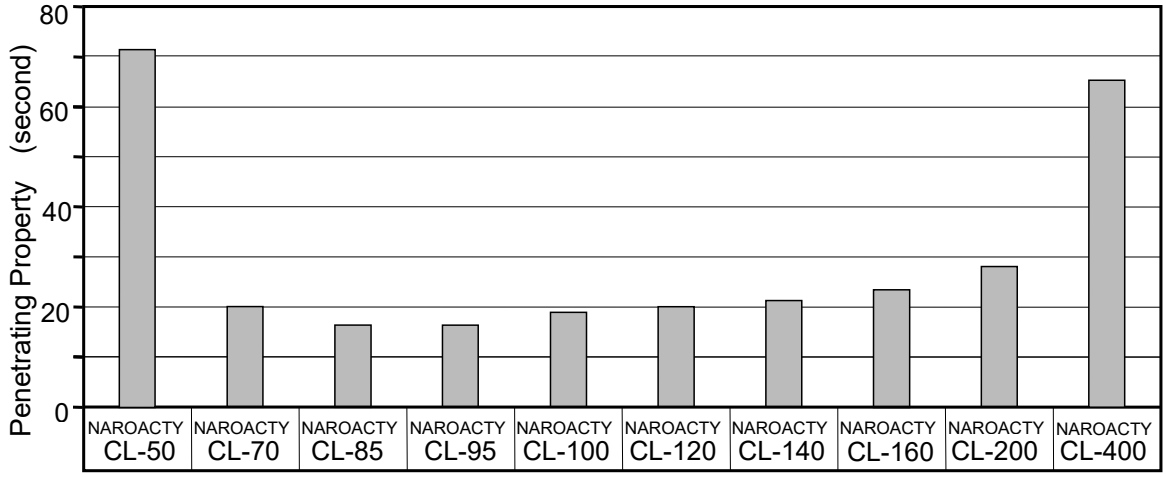

Figure 7. Penetrating Property

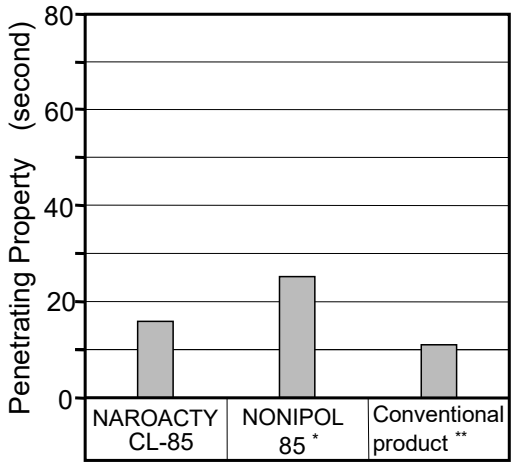

Figure 8. Comparison of NAROACTY CL-85 with Conventional Nonionic Surfactants

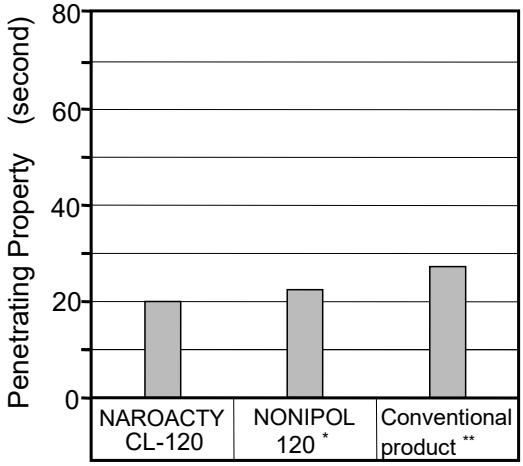

Figure 9. Comparison of NAROACTY CL-120 with Conventional Nonionic Surfactants

* Sanyo Chemical's nonionic surfactant derived from nonylphenol

** Nonionic surfactant derived from higher alcohol, manufactured using a Sanyo Chemical's conventional synthetic technique

Testing Method:

A square piece (15 mm × 15 mm) of cotton canvas was floated on the surface of each sample solution (200 mL adjusted to 20 °C) and the time required for the canvas to begin to sink was measured. The lower the value, the better the penetrating property.

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4. Detergency

A. Performance for Kitchen Detergents

Figure 10 shows the detergency of an example formulation of both NAROACTY CL-85 and its equivalents (conventional nonionic surfactants with the same cloud point).

Compared to its equivalents, NAROACTY CL-85 has higher detergency. Moreover, this product does not have odor because minimal amounts of unreacted higher alcohol remain.

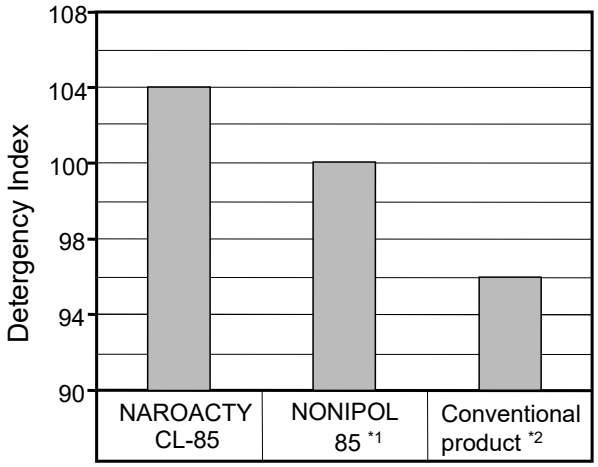

Figure 10. Detergency of NAROACTY CL-85 (in the case of NONIPOL 85 = 100)

*1 Sanyo Chemical's nonionic surfactant derived from nonylphenol

*2 Nonionic surfactant derived from higher alcohol, manufactured using a Sanyo Chemical's conventional synthetic technique

Materials and Methods:

Materials:

The following example formula for kitchen detergents was used for samples.

	wt %
Nonionic surfactant:	5
Sodium polyoxyethylene alkyl ether sulfate:	12
Coconut fatty acid diethanolamide:	3
Ethanol:	2
Water:	Balance
Total:	100

Methods:

Detergency was measured using the Leenerts method (JIS K 3370, Japanese Industrial Standard). Each sample consisted of a set of six glass plates, which were washed at 30 °C with a 0.15 wt % aqueous solution of the example formulation for kitchen detergents in a modified Leenerts tester. The glass plates (6 sheets) were coated with the following artificial sebum.

Artificial sebum

20 g of fats composed of beef tallow and soybean oil (the volume ratio is 1:1), 0.25 g of monoolein and 0.1 g of oil red were dissolved in 60 mL of chloroform.

Detergency was calculated using the following equation.

$$\text{Detergency (\%)} = \frac{\text{Dirt before washing (g)} - \text{Dirt after washing (g)}}{\text{Dirt before washing (g)}} \times 100$$

The detergency of NONIPOL 85 was taken 100 and detergency Index was calculated by the following equation.

$$\text{Detergency Index} = \frac{\text{Detergency of samples}}{\text{Detergency of NONIPOL 85}} \times 100$$

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B. Performance for Laundry Detergents

Figure 11 shows the detergency of an example formulation of both NAROACTY CL-120 and its equivalents (conventional nonionic surfactants with the same cloud point).

Compared to its equivalents, NAROACTY CL-120 has higher detergency.

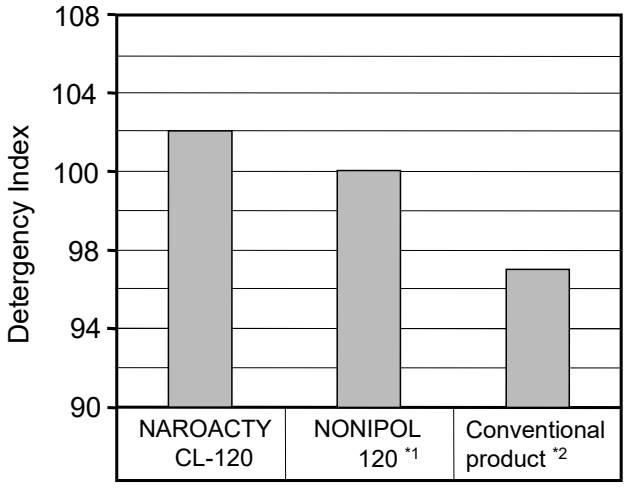

Figure 11. Detergency of NAROACTY CL-120
(in the case of NONIPOL 120 = 100)

*1 Sanyo Chemical's nonionic surfactant derived from nonylphenol
*2 Nonionic surfactant derived from higher alcohol, manufactured using a Sanyo Chemical's conventional synthetic technique

Materials and Methods:

Materials:

The following example formula for laundry detergents was used for samples.

	wt %
Nonionic surfactant:	7
Sodium linear alkylbenzenesulfonate (LAS):	18
Zeolite:	13
Sodium metasilicate:	11
Sodium carbonate:	13
Soap (powder):	2
Sodium carboxymethyl cellulose:	1
Sodium sulfate:	33
Fluorescent brightener, perfume, colorant and water:	Proper quantity
Total:	100

Methods:

Artificially contaminated cloth (made by the Washing Science Association) was washed using a Terg-O-Tometer under the conditions shown below, and its reflectivity were measured using a multi-spectro-color meter at 540 nm.

· Washing: Performed with each 0.133 wt % aqueous sample solution at 30 °C for 10 min, employing a 1:30 bath ratio (fabric:solution, by weight).
· Rinsing: Performed at 30 °C for 3 min 2 times.

Detergency was calculated using the following equation.

$$\text{Detergency (\%)} = \frac{(\text{Reflectivity after washing}) - (\text{Reflectivity before washing})}{(\text{Reflectivity before contamination}) - (\text{Reflectivity before washing})} \times 100$$

The detergency of NONIPOL 120 was taken 100 and detergency Index was calculated by the following equation.

$$\text{Detergency Index} = \frac{\text{Detergency of samples}}{\text{Detergency of NONIPOL 120}} \times 100$$

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5. Emulsifiability

A. Emulsifiability of Mineral Oil

Figure 12 shows the emulsifiability of NAROACTY CL products and their equivalents (conventional nonionic surfactants with the same phenol index) of mineral oil.

NAROACTY CL products have the emulsifiability equivalent to the nonionic surfactants derived from nonylphenol.

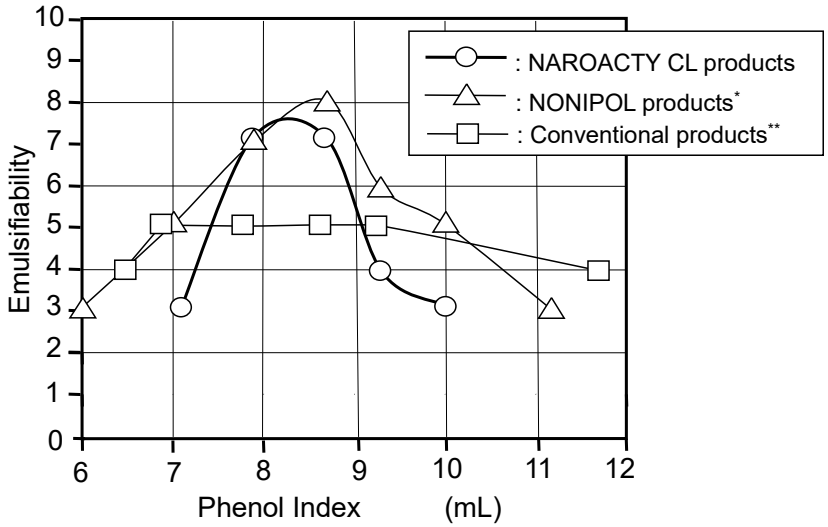

Figure 12. Emulsifiability of Mineral Oil

* Sanyo Chemical's nonionic surfactant derived from nonylphenol

** Nonionic surfactant derived from higher alcohol, manufactured using a Sanyo Chemical's conventional synthetic technique

Materials and Methods:

Materials:

The following determined amounts of (1) and (2) were mixed in a measuring cylinder (100 mL) equipped with a stopper, and then (3) was added to the mixture. It was shaken strongly and used for samples.

	wt %
(1) Mineral oil (aniline point: 70 °C):	4.85
(2) Nonionic surfactant:	0.15
(3) Ion-exchange water:	95
Total:	100

Methods:

After each sample was kept at 25 °C for 1 hour, the appearance of resulting solution was visually evaluated for the emulsifiability as follows:

10 : No separation, emulsified.
9 : Almost emulsified. Upper layer is separated a few millimeters.
8 : Almost emulsified. Upper layer is separated approx. 10 mm.
7 : Almost emulsified. Upper layer is separated approx. 15 mm.
6 : Clearly separated. The interface is unclear and both layers are milky.
5 : Clearly separated. The interface is clear and both layers are milky.
4 : Clearly separated. Upper layer is milky and lower layer is transparent to some extent.
3 : Clearly separated. Upper layer is milky and lower layer is almost transparent.
2 : Clearly separated. Upper layer is milky and lower layer is transparent.
1 : Clearly separated. Both layers are transparent.

B. Emulsifiability of Oxidized Polyethylene Wax

Figure 13 shows the emulsifiability of NAROACTY CL products and their equivalents (conventional nonionic surfactants with the same cloud point) of oxidized polyethylene wax.

NAROACTY CL products have the emulsifiability equivalent to the nonionic surfactants derived from nonylphenol.

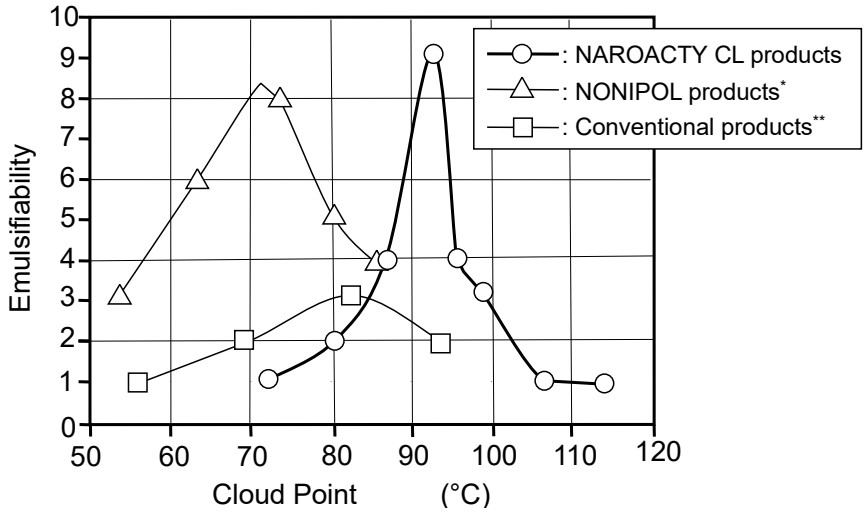

Figure 13. Emulsifiability of Oxydized Polyethylene Wax

* Sanyo Chemical's nonionic surfactant derived from nonylphenol

** Nonionic surfactant derived from higher alcohol, manufactured using a Sanyo Chemical's conventional synthetic technique

Materials and Methods:

Materials:

The following determined amounts of (2), (3) and (4) were mixed uniformly in an autoclave, and then (1) was added to the mixture. It was heated to 140 °C while being agitated. After being kept between 140 and 150 °C for 1 hour, it was cooled down immediately to ambient temperature (20±15 °C), and used for samples.

	wt %
(1) Oxidized polyethylene wax:	40.0
(2) Nonionic surfactant:	11.0
(3) Potassium hydroxide:	0.5
(4) Ion-exchange water:	48.5
Total:	100

Method:

Each sample was diluted with water to achieve 1 wt % solution and the transmittance was measured using a spectrophotometer at 750 nm. The emulsifiability was evaluated as follows:

Emulsifiability	Transmittance (Tr)
10 :	Tr ≥ 80%
9 :	70 ≤ Tr < 80%
8 :	60 ≤ Tr < 70%
7 :	50 ≤ Tr < 60%
6 :	40 ≤ Tr < 50%
5 :	30 ≤ Tr < 40%
4 :	Tr ≤ 30% (liquid dispersed uniformly)
3 :	Tr ≤ 30% (paste with a high viscosity)
2 :	Tr ≤ 30% (a few aggregation was observed)
1 :	Tr ≤ 30% (a lot of aggregates were observed or solidification)

Important :

Before handling this product, refer to the Safety Data Sheet for recommended protective equipment, and detailed hazards and precautionary information.

For detailed information, please contact below.
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