A Motor Oil Soil for Detergency Testing

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ABSTRACT

Bright Stock/Pale Oil (BS/PO) soil represents a typical motor oil soil, but it is more constant in composition than clean or dirty commercial motor oil. It does not require the addition of any dye, as is the case with mineral oil or cooking oil, and when applied to cloth, it produces very uniform soilings. The statistical reproducibility of detergency tests run with BS/PO is better than mineral oil and about as good as sebum.

Oily soils such as mineral oil, cooking oil, and motor oil are important for testing the detergency performance of household laundry products. However, each of these soils suffers from some disadvantages. Both refined mineral oil and cooking oil are colorless, and they require the addition of a dye for the test swatches to be evaluated colorimetrically. The presence of dye can cause problems because of fading and there is always the problem of whether oil and dye are removed from soiled cloth at the same rate.

Motor oil suffers from a problem of reproducibility since each brand generally contains its own unique additive package (e.g., dispersants, corrosion inhibitors) blended with the base stock. Used motor oil can be even more inconsistent because of additional variables such as type and condition of the vehicle and driving habits of the operator.

We have been testing a new oily soil which avoids the previously mentioned problems of motor oil solids but still is by nature a motor oil soil. This oily soil is a 1:1 blend of 95 bright stock and 100 pale oil (Conoco Chemicals, Houston, TX). The terms 95 bright stock and 100 pale oil are general terms commonly used in the refining industry to designate specific lube oil product streams of certain viscosity and other physical property characteristics. Both bright stock and pale oil are major constituents of motor oil base stocks, and a 1:1 blend of the two products represents a typical motor oil without any of the additives. Because these products are refinery streams, their composition is fairly constant and reproducible in sufficient quantity. The pertinent specification data for both bright stock and pale oil are listed in Table 1.

TABLE I

Specification Data for Bright Stock and Pale Oil

	Bright stock	Pale oil
Carbon composition (%)		
Aromatic	6	<1
Napthenic	18	34
Paraffinic	76	66
Hydrogen compositions by NMR		
Total hydrogen (wt %)	13.59	13.80
Aromatic H (% of total)	1.6	1.2
α-aliphatic	3.5	2.9
CH_2 aliphatic	70.1	68.5
CH_3 aliphatic	24.8	27.4
C/H wt ratio	6.36	6.24
Mean molecular weight	784	366

As a result of its aromatic content, bright stock has a deep amber color under normal light and exhibits bright blue fluorescence under UV illumination. For this reason, a 1:1 blend of bright stock/pale oil (BS/PO) does not need any added dye, as is the case with mineral oil and cooking oil.

The procedure of applying BS/PO to cloth is very simple. Strips of permanent press cloth 7 in. long are dipped into a warmed tray of oil and then fed by their ends into a hand-cranked wringer (Schroeder and Tremayne, St. Louis) to squeeze out most of the absorbed oil. The warmed tray (about 90 F) helps keep the oil at a workable viscosity. After each strip has been soiled and run

TABLE II

Statistical Analysis of Soiled Cloth Data, BS/PO Soiled Perm Press Soiled 3-20-80, Plate 2597 Used

Y values
No. of data points = 618
Mean = 49.2
Standard deviation = 0.3391
Stack data

Stack no.	Stack range	No. of cloths
1	48.4-49.1	243
2	49.2-49.9	374

TABLE III

Statistical Analysis of Soiled Cloth Data, Red Mineral Oil Soiled Perm Press, Plate 2597 Used in Reading Soiled 3-20-80

Y values
No. of data points = 645
Max. value = 37.4; min. value = 33.6
Standard deviation = 0.9554
Stack data

Stack no.	Stack range	No. of cloths
1	33.7-34.4	148
2	34.5-35.2	150
3	35.3-36.0	157
4	36.1-36.8	157

TABLE IV

Comparison of Detergency Statistics

Soil	Typical LSD values
Sebum	.9
Red dyed mineral oil	1.8
BS/PO	1.0

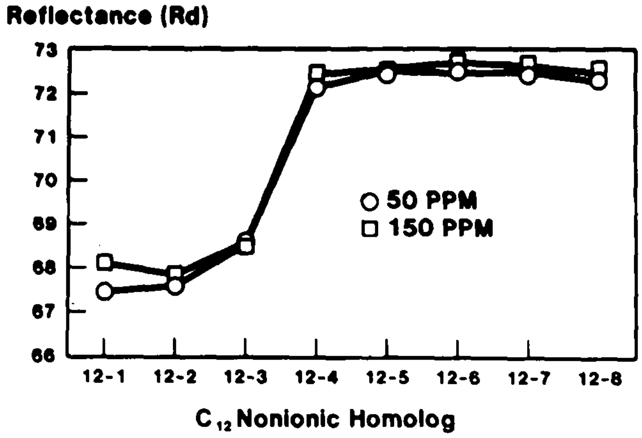

FIG. 1. BS/PO response to individual C_{12} nonionic homologs 35% Ni, 10% LAS.

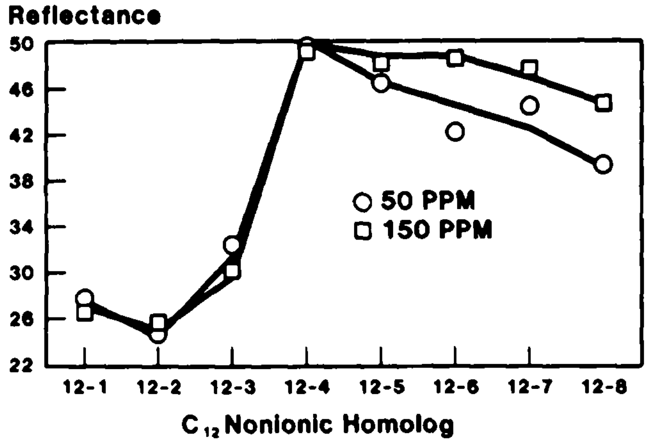

FIG. 2. Mineral oil response to individual C_{12} nonionic homologs 35% N, 10% LAS.

through the wringer once, each is sandwiched between two paper towels and run through the wringer again to squeeze out all the excess oil. The strips are then doubled over several times and cut into 3 in. x 4 in. swatches using a pinked edge die.

The Y reflectance values for each swatch are read and recorded using a Gardner XL-20 interfaced to a G.E. Termi-Nette 200 computer terminal with cassette tape data storage capability. The interface was custom built. The swatches for a given batch are then sorted into stacks, depending on their Y reflectance value. Each stack contains swatches whose Y reflectance values lie within a .7 reflectance unit range.

The uniformity of the soiling of a batch is reflected by the distribution of the swatches. A statistical analysis of a BS/PO soiling is shown in Table II. For comparison, a similar analysis is shown in Table III for a batch of dyed-mineral-oil-soiled cloth. The mineral oil used in these tests was Squibb mineral oil (available at drugstores). The standard deviation of the reflectance values for BS/PO is about .34, whereas for mineral oil it is about .96. The reason for this difference is that all the BS/PO cloths fit into two stacks whereas the mineral oil cloths are distributed among four stacks.

The response of BS/PO soil to a series of C_{12} nonionic homologs is illustrated in Fig. 1. For comparison, the same data for mineral oil soil are shown in Fig. 2. Both soils show similar trends: low detergency for 12-1, 12-2, 12-3 nonionic homologs, and a big increase for 12-4 on up to 12-8. The mineral oil soil is somewhat more sensitive to slight differences in EO distribution of the C_{12} nonionics.

However, the statistical uniformity of the detergency data using BS/PO is much better than with mineral oil. The data illustrated in Table IV compare typical LSD (least significant difference) values for sebum, red dyed mineral oil, and BS/PO soils. The LSD values for BS/PO are about half of the red dyed mineral oil LSD values and are more like the sebum LSD values. This means both the within-pot variation and the pot-to-pot variation of swatches is lower than with mineral oil.

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