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Technical Information

BULLETIN ORS-403B
(Supersedes ORS-403A)

HERCOFLEX® 600 Plasticizer

For Use in Nitrile Rubber

HERCOFLEX® 600 plasticizer is a pale, high-boiling liquid noted for its permanence in vinyl compounds and nitrocellulose lacquer formulations requiring high performance after extended aging. Its extremely low volatility and excellent resistance to heat, light, and moisture are well recognized. These same attributes can also be used to advantage in nitrile rubber (NBR), in which Hercoflex 600 is a very efficient plasticizer and is highly resistant to evaporation. Nitrile rubber plasticized with Hercoflex 600 shows superior low-temperature brittleness properties, particularly after heat-aging.

Hercoflex 600 exhibits no incompatibility or bleed at the 30-phr level in a medium-high acrylonitrile NBR compound. The ease of incorporation and handling during mill mixing is excellent, even in a highly filled compound.

Physical Properties

The value of Hercoflex 600 as a plasticizer for nitrile rubber can best be illustrated by comparison with two well-known plasticizers recommended for this use. Product A is a formal, ether-type plasticizer known for its outstanding low-temperature performance; Product B is a nonvolatile, polymeric, ester-type plasticizer well recognized for its permanence. All three materials were used at the 30-phr level, as indicated below.

Formulation

Materials	Parts by Weight
Nipol[a] 1042	100.0
SRF black	90.0
ZnO	5.0
Stearic acid	1.0
Sulfur	1.5
MBTS[b]	1.5
Plasticizer	30.0

[a] Zeon Chemicals, Inc.
[b] Benzothiazyl disulfide, R. T. Vanderbilt Co. Inc.

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Outstanding Characteristics of Hercoflex® 600 Plasticizer in Nitrile Rubber

- Excellent processibility.
- Low-percent weight change and plasticizer loss after heat-aging.
- Good plasticizer efficiency in reducing hardness.
- Good retention of low hardness after heat-aging, indicating low plasticizer loss.
- Good low-temperature properties.
- Good retention of low-temperature properties after heat-aging, indicating low plasticizer loss.
- Good retention of physical properties relative to the control (unplasticized).
- Low relative change in physical properties after heat-aging, indicating low plasticizer loss.
- Good compression set.

Table I

Comparative Aging Data on Nitrile Rubber

	No Plasticizer	Hercoflex 600	Plasticizer A, Formal Ether	Plasticizer B, Polymeric Ester
Weight change after aging				
70 hrs at 257°F (125°C), %	−0.9	−1.7	−13.2	−1.0
Estimated plasticizer loss				
after aging 70 hrs at 257°F (125°C), %	—	6	94	1
Shore A hardness, points				
Unaged	80	62	61	69
Aged 70 hrs at 257°F (125°C)	89	73	87	80
Net change	+9	+11	+26	+11
Low-temperature brittleness (ASTM D 746B)				
Pass (unaged), °C	−35	−50	−55	−35
Pass (aged 70 hrs at 257°F), °C	−15	−40	−20	−25
Net change, °C	+20	+10	+35	+10
Unaged physical properties (ASTM D 412)				
300% modulus, psi (MPa)	—	2,400 (16.6)	2,240 (15.4)	—
Tensile strength, psi (MPa)	3,380 (23.3)	2,600 (18.0)	2,590 (17.9)	2,030 (14.0)
Elongation, %	270	350	350	280
Aged physical properties, 70 hrs at 257°F (125°C) (ASTM D 573)				
Tensile strength, psi (MPa)	2,940 (20.2)	2,340 (16.1)	2,840 (20.0)	1,770 (12.2)
Change from unaged, %	−25.2	−10.0	+9.7	−12.8
Elongation, %	70	130	100	100
Change from unaged, %	−74.1	−62.9	−71.4	−64.3
Compression set (ASTM D 395, Method B, 25% deflection)				
22 hrs at 212°F (100°C), %	36.7	42.1	54.5	36.9

The data tabulated in Table I demonstrate the excellent performance of Hercoflex® 600 plasticizer. Plasticizer loss after oven-aging is superior to that for Plasticizer A and comparable to that for Plasticizer B. This is reflected not only in the weight loss, but in the relative change in Shore hardness as well. Low-temperature brittleness of Hercoflex 600 compares favorably with that for the comparator plasticizers, and is outstanding after heat-aging. The initial physical characteristics of Hercoflex 600 show good plasticizing efficiency. After heat-aging, the retention of properties is good relative to that for the comparator plasticizers.

Performance in Reference Fuel B and ASTM Oils 1 and 3 is typical of that of monomeric ester plasticizers and similar to Plasticizer A performance, as indicated by the data in Table II.

Table II

Comparative Performance of Reference Fuel B and ASTM Oils 1 and 3

	No Plasticizer	Hercoflex 600	Plasticizer A, Formal Ether	Plasticizer B, Polymeric Ester
Immersion in Reference Fuel B for 70 hrs at room temperature (ASTM D 412, D 471)				
Tensile change, %	−38.8	−28.5	−23.2	−52.7
Elongation change, %	−40.7	−31.4	−25.7	−50.0
Hardness change, points	−17	−10	−8	−17
Volume change, %	+13.6	−5.0	−7.4	+8.7
Weight change, %	+8.3	−6.0	−7.4	+4.6
Immersion in ASTM Oil 1 for 70 hrs at 257°F (125°C) (ASTM D 412, D 471)				
Tensile change, %	−4.7	+6.9	+6.9	+5.9
Elongation change, %	−40.7	−42.9	−45.7	−42.9
Hardness change, points	−2	+15	+16	+6
Volume change, %	−0.1	−15.1	−15.7	−2.0
Weight change, %	−0.5	−12.5	−12.8	−2.2
Immersion in ASTM Oil 3 for 70 hrs at 257°F (125°C) (ASTM D 412, D 471)				
Tensile change, %	−5.1	−6.5	−12.0	−11.3
Elongation change, %	−18.5	−28.6	−37.1	−32.1
Hardness change, points	−10	+2	+3	−8
Volume change, %	+17.1	−0.4	−1.0	+16.9
Weight change, %	+12.6	−0.7	−1.1	+12.1

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Processing and Curing Characteristics

Shearing viscosity data (Mooney viscometer) and cure characteristics (oscillating disc rheometer) for the same formulation with and without Hercoflex® 600 plasticizer are tabulated in Table III.

The decrease in Mooney viscosity again indicates a high degree of plasticizer efficiency, and rheometer data exhibit no tendency toward premature cure (scorch).

Table III

Comparative Processing and Curing Characteristics of Nitrile Rubber With and Without Hercoflex 600

	No Plasticizer	Hercoflex 600	Plasticizer A, Formal Ether	Plasticizer B, Polymeric Ester
Mooney viscosity (ASTM D 1646), ML (1+4), at 212°F (100°C)	Too stiff to run	50	41	66
Cure characteristics[c] (ASTM D 2084)				
Minimum torque, M_L, lbf/in.	18.8	5.6	4.4	5.8
Maximum torque, M_H, lbf/in.	125.6	57.4	60.0	53.2
Scorch time, t_s2, min	3.3	4.4	3.2	4.4
Cure time, t_{90}, min	14.3	16.8	13.0	19.4

[c] Monsanto rheometer, 3° arc; 100 cpm, 310° F (154° C).

Product Safety

Read and understand the Material Safety Data Sheets (MSDSs) before using these products.

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