Issue Date: 1-Nov-98
Supersedes: all other versions

Phosflex® Flame Retardant Plasticizer

Phosflex T-BEP

Product Description

Tributoxyethyl Phosphate is a non-reactive, medium viscosity liquid that shows strong resistance to hydrolysis. It has high solvency for many natural and synthetic resins, and is compatible with waxes, vinyls, cellulosics, polystyrene, polyacrylates, styrene acrylic copolymers, shellac, nitriles, and chlorinated rubbers.

Chemical Name: Tributoxyethyl Phosphate

Typical properties: Structural Formula	$[C_4H_9OC_2H_4O]_3P=O$
Physical appearance	Clear, transparent liquid
Phosphorus content, wt.%	7.8
Specific gravity, 20°C/20°C	1.020
Density @ 20°C, lbs/gal	8.5
kg/m^3	1020
Viscosity @ 25°C, mPa.s	12
Acidity, mg KOH/g	0.5
Water content, wt.%	0.2
Colour, APHA	<75

Uses

Phosflex T-BEP is used commercially as a plasticizer in vinyl plastics, imparting flame retardance and low temperature flexibility. It is a leveling agent in waxes, floor polishes, and paper coatings and is also an excellent antifoam agent in ore benefications.

Synthetic Rubber Compounds

Phosflex T-BEP is widely used as a softener in chlorinated rubber and nitrile formulations. It imparts exceptionally good low temperature flexibility, good resilience, low compression set, and lower flammability. Recommended uses are for seals, gaskets, hoses, shoe soles, and similar applications.

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Phosflex T-BEP (Cont'd)

Typical Formulations

Material	Parts
Nitrile Rubber	100.00
Zinc Oxide	5.00
Sulfur	1.50
Stearic Acid	1.50
SRF Black	60.00
Benzothiazylsulphide	1.50
Tributoxyethyl Phosphate	30.00

TABLE I: Test Results of "Original Properties" of the Vulcanizate Made from the above Formulation

	Cure (In Minutes @ 310°F)	
(Test)	30	45
Modules @ 300% Elongation, psi	1010	1210
Ultimate Tensile Strength, psi	1825	2050
Ultimate Elongation, %	435	440
Hardness Duro A	46	46 (B)
Lupke Rebound, %	--	57
Compression Set (%) ASTM Method B 22 Hours @ 158°F	--	23
ASTM Freeze Test	Pass-60	--
	Fail -70	--
Specific Gravity	--	1.20

TABLE II: Test Results of "Aged Properties" of the Vulcanizate Made from the Formulation and Cured for 30 Minutes @ 310°F

(Test) Emersion Fluids*	Ult. Tensile Strength psi	Ult. Elongation %	Hardness (Duro A)	Vol. Change %	Weight Change %
ASTM #3 Oil	2050	385	48	+1	
ASTM #2 Oil	1400	255	55	-7	
ASTM #1 Oil	2200	385	60	-12	
Ethylene Glycol	2000	265	58	+8	
Distilled Water	1250	235	47	+26	
SR-10 Fuel	1600	385	50	+2	
SR-6 Fuel	800	235	40	+25	
Air Oven	1500	275	48	--	-1

**All Aging done at 212°F for 70 hours*

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TABLE III: Comparison of "Low Temperature Flexibility of Softeners" in a Typical Nitrile Formulation

Softener	Low Temperature Flexibility °C**
Coal Tar Pitch	0
Chlorinated Tricresyl Phosphate	0
Santicizer	-10
Arochlor No. 5460	-10
Glyceryl Triacetate	-10
Tricresyl Phosphate	-10
Methyl Cyclohexyl Adipate	-10
Cumar P-25	-10
Factice 83A	-10
Butyl Captyl Phthalate	-20
Camphor	-20
Dicapryl Phthalate	-25
Baker's No. 781 Oil	-30
Cyclohexyl Phthalate	-30
Dibutyl Phthalate	-35
Dioctyl Phthalate	-35
Cyclohexyl Adipate	-40
Diisobutyl Adipate	-40
Dibenzyl Sebacate	-45
Tributyl Aconite	-45
Phosflex T-BEP	-45

***Test Method and Formulation can be supplied upon request*

Plasticizer

Phosflex T-BEP is a good plasticizer for vinyl plastics. It imparts excellent low temperature flexibility and will produce self-extinguishing properties. It can be used in combination with other plasticizers for producing low-viscosity plastisols.

Typical Formulations

Material	Parts
Polyvinyl Chloride Resin	100.00
Stabilizer	1.00
Phosflex T-BEP	44.00

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TABLE IV: Test Results Obtained in the Above Formulation

(Test)	Results
Modulus @ 100% Elongation (25°C and 50% RH)	1470 psi
Ult. Tensile Strength (25°C and 50% RH)	2800 psi
Ult. Elongation (25°C and 50% RH)	290%
Hardness, Shore Dur. A (25°C and 50% RH)	78
Low Temperature Flexibility - SPI Crack Test	
80% passed at	-40°F
50% passed at	-45°F
Flammability SPI in/sec	Self-Extinguishing

Floor Polishes and Waxes

Phosflex T-BEP is an important ingredient in high quality floor polishes. It is widely used in polystyrene, polyacrylate, and styrene acrylic copolymer formulations. It acts as a plasticizer and improves leveling and spread. Films can be cast that do not show puddling or drawing-in without excessive softening. It can readily be emulsified and is compatible with many resins, polymers, and natural waxes.

For some floor wax compositions, *Phosflex* T-BEP is used as a co-plasticizer with tributyl phosphate or phthalate plasticizers. The combined effect is to render the ingredients mutually compatible. This process is employed with a carnauba wax, shellac, polystyrene composition. *Phosflex* T-BEP is not completely compatible with some microcrystalline waxes.

Typical Polystyrene Emulsion Floor Polish

	Parts
(a) Shellac modified polystyrene emulsion at 14%	70.0
(b) Shellac solution at14%	20.0
(c) Polyethylene Emulsion at 14%	10.0
Phosflex T-BEP	1.0

This type of polish is typical of the shellac-containing polishes most common to the floor polish industry. Its high resistance to water spotting, excellent recoatability, and durability assure its performance in both conventional and spray maintenance.

		Parts
(a)	U.B.S. Chemical Co. (UL-2001 Ubatol)	
(b)	Shellac Solution	100.0
	Light colored shellac	25.0
	NH_4OH-26°Be'-28%	589.0
	Water to 14%	
(c)	Polyethylene Emulsion	100.0
	Emulsified polyethylene	20.0
	Oleic Acid	20.0
	Morpholine	717.0
	Water to 14%	

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Phosflex T-BEP (Cont'd)

Typical Acrylic Emulsion Floor Polish

	Parts
(a) Acrylic Emulsion	80.0
(b) Ammonia	12.5
(c) Morpholine Oleate	7.5
(d) Leveling Agents	1.0
Phosflex T-BEP	0.7

(a) U.B.S. Chemical Company *U-3101 Ubatol)
(b) Durez Plastic Division Hooker Chemical (Durez 15546)
(c) Semet-Solvay Div., Allied Chemical Corp. (AC-629)
(d) Minnesota Mining and Manufacturing Co. (FC-134)

Typical Formulation for Buffable Floor Polish (14% Solids)

	Parts
Polymer emulsion (14% concentration)	70.0
Nonionic-anionic wax emulsion, 14%	30.0
Tributoxyethyl Phosphate	1.0
Methyl Carbitol	2.0
Wetting Agent	0.5

The ingredients are blended in order listed using good agitation. Maintain stirring for 30 minutes after last addition as with conventional polish systems. It is best to dilute the polymer before adding the other components.

Toxicity
Tributoxyethyl phosphate is an organic solvent that can be handled safely when the usual industrial hygiene practices are observed. As with most organic solvents, prolonged or repeated contact with the skin should be avoided. Although *Phosflex* T-BEP is of relatively low volatility, it should be used with adequate ventilation. *Phosflex* T-BEP must not be taken internally.

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Harwick Standard Distribution Corporation

Plasticizers

Harwick Standard offers a broad line of plasticizers to meet the needs of both rubber compounders and flexible PVC formulators. By offering a large range of products, we provide our customers the versatility of identifying a plasticizer family that is effective with various polymers, and gives several product options from which to choose for optimum performance characteristics - from general use to most demanding requirements.

Harwick Standard's experienced technical and sales staff can assist in selecting the best plasticizer to meet your requirements. Please contact us for assistance with your compounding needs.

Non-Phthalate C-9

Tradename(s)	Chemical Name	Polymer Usage	General Purpose	Low Temperature/ Flexibility	Low Volatitity	Low Extraction	Heat Aging Resistance	High Solvating	Miscellaneous
Polycizer® DHIN	1-2 cylcohexane dicarboxylic acid diisononyl ester	R-1,2/P-1	√						Performance similar to DOP in NBR compounds

Adipates

Tradename(s)	Chemical Name	Polymer Usage	General Purpose	Low Temperature/ Flexibility	Low Volatitity	Low Extraction	Heat Aging Resistance	High Solvating	Miscellaneous
Polycizer® DOA	Di-2 ethylhexyl adipate	R-1,2/P-1,2	√	√					FDA, low water extraction, UV stability
Merrol® 4206 (DBEA)	Dibutoxyethyl adipate	R-1,2,3/P-2		√					
Polycizer DBEEA Merrol 4226	Dibutoxyethoxyethyl adipate	R-1,2,3		√	√	√	√		

Azelates

Tradename(s)	Chemical Name	Polymer Usage	General Purpose	Low Temperature/ Flexibility	Low Volatitity	Low Extraction	Heat Aging Resistance	High Solvating	Miscellaneous
Merrol DOZ-E	Di-2 ethylhexyl azelate	R-1,2/P-1,2	√	√	√				Excellent low temp

Polymer Usage Key	
R-1	NBR, NBR/PVC
R-2	CR, CPE, CSM
R-3	ECO, Fluoroelastomers, Polyacrylates

Polymer Usage Key	
P-1	PVC
P-2	PVAC, PS, ABS, Cellulosics
P-3	Eng, Resins, Polyester, Alloys

Benzoates

Tradename(s)	Chemical Name	Polymer Usage	General Purpose	Low Temperature/ Flexibility	Low Volatitity	Low Extraction	Heat Aging Resistance	High Solvating	Miscellaneous
Benzoflex® 9-88	Dipropylene glycol dibenzoate	R-1/P-1,2			√			√	Polyurethanes
Benzoflex 50	Diethylene/ dipropylene glycol dibenzoate	R-1/P-1,2			√			√	Water-based adhesives
Benzoflex 2088	Diethylene glycol dibenzoate, triethylene glycol dibenzoate, dipropylene glycol dibenzoate	R-1/P-1,2			√	√		√	High solvator, low VOC's, FDA

Chlorinated Paraffins

Tradename(s)	Chemical Name	Polymer Usage	General Purpose	Low Temperature/ Flexibility	Low Volatitity	Low Extraction	Flame Resistance	High Solvating	Miscellaneous
Chloro Flo/ Paroil Series	Liquid chlorinated paraffins	R-2/P-1	√		√		√		

Mono-Esters

Tradename(s)	Chemical Name	Polymer Usage	General Purpose	Low Temperature/ Flexibility	Low Volatitity	Low Extraction	Heat Aging Resistance	High Solvating	Miscellaneous
Polycizer Butyl Oleate	N-butyl oleate	R-2/P-2		√					Primary light color plasticizer for polychloroprene
Polycizer MO	Vegetable Oil	R-2		√	√		√	√	Low & high temp for polychloroprene
Plasticizer OLN	Oleyl nitrile	R-1				√		√	Low & high temp for polychloroprene
Natroflex® IOT	Isooctyl tallate	R-1,2	√	√					
Merrol 818T	Alkyl tallate	R-1/P-2	√	√					

Polymer Usage Key	
R-1	NBR, NBR/PVC
R-2	CR, CPE, CSM
R-3	ECO, Fluoroelastomers, Polyacrylates
P-1	PVC
P-2	PVAC, PS, ABS, Cellulosics
P-3	Eng, Resins, Polyester, Alloys

Petroleum Process Oils

Tradename(s)	Chemical Name	Polymer Usage	General Purpose	Low Temperature/ Flexibility	Low Volatitity	Low Extraction	Heat Aging Resistance	High Solvating	Miscellaneous
Stan-Lube Series	Paraffinic oils	Non-polar	√						Light color, good for EPRs
Stan-Plas Series	Naphthenic oils	R-1	√						General Processability
Duoprime® Series	White oils	Non-polar	√						FDA

Phosphate Esters

Tradename(s)	Chemical Name	Polymer Usage	General Purpose	Low Temperature/ Flexibility	Low Volatitity	Low Extraction	Flame Resistance	High Solvating	Miscellaneous
Lindol®	Tricresyl phosphate	P-1,2	√		√		√	√	
Phosflex® 41L Merrol 521	Isopropylated triaryl phosphate	R-1,2/P-1					√		
Phosflex T-BEP	Tributoxylethyl phosphate	R-1,2,3/P-1,2		√			√	√	
Phosflex 71-B	Butylated triphenyl phosphate	R-1,2/P-1					√		
Phosflex 362	2-ethyhexyl diphenyl phosphate	R-1,2/P-1,2					√		
Phosflex 390	Isodecyl diphenyl phosphate	R-1,2/P-1,2					√		

Polymer Usage Key	
R-1	NBR, NBR/PVC
R-2	CR, CPE, CSM
R-3	ECO, Fluoroelastomers, Polyacrylates
P-1	PVC
P-2	PVAC, PS, ABS, Cellulosics
P-3	Eng, Resins, Polyester, Alloys

Phthalates

Tradename(s)	Chemical Name	Polymer Usage	General Purpose	Low Temperature/ Flexibility	Low Volatitity	Low Extraction	Heat Aging Resistance	High Solvating	Miscellaneous
Merrol DAP	Diallyl phthalate	R-1,2/P-3						√	Co-curing
Polycizer DBP Merrol DBP	Di-n-butyl phthalate	R-1,2/P-1,2	√					√	Good emollient for cosmetics
Polycizer DIDP	Diisodecyl phthalate	R-1,2/P-1,2			√	√			Also E grade
Polycizer DINP Merrol DINP	Dissononyl phthalate	R-1,2/P-1,2			√				
Polycizer DOP Merrol DOP	Di-2-ethylhexyl phthalate	R-1,2/P-1,2	√						
Polycizer DUP	Diundecyl phthalate	R-1,2/P-1,2		√	√		√		Low fogging Also CA grade

Polymerics

Tradename(s)	Chemical Name	Polymer Usage	General Purpose	Low Temperature/ Flexibility	Perme-ability	Migration Resistance	Low Extraction	Heat Aging	Miscellaneous
Admex® P-27	Polyester adipate	R-1/P-1,2				√			High purity, good electrical properties
Admex 409	Polyester adipate	R-1/P-1,2	√			√		√	Good electrical properties
Admex 412	Polyester adipate	R-1/P-1		√	√				Low viscosity, easy processing
Amdex 429	Polyester adipate	R-1,2/P-1,2				√			Non-fogging, humidity resistance
Admex 523	Mixed polyester	R-1/P-1,2	√			√	√		Low viscosity
Admex 760	Polyester adipate	R-1,2/P-1,2			√	√			Excellent permanence, low water extractability
Admex 761	Polyester adipate	R-1/P-1,2					√		
Admex 770	Mixed polyester	R-1,2/P-1,2			√	√			Excellent weatherability (decals)
Admex 775	Mixed polyester	R-1/P-1,2							Excellent resistance to aqueous & organic solvents
Admex 910-001	Mixed polyester	R-1/P-1,2					√		Low water extraction
Admex 1723	Mixed polyester	R-1/P-1,2			√				Printability
Admex 2632	Mixed polyester	R-1/P-1,2	√						FDA

Polymerics (continued)

Tradename(s)	Chemical Name	Polymer Usage	General Purpose	Low Temperature/ Flexibility	Perme-ability	Migration Resistance	Low Extraction	Heat Aging	Miscellaneous
Admex 6187	Polyester adipate	R-1/P-1,2				√	√		Solvent & oil resistance
Admex 6985	Polyester adipate	R-1/P-1,2				√	√	√	Very low volatility
Admex 6994	Mixed polyester	R-1/P-1,2				√			Mar resistance, low fogging
Admex 6995	Polyester adipate	R-1/P-1,2			√				UV weatherability
Admex 6996	Polyester adipate	R-1/P-1,2		√					Printability

Tradename(s)	Chemical Name	Polymer Usage	General Purpose	Low Temperature/ Flexibility	Low Volatility	Low Extraction	Heat Aging Resistance	High Solvating	Miscellaneous
Merrol P-6320	Polyester adipate	R-1,2/P-1		√		√			Solvent & oil resistance, low temp flexibility
Merrol P-6412	Polyester adipate	R-1,2/P-1,2				√			Medium viscosity, FDA
Merrol P-6410	Polyester adipate	P-1,2			√	√			
Merrol P-6420	Polyester adipate	P-1				√			Good color

Sebacates

Tradename(s)	Chemical Name	Polymer Usage	General Purpose	Low Temperature/ Flexibility	Low Volatitity	Low Extraction	Heat Aging Resistance	High Solvating	Miscellaneous
Polycizer DBS	Di-n-butyl sebacate	R-1,2/P-1,2		√				√	FDA
Polycizer DOS Merrol DOS	Di-2-ethylhexyl sebacate	R-2/P-1,2	√	√		√			Low temp greases & caulks

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Polymer Usage Key	
R-1	NBR, NBR/PVC
R-2	CR, CPE, CSM
R-3	ECO, Fluoroelastomers, Polyacrylates
P-1	PVC
P-2	PVAC, PS, ABS, Cellulosics
P-3	Eng, Resins, Polyester, Alloys

Specialty

Tradename(s)	Chemical Name	Polymer Usage	General Purpose	Low Temperature/ Flexibility	Perme-ability	Migration Resistance	Low Extraction	Heat Aging	Miscellaneous
Plasticizer SC-B	Triethyleneglycol dicaprate/caprylate	R-1,2,3		√				√	FDA
Plasticizer SC-E	Triethyleneglycol di 2-ethylhexanoate	R-1,2,3		√					Flexibilitity over a wide temp range
Hercoflex® 600	Pentaerythritol ester of fatty acids	R-1,2		√	√	√	√	√	Excellent low and high temp
Hercoflex 707, 707A	Pentaerythritol ester of fatty acids	R-1,2		√	√	√	√	√	Excellent low and high temp
Polycizer ESO Merrol E-68	Epoxidized soybean oil	R-1/P-1,2,3			√	√		√	Good heat stabilizer

Trimellitates

Tradename(s)	Chemical Name	Polymer Usage	General Purpose	Low Temperature/ Flexibility	Perme-ability	Migration Resistance	Low Extraction	Heat Aging	Miscellaneous
Polycizer TOTM	Tri-2-ethylhexyl trimelliatate	R-1,2/P-1,2			√		√	√	Also E&CA grades, excellent water resistance
Merrol 810TM-E	Tri(n-octyl/n-decyl) trimellitate	R-2		√	√		√	√	Oxidation resistance, excellent water resistance
Polycizer TINTM	Triisononyltrimellitate	R-1,2/P-1,2			√	√	√	√	

Polymer Usage Key	
R-1	NBR, NBR/PVC
R-2	CR, CPE, CSM
R-3	ECO, Fluoroelastomers, Polyacrylates
P-1	PVC
P-2	PVAC, PS, ABS, Cellulosics
P-3	Eng, Resins, Polyester, Alloys

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