Momentive Performance Materials' New e-free* 189 silane

SILANES - TIRE & RUBBER

The latest advancement in silanes for mineral coupling in industrial rubber and other applications is e-free 189 silane. This mercapto-functional silane is essentially ethanol-free. It offers excellent all-around performance with significant improvements in processing characteristics *(i.e.* reduced viscosity, faster cure with adequate scorch safety). Improved filler dispersion with maximum silica/polymer coupling is evident by the outstanding reinforcement index. Therefore physical properties are further enhanced while maximizing abrasion resistance gains. e-free 189 silane may be used to replace traditional mercapto silanes to achieve increased end-product performance or may be used at reduced levels to maintain properties and lower overall compound cost. e-free 189 silane should virtually eliminate(1) the ethanol that is released during processing and use of mineral-reinforced rubber articles associated with traditional mercapto silanes like Silquest* A-189 silane and Silquest A-1891 silane.

(1) Contains less than 1% by weight, total releasable ethanol.

Features and Benefits of e-free 189 silane

e-free 189 silane is an excellent candidate to consider for improved dynamic and physical properties with reduced manufacturing costs, through improved processing and virtual elimination of ethanol emissions.

Key Features and Typical Benefits

- ethanol (VOC) emissions essentially eliminated during mixing and use
- easier mixing, faster processing and shorter curing cycles resulting in higher throughput
- high temperature mixing without viscosity increase or scorch safety reduction
- long shelf life for uncured compounds, yielding less scrap due to over-aged green compounds
- improved modulus, tensile strength and abrasion resistance
- improved balance in abrasion and cushioning effects in shoe sole compounds
- excellent dispersion and low reagglomeration

Typical Physical Properties(2)	
Physical Form	Liquid
Color	Clear, colorless
Specific Gravity at 25°C	1.078
Flash Point, Pensky-Martens Closed Cup, ASTM D93 (estimated) °C (°F)	>93 (200)

(2) Values shown only for information and are not intended for specification preparation.

How to Use

Following are typical suggested loading levels of e-free 189 silane:

- shoe sole compounds with silica (1.5-2.5 phf)
- wire and Cable and/or Clay compounds (0.25-1.0 phf)

The optimal loadings of e-free 189 silane and the processing conditions including mixing temperature and time may vary, depending on formulations used. The user should optimize the loadings and mix conditions before end use.

Processing and Performance of e-free 189 silane

The formulation in Table 1 was used to compare e-free 189 silane with traditional mercapto silanes in a simplified model shoe-sole compound. The compounds were mixed at 160°C in two non-productive mix steps.

Table 1: Simplified Formulation for Shoe Soles

Ingredient	PHR
Butadiene Rubber	60
Natural Rubber	20
Nitrile Rubber	20
Silica	42
Wax	3
Stearic Acid	0.5
Zinc Oxide	4
Silane	1.5
Processing Aid	3
Tackifier	2
Antioxidant	1
Vulcanizing Agents	
Sulfur	2
MBT	0.2
MBTS	1
TMTM	0.12

Note: Test data. Actual results may vary.

Comparison of Performance Characteristics: e-free 189, Silquest* A-1891 silane

Compound performance and processing characteristics with e-free 189 silane, Silquest A-1891 silane (Mercapto triethoxy silane), and with no silane are compared in Table 2. These data demonstrate a reduction of compound viscosity with improved silica dispersion for smoother extrusion and faster mold flow with e-free 189 silane. Physical properties are enhanced with more effective coupling, higher modulus and tensile and with maximum abrasion resistance. Shorter curing cycles allow for a faster cure rate index (t90-ts2).

Table 2

Ingredient (phr)	e-free 189 silane	Silquest A-1891 silane	No silane
e-free 189 silane	1.5	–	–
Silquest A-1891 silane	–	1.5	–
Viscosity @ 212°F			
Milled MB ML1+4	89	116	94
Final ML1+4	59	67	77
Scorch (t5) @ 250°F (min)	2.3	2.43	6.1
Rheometer (ODR) Properties (302°F/30 min/1°arc)			
t_{s2} (min)	1.2	1.15	2.48
t90 (min)	2.76	3.56	3.85
Cure Rate Index (t90-ts2)	1.56	2.41	1.37
M_L	9.11	10.57	13.31
M_H	32.35	31.34	37.65
Physical Properties, cured 5 min @ 302°F			
Hardness (Shore A)	56	55	61
Elongation (%)	445	444	670
10% Modulus (Mpa)	58	69	84
100% Modulus (Mpa)	407	475	318
300% Modulus (Mpa)	1461	1417	795
Reinforcement Index (300%/100%)	3.59	2.98	2.50
Tensile (psi)	2515	2194	2468
Abrasion Resistance, DIN Method			
Volume Loss, mm^3	28	27	51

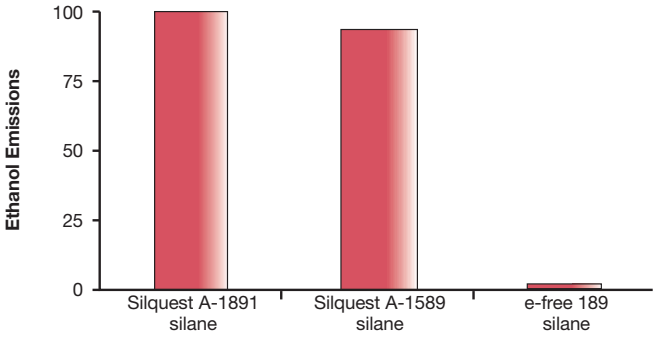
Note: Test data. Actual results may vary.

*e-free and Silquest are trademarks of Momentive Performance Materials Inc.

Ethanol Emissions Measurement

Ethanol emissions are reduced by more than 97% with New e-free 189 silane, and 6% with Silquest* A-1589 silane (disulfide silane), versus Silquest A-1891 silane (mercapto triethoxy silane). Ethanol emissions were measured during Banbury mixing (1.5 liter mixer) of a rubber compound containing 100 phr of an SBR/BR blend, 80 phr precipitated silica and 6.2 phr of silane(1) The compounds were mixed in one non-productive step for a total of 15 minutes with the mix held at about 160°C for 10 minutes. Exhaust gases were suctioned out from the vent line at 1.5 liters/min and adsorbed onto charcoal tubes, which were later analyzed for ethanol content. Ethanol evolved from mixing with Silquest A-1891 silane is normalized to 100 in Table 3.

Table 3: Ethanol Emissions Measurements – 1.5 Liter Banbury Mixer



1) Silquest A-1589 silane (Disulfide silane), Silquest A-1891 silane (Mercapto triethoxy silane), and e-free 189 silane

Note: Test data. Actual results may vary.

Patent Status

e-free silane is the subject of multiple pending U.S. patent applications.

Nothing contained herein shall be construed to imply the nonexistence of any relevant patents or to constitute the permission, inducement or recommendation to practice any invention covered by any patent, without authority from the owner of the patent.

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