

NAUGARD[®] P and NAUGARD[®] PHR

Organic Phosphite
Antioxidants

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NAUGARD® P AND NAUGARD® PHR ORGANIC PHOSPHITE ANTIOXIDANTS

FEATURES

- **FDA APPROVED*** for protecting polymeric products used for packaging or handling food
- **LOW VOLATILITY** minimizes losses during incorporation and high temperature processing.
- **LOW COST** and effective in small amounts (as little as 0.05% may be used in some applications)
- **PROVEN EFFECTIVENESS** in a wide variety of polymers.

* See Back Page – FDA Status.

NAUGARD® P is tris(mono-nonylphenyl)phosphite. It is an effective processing stabilizer and antioxidant for a wide variety of plastics. NAUGARD® PHR is an especially hydrolysis-resistant form of Naugard P which contains tri-isopropanol amine to retard hydrolysis during extended storage periods under humid conditions or during contact with moisture at high temperatures.

APPLICATIONS

Naugard P alone or in combination with other antioxidants is effective in polyethylene, polypropylene, EVA-wax blends, PVC, polycarbonates and polyphenylene oxide, halogenated polyolefins, polyvinyl ethers, waxes, and related materials. In addition, it is useful as an additive to protect scrap resins during reclaiming.

The synergism shown by combinations of Naugard P with hindered phenolic and thiodipropionate antioxidants has proven valuable in several polymers. In addition to the improved antioxidant activity of the combinations, Naugard P also inhibits discoloration caused by some phenolic antioxidants.

The basic function of Naugard P, peroxide decomposition, suggests that it could be of value in many organic materials subject to oxidative degradation.

In general, Naugard P and Naugard PHR are interchangeable with the latter being recommended where hydrolysis may be a particular problem.

GENERAL PHYSICAL PROPERTIES

Physical Form	clear viscous liquid
Color – Pt-Co	75 max
Specific Gravity 25/15.5°C	0.985
Refractive Index	1.527
Viscosity, 25°C (77°F) 49°C (120°F)	6,000 cps (6.0 N s/m ²) 525 cps (0.5 N s/m ²)
Pour Point	-7°C (20°F)
Flash Point (TOC)	221°C (430°F)
Fire Point (TOC)	235°C (455°F)
Phosphorus Content	4.3%
Solubility	miscible with most organic solvents. Insoluble in water

VOLATILITY PROPERTIES

Naugard P and PHR have good volatility properties as shown in Figure 1. The thermogravimetric analysis was done under an air atmosphere with a heating rate of 5°C per minute.

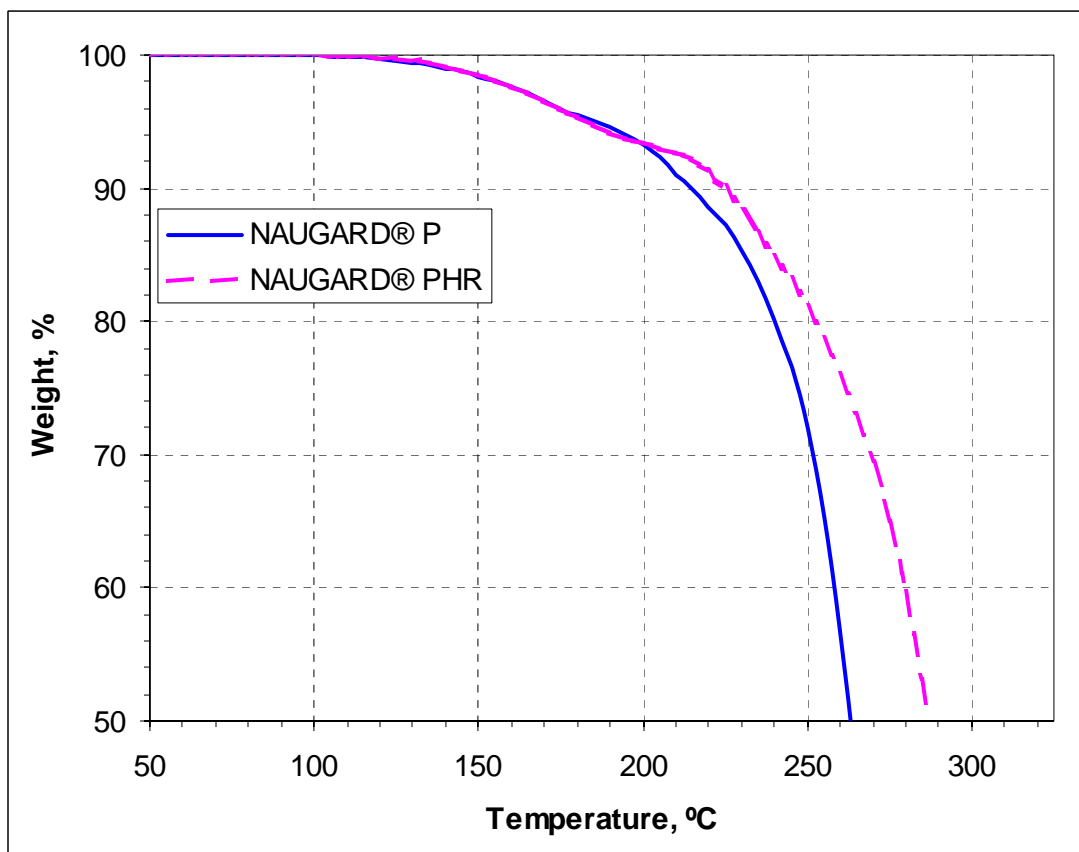


Figure 1

HYDROLYSIS RESISTANCE OF NAUGARD PHR

As previously mentioned, Naugard PHR is an especially hydrolysis resistant form of Naugard P. With normal storage and handling conditions Naugard P is quite satisfactory, but occasional problems arise due to hydrolysis under humid conditions. Naugard PHR is more resistant to hydrolysis under these unusual circumstances. The data in Figure 2 gives a comparison of Naugard P, Naugard PHR and competitive products in an accelerated test for hydrolytic stability.

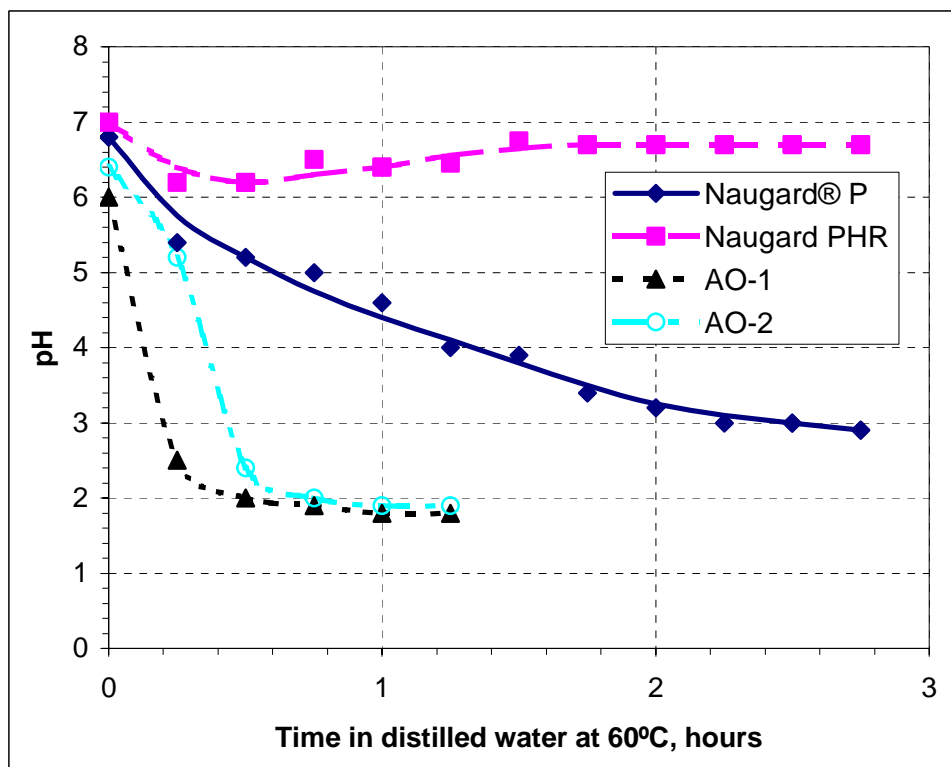


Figure 2

Conditions: Two mmoles (equivalent P-OR) were added to 50 mls distilled water and heated at 60°C while pH is monitored.

*AO-1 = di(stearyl)pentaerythritol diphosphite.

AO-2 = di(stearyl)pentaerythritol diphosphite with up to 1.0% triisopropanol amine.

ADDITION TO RUBBER

Naugard P and Naugard PHR are used during the manufacture of emulsion rubbers (SBR and NBR) to prevent polymer degradation during isolation and drying as well as to provide a constant Mooney viscosity during shipment and storage. These stabilizers are added in emulsion form, and a suitable emulsion recipe follows.

27.4% Active Emulsion Recipe for Naugard P or Naugard PHR

Ingredient	Parts by Weight
Naugard P or Naugard PHR	100.00
Oleic Acid	8.75
Sodium Hydroxide (100%)	1.57
Softened Water	254.00
Total	364.32

To prepare the emulsion, Naugard P (or PHR) is charged to the tank and oleic acid is added with continuous agitation. The caustic (sodium hydroxide) is diluted separately to give a 25% solution, then added slowly to the Naugard P and oleic acid mixture. The remaining water is metered in slowly. If necessary, the pH is adjusted to 10.5 minimum with dilute caustic. Do not heat the emulsion over 50°C (120°F) and do not let the Naugard P contact water alone, caustic should always be present.

Naugard P in emulsion form was added to unstabilized SBR 1502 at 1.0% active antioxidant, then the latex was coagulated, washed and dried. The resulting gum rubber was aged in a circulating air oven with samples periodically taken for measurement of Mooney viscosity. The results of aging at 100°C (212°F) are shown in Figure 3.

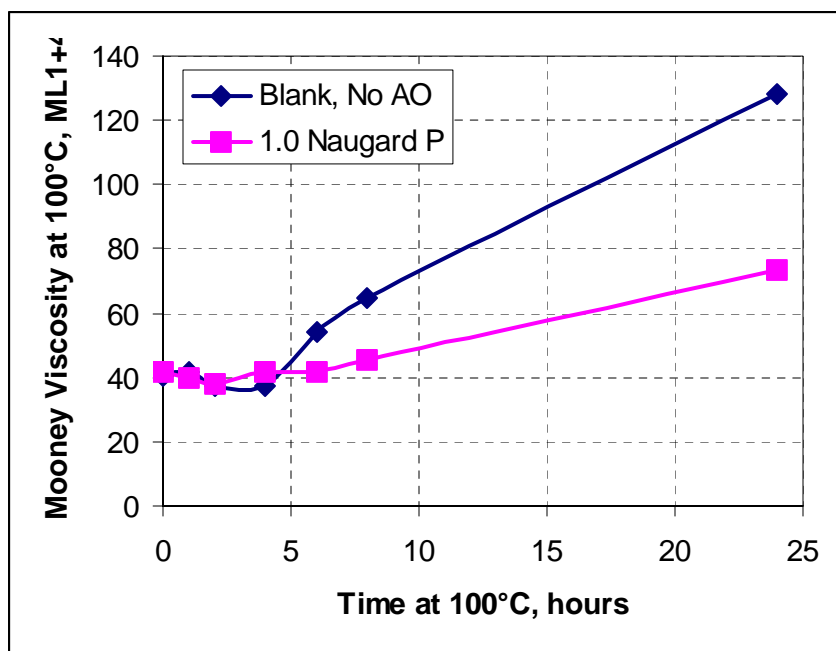


Figure 4

Similar agings at 70°C (158°F) show the rubber stabilized with Naugard P has less change in Mooney viscosity after 3 weeks than the blank after 1 week.

ADDITION TO PLASTICS

Both Naugard P and Naugard PHR may be added to plastics by spraying into a suitable dry blender or by adding directly to the polymer latex by emulsification. The viscosity of these products may be reduced by heating (see Figure 3 Viscosity Curve) or diluting with a suitable carrier such as mineral oil. Subsequent fluxing in an extruder will insure complete dispersion in the polymer. In cases where dry blending is not used, Naugard P and Naugard PHR may be added directly on a mill or into a Banbury.

STORAGE AND HANDLING NAUGARD P AND NAUGARD PHR

These products may be stored several months in sealed drums. Storage may be indoors or outside. If the storage temperature is in excess of 49°C (120°F), storage life is 4-5 months. If stored outside in cold weather, the drums should be warmed to facilitate pouring. (See Figure 3 for viscosity data). Opened drums should be used as soon as possible to avoid hydrolysis, especially during humid weather.

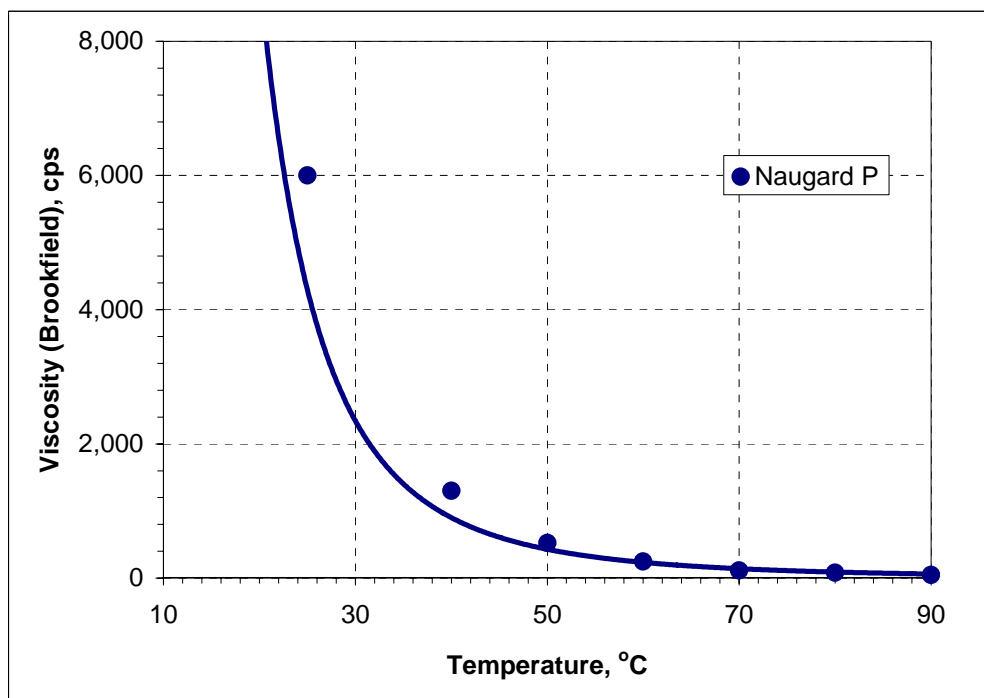


Figure 4

Bulk storage may be in steel tanks. The initial loading may show some discoloration but subsequent material will not discolor because pickling of the steel occurs. Stainless steel (type 304) shows no discoloration on initial loading. For easy pumpability, storage at 49-60°C (120-140°F) is recommended (See Figure 3). For heating, steam coils, plate coils or jacketing may be used. Steam pressure should not exceed 50 psig and a controller should be used to prevent overheating of the Naugard P or PHR. If steam

coils are used, they should be checked periodically to insure that excessive corrosion and resultant failure is prevented.

The tank vent should be equipped with a desiccator to prevent sucking in humid air. If it is necessary to heat pump lines, etc., steam tracing is adequate.

Table 1 shows the estimated storage life of Naugard P at various temperatures in bulk storage equipped with a desiccator type vent.

**TABLE 1
BULK STORAGE LIFE OF NAUGARD P**

121°C (250°F)	4 days
60°C (140°F)	2-3 months
27°C (80°F)	6 months – one year

Naugard PHR would have substantially longer storage life under the above conditions.

FDA STATUS

Naugard P and Naugard PHR have unrestricted approval under Food Additives Regulations, Subpart F, Section 178.2010 (Antioxidants and/or Stabilizers for Polymers). Naugard P and PHR may be used in any base polymer system which has approval under the FDA Food Additives Regulations.

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