TAMOL™ 960
TAMOL 731A Scale Inhibitors

Description

In aqueous systems, such as boiler feed water and recirculated cooling water, dissolved salts and solid particles are present, which can form harmful scale deposits on equipment surfaces. Prevention of these deposits is essential for efficient equipment operation. Scale inhibition can be accomplished effectively with the use of synthetic polymers. Highly carboxyl-functional polymers such as TAMOL™ 960 and TAMOL 731A, scale inhibitors can be used in various aqueous systems over a wide temperature range.

Features and Benefits

- Inhibit scale deposits on equipment surfaces
- Promote efficient heat transfer
- Inhibit corrosion
- Decrease equipment damage
- Used over a wide range of temperatures

Mechanism for Scale Inhibition

Polymeric scale inhibitors like TAMOL™ 960 and TAMOL 731A have several functions. The specific conditions in the aqueous system give predominance to one or more functions:

- Anti-precipitant action: Adsorption on the active sites of the crystal nuclei delays crystal growth and precipitation.
- Adsorption on positive sites of growing crystals forms crystals of distorted structure that are weak and less adherent to surfaces.
- Dispersant action by adsorption increases the negative charge on the sludge particles, reduces their tendency to agglomerate, and inhibits scale formation by keeping them suspended.

Typical Physical Properties

Table I

These properties are typical but do not constitute specifications

Product	Type	Molecular Weight Mw[1]	Appearance	% Total Solids	Density 25°C, lbs/gal	pH	Brookfield Viscosity 25°C, m.Pa.s/ cps	Spindle/ Speed
Tamol™ 960	Na Salt of PMAA	5000	Clear, pale yellow liquid	40	10.6	8.9	550	# 2 @ 30
Tamol 731A	Na Salt of a maleic anhydride copolymer	15000	Clear, pale yellow liquid	25	9.2	10.4	55	# 2 @ 50

[1]Weight average molecular weight determined by aqueous GPC.

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Thermal Stability

High-temperature stability is an important requirement in most water treatment applications and is a fundamental requirement for polymers used in internal boiler-water treatment. Thermogravimetric analysis is often used to rank polymers in order of their thermal stability. This is done by comparing polymer weight loss vs. temperature. In Table II the decomposition temperature is the temperature at which the onset of significant polymer weight loss occurs.

Table II
Thermogravimetric Analysis of TAMOL™ Polymers

Polymer	Decomposition Temperature (in air, °C)
Tamol 960	425
Tamol 731A	365

As the data in Table II indicate, TAMOL 960 is stable to temperatures above the critical point of water (375°C): this suggests that this polymer has potential as a sludge scale inhibitor even in high-pressure boiler-water treatment.

Dispersant Activity

The dispersant activity of carboxyl-functional polymers is an important element of their ability to inhibit scale formation. The effectiveness of a polymeric dispersant is dependent on the particle to be dispersed, the medium in which it is being dispersed, and the chemical structure of the dispersant. A determination of Fluidity Point gives a general indication of the dispersant activity of a polymer. The Fluidity Point is determined by a titration method and is defined as the concentration of dispersant needed to achieve fluidity in a mass of particles in an aqueous system. The Fluidity Point is the minimum amount of dispersant that must be used to deflocculate the particles in the system.

The data in Table III illustrate that TAMOL™ 960 and TAMOL 731A exhibit good dispersant activity, an important function for effective scale inhibition.

Table III
Fluidity Point

Compound	% Polymer Solids Based on Dispersed Solids	
	TAMOL 960	TAMOL 731A
Calcium Phosphate	0.07	0.09
Calcium Carbonate	0.04	0.05
Magnesium Oxide	0.90	1.08
Iron Oxide	0.13	0.15

TAMOL 731A dispersant is exceptionally effective for stabilizing dilute iron oxide suspensions, as Table IV shows. In this study, a suspension containing 700 ppm of iron oxide (pH 7.5) was allowed to settle four hours. The turbidity of the uppermost layer was measured in a nephelometer. The higher the turbidity value, the greater the stability of the suspension and the more effective the dispersant. The result suggests that TAMOL 731A dispersant should greatly reduce the tendency of iron oxide to form deposits from recirculated cooling and boiler feed waters.

Dispersant Activity (Cont'd)

Table IV
Turbidity of Iron Oxide Suspensions

Dispersant	Turbidity Units
None	77
Tamol™ 731A (3 ppm)	860
Polyacrylate (3 ppm)	100
Phosphonate (3 ppm)	60

Viscosity Characteristics

TAMOL™ 960 and TAMOL 731A have low viscosity at temperatures as low as 5°C and should present no handling problems at temperatures above freezing, as indicated in Table V.

Table V
Viscosity vs. Temperature

Temperature, °C	Viscosity (cps), 12 rpm TAMOL 960 40%	TAMOL 731A 25%
5	2,300	150
25	500	70

Surface-Active and Foaming Properties

TAMOL™ 960 exhibits very little surface activity and is essentially non-foaming. TAMOL 731A is weakly surface-active and produces somewhat more foam than the other polymers; however, at low use levels, TAMOL 731A should present no foaming problem. Table VI illustrates the effect of these polymers on the surface tension and the interfacial tension between water and a highly refined mineral oil. The properties of TRITON X-100, a commonly used surfactant, are included for comparison. Values were obtained by ASTM Method D 1331-56, using a du Nouy Tensiometer. Table VII gives the foam heights for several concentrations of the TAMOL polymers.

Table VI
Surface-Active Properties of TAMOL Polymers at 25°C

Product	Surface Tension (dynes/cm)		Interfacial Tension of Acroprime 90 vs. water (dynes/cm)	
Active Ingredient, %	1.0%	0.1%	1.0%	0.1%
TAMOL 960	63	-	42	-
TAMOL 731A	36	64	15	40
Triton X-100	30	29	1	5
None	72	-	52	-

Surface-Active and Foaming Properties (Cont'd)

Table VII
Foam High of TAMOL™ Polymers
(Hamilton Beach Test, 25°C, cm)

Polymer Active Ingredient	TAMOL 960 0.1%	TAMOL 731A 0.1%	TAMOL 731A 0.01%
5 seconds	0.2	4.4	0.6
15 seconds	0.2	4.0	0.4
30 seconds	0.1	3.3	0.3

FDA Clearance

TAMOL™ 960 and TAMOL 731A conform with the U.S. Food and Drug Administration (FDA) regulations indicated below, provided that the final formulation meets any extractives limitations and other conditions prescribed by the regulation:

Regulation Number	Title or Application	TAMOL 960	TAMOL 731A
21CRF173.310	Boiler-water additives	X	
21CRF175.105	Adhesives	X	X
21CRF175.300	Resinous and polymeric coatings	X	
21CRF176.170	Components of paper, paperboard in contact with aqueous and fatty food	X[1]	
21CRF176.180	Components of paper, paperboard in contact with dry food	X	X

[1]TAMOL 960 may be used as a coating adjuvant for controlling viscosity when used at a level not to exceed 0.1% by weight of coating solids.

ISO 9002-Certified

These products are manufactured in an ISO 9002-certified facility.

Toxicity

Toxicity screening tests have shown that the acute oral toxicity (LD_{50}) in rabbits is greater than 5 g/kg for all of these materials. The acute dermal toxicity (LD_{50}) in rabbits is greater than 2 g/kg for TAMOL™ 731A. The TAMOL brand products contain a low level of formaldehyde preservative (except TAMOL 731A). TAMOL 960 contains a low level (below 0.1%) of residual monomer. Inhaling vapors of these materials may irritate the eyes and respiratory tract and may cause headache and nausea, especially in poorly ventilated workplace areas.

Direct contact with the liquid grades irritates the eyes and prolonged or repeated contact with the skin may be irritating and produce rashes.

Handling Precautions

Before using this product, consult the Material Safety Data Sheet (MSDS)/Safety Data Sheet (SDS) for details on product hazards, recommended handling precautions and product storage.

Storage

Store products in tightly closed original containers at temperatures recommended on the product label.

Disposal Considerations

Dispose in accordance with all local, state (provincial) and federal regulations. Empty containers may contain hazardous residues. This material and its container must be disposed in a safe and legal manner.

It is the user's responsibility to verify that treatment and disposal procedures comply with local, state (provincial) and federal regulations. Contact your Dow Technical Representative for more information.

Product Stewardship

Dow has a fundamental concern for all who make, distribute, and use its products, and for the environment in which we live. This concern is the basis for our product stewardship philosophy by which we assess the safety, health, and environmental information on our products and then take appropriate steps to protect employee and public health and our environment. The success of our product stewardship program rests with each and every individual involved with Dow products - from the initial concept and research, to manufacture, use, sale, disposal, and recycle of each product.

Customer Notice

Dow strongly encourages its customers to review both their manufacturing processes and their applications of Dow products from the standpoint of human health and environmental quality to ensure that Dow products are not used in ways for which they are not intended or tested. Dow personnel are available to answer your questions and to provide reasonable technical support. Dow product literature, including safety data sheets, should be consulted prior to use of Dow products. Current safety data sheets are available from Dow.

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