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BENTHAL*
APPLICATION IN ALKYD RESINS

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Monsanto Chemical Co., St. Louis 4, Mo.

INTRODUCTION

Short oil modified alkyd resins, when prepared under certain conditions with dibasic acids or anhydrides and polyhydric alcohols, react rapidly and give products with high acid values. The replacement of a portion of the dibasic acid by BENTHAL in such alkyd resins will retard the bodying and permit longer processing time in order to reduce the acid value of the product. The BENTHAL polyhydric alcohol product becomes part of the resin molecule and acts as an internal plasticizer, thus improving flexibility and adhesion of the dried film.

*Reg. U.S. Pat. Off.

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BENTHAL Specifications

Appearance	-	Light yellow powder
Ash	-	0.20% Max.
Odor	-	Strong characteristic
Melting Point	-	118°C. Min. to start

Properties Given to Alkyd Resins by BENTHAL

BENTHAL reacts with ethylene glycol, glycerol and pentaerythritol to form a liquid resin with low acid value. It is effective in alkyd resins when added in recommended quantities with phthalic anhydride during processing.

1. Reduces the acid value.
2. Reduces the viscosity.
3. Slightly improves the original color.
4. Retards yellowing on baking at elevated temperature.
5. Retards after-bodying.
6. Improves flow properties.
7. Does not retard air drying or baking.
8. Does not change water or chemical resistance of dried films.
9. Improves stability.
10. Improves film adhesion of pentaerythritol types.
11. Improves flexibility of dried films.

Reactions of BENTHAL in Alkyd Resins

Three parts by weight of BENTHAL react with one part of glycerol if heated and agitated 3 hours at 450°F. in the presence of an inert gas. The final product has an acid value of 2-3, a viscosity K-M (Gardner-Holdt viscosimeter) and a color 4-5 (Gardner color standards). It is non-drying and has plasticizing properties. The replacement of 3-10% of phthalic anhydride by BENTHAL in short oil (40%) modified alkyd resins lengthens the processing time, lowers the acid value, and retards the bodying action. The BENTHAL was added with the phthalic anhydride. Properties, such as air drying, baking, and resistance to water, alkali, and weather, are not appreciably changed in alkyd resins of the linseed, soy, or castor oil type. The color is slightly paler. In all the experiments following, a 600 ft./min. peripheral speed turbine was used as agitator. Carbon dioxide was bubbled through the alkyd resins mixture and was started at the beginning of heating and continued until the batch was ready for thinning. The carbon dioxide was introduced into the bottom of the batch directly beneath the turbine through a perforated ring near the bottom of the kettle.

Other Modifications

Other polyhydric alcohols such as sorbitol and mannitol can be used in alkyd resins containing 3-10% BENTHAL based on the phthalic anhydride replacement with satisfactory results for lengthening the processing time, reducing the acid value, and retarding the bodying.

Experimental Data on Processing Alkyd Resins with BENTHAL

(1) Castor Oil Alkyd Resin -- Short Oil Modified

Reagents: Raw castor oil (40% oil modified)
2.6 moles glycerine
3.0 moles phthalic anhydride
BENTHAL replacement for 5 and 10%
phthalic anhydride

Process: All ingredients were added to the
kettle and heated slowly to 480°F.
and held for body.

Evaluation:

TABLE I

Alkyd Resin	Processing Time at 480°F.	Acid Value	Viscosity 50% Xylol	Color 50% Xylol	Sward Hardness
					Alkyd 70% Solids Melamine 30% Solids 1/2 Hr. 300°F.
Control	60 min.	22.0	Z-2	5	16-18
5% BENTHAL	107 min.	9.4	Z-2	4-5	16-18
10% BENTHAL	210 min.	7.2	Z-2	4-5	16-18

(2) Linseed Oil Alkyd Resin -- Short Oil Modified

Reagents: Varnish type linseed oil (40% oil modified)
2.4 moles glycerine
3 moles phthalic anhydride
BENTHAL replacement for 3 and 5% phthalic anhydride

Process: The linseed oil and glycerine (25% by weight of the former) were subjected to alcoholysis at 450°F. in the presence of a litharge catalyst (0.10% Pb of the weight of glycerine). The balance of glycerine was added, followed by the phthalic anhydride and BENTHAL and the total batch processed to 450°F. and held for body.

Evaluation:

TABLE II

<u>Alkyd Resins</u>	<u>Processing Time at 450°F. Minutes</u>	<u>Acid Value</u>	<u>Viscosity 50% Xylol</u>	<u>Color 50% Xylol</u>	<u>Sward Hardness Bake at 300°F. 1 Hr.</u>
Control	60	15	F	6-7	12
3% BENTHAL	75	12	F	6-7	12
5% BENTHAL	90	8	F	6	11

(3) Soy Fatty Acid-Alkyd Resin -- Short Oil Modified

Reagents: Double distilled soy fatty acids (40% oil modified)
2.4 moles glycerine (98%)
3 moles phthalic anhydride
BENTHAL replacement for 2 and 4% phthalic anhydride
Extra glycerine in amount of 10% of soy fatty acids

Process: All ingredients were added to the kettle and heated slowly to 450°F. and held for body.

Evaluation:

TABLE III

<u>Alkyd Resins</u>	<u>Processing Time at 450°F. Minutes</u>	<u>Acid Value</u>	<u>Viscosity 50% Xylol</u>	<u>Color 50% Xylol</u>	<u>Sward Hardness Bake 300°F. 1 Hr.</u>
Control	90	12	F	5-6	11
2% BENTHAL	100	10	F	5-6	11
4% BENTHAL	120	8	F	5	10

(4) Cocoonut Fatty Acids Alkyd Resin -- Short Oil Modified

Reagents: Distilled cocoonut fatty acids (34% modification)
2.4 moles glycerine
3.0 moles phthalic anhydride
Pentaerythritol replacement for 10% of glycerine
extra glycerine in amount of 10% of cocoonut fatty acids
BENTHAL replacement for 3 and 5% phthalic anhydride

Process: All ingredients were added to the kettle and processed slowly to 450°F. and held for body.

Evaluation:

TABLE IV

Alkyd Resins	Processing Time at 450°F. Minutes	Acid Value	Viscosity 60% Xylol	Color 60% Xylol	Sward Hardness
					Alkyd Resins 70% Sol. Melamine 30% Solid 1/2 Hr. 300°F.
Control	75	18	U-W	5-6	16
3% BENTHAL	90	15	U	5	15
5% BENTHAL	120	12	U	5	14

(5) Soy-Tung-Pentaerythritol-Maleic Anhydride-Alkyd Resin -- Long Oil Modified

Reagents: 50% Alkali refined soy oil
8% Pentaerythritol
20% W. W. Rosin or 12% W. W. Rosin and 8% BENTHAL
17% Tung oil
5% Maleic anhydride

Process: The soy oil and pentaerythritol were subjected to alcoholysis in the presence of a litharge catalyst (0.10% Pb per weight of pentaerythritol), by heating for 20 min. to 480°F. for solubility of 1:1 in methyl alcohol. The temperature was reduced to 400°F. and the rosin, BENTHAL and finally tung oil were added. The batch was heated until clear when cold. Finally the maleic anhydride was added and the batch was heated to 500°F. and the process completed at 570°F.

Evaluation:

TABLE V

Alkyd Resin	Processing at 500-570°F. Minutes	Acid Value	Viscosity 50% Mineral Spirits	Air Drying Time Co-drier
Rosin type	75	18	E-F	4 hours-dust free
BENTHAL type	120	10	E	4 hours-dust free

(6) Soy Fatty Acid-Glycerine-Maleic Anhydride-BENTHAL-Alkyd Resin-Short Oil Modified

Reagents: 39.4% Distilled soy fatty acids
15.8% Glycerine
15.4% Maleic anhydride
29.4% BENTHAL

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Process and
Evaluation:

All ingredients were heated at 450°F. for one hour and forty minutes. The batch was thinned with 50% xylene. The product had an acid value of 8.4 (solids), viscosity S, color 5, and the film baked hard in 1/4 hour at 300°F. and air dried (Pb and Co drier) in 2 hours to dust free stage.

(7) Soy Fatty Acid-Pentaerythritol-Glycerine,
BENTHAL-Alkyd Resin-Short Oil Modified

Reagents: 41% Distilled soy fatty acids
4% Glycerine (98%)
21% Technical pentaerythritol
32% Phthalic anhydride
2% BENTHAL

Process and

Evaluation: All ingredients were heated to 430°F. and held for 3-1/2 hours. The batch was thinned with 50% xylene. The product had an acid value of 10 (solids), color 7, viscosity W. The films baked hard in 1/2 hour at 300°F.

(8) Soy Oil-Pentaerythritol-BENTHAL-Phthalic Anhydride-
Alkyd Resin-Short Oil Modified

Reagents: 270 g. Alkali refined soy oil
133 g. Technical pentaerythritol
180 g. Phthalic anhydride
120 g. BENTHAL

Process and

Evaluation: Alkali refined oil and 27 g. technical pentaerythritol were processed at 480°F. using calcium catalyst for 30 minutes until clear (soluble in methyl alcohol 1-1). Then 106 g. technical pentaerythritol were added and the batch temperature was held at 480°F. until clear. The temperature was then dropped to 400°F. and phthalic anhydride and BENTHAL were added and processed at 450°F. for six hours. The batch was thinned with 50% xylene. The product had an acid value of 12 (solids), viscosity W, color 8. The film baked hard in 1/2 hour at 300°F. (Sward 12).

(9) Soy Oil-Pentaerythritol-BENTHAL-Succinic Acid-Alkyd
Resin-Long Oil Modified

Reagents: 240 g. Alkali refined soy oil
69 g. Technical pentaerythritol
63 g. Succinic acid
60 g. BENTHAL

Process and
Evaluation:

Alkali refined soy oil and 24 g. technical pentaerythritol were processed at 480°F. using calcium catalyst, for 30 minutes until clear and then 45 g. technical pentaerythritol were added and held until clear. Succinic acid and BENTHAL were added at 400°F. and processed at 450°F. for 4 hours. The batch was thinned with 50% mineral spirits. The product had an acid value of 5.8 (solids), viscosity D, and color 6. The film air dried (Pb and Co drier) in 3 hours to a dust free stage.

For further information about BENTHAL
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