A Note On

Water Absorption by Dehydrated Castor Oil Modified Alkyd Resins

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Summary

DEHYDRATED Castor oil modified alkyd resin films show more whitening when immersed in water compared to linseed oil modified alkyd. The reliability of this test as a measure of water resistance has been questioned. The water absorption of oil modified alkyds containing 20 per cent D.C.O. has been compared with that of linseed oil modified alkyd and it has been found that the resistance to water uptake is greater with D.C.O. modified films.

Introduction

Dehydrated castor oil (D.C.O.) is finding increasing use in the manufacture of alkyd resins owing to its resistance to discolouration and its ability to impart flexibility to the resin films. Addition of small proportions of D.C.O. to alkyds have useful effects both in promoting polymerization and in assisting alcoholysis.[1] As the strongly polar hydroxyl group is removed by dehydration from the structure of castor oil fatty acid, films obtained from D.C.O. modified alkyd resins should be relatively more resistant to water. Water resistance is at present measured by the degree of whitening developed when the varnish film is immersed in cold water for a specified period. Results obtained by this method are not in conformity with the expected water-resisting characteristics of D.C.O. modified alkyds.[2] Von Mikush[3] also has expressed dissatisfaction with this method of determining water resistance. He suggested quantitative measurement of water absorbed by the film. This has now been carried out on alkyd resin modified with 20 per cent D.C.O. and the results are reported in this paper. A knowledge of this aspect of water resistance of paint films is also of importance in corrosion — resistant paint formulations.

Preparation of Resins

The proportion of reactants used in the preparation of resins are given in table 1. The oils were heated to 100°C, lead naphthenate added, the temperature then raised to 180°C and glycerol equivalent to one fourth of the weight of oil added. The temperature was further raised to and maintained at 260°C till adequate partial esterification took place as assessed by solubility in hot methanol (1:1 dilution). The partial ester product was cooled to 180°C and phthalic anhydride and the rest of the glycerol were added. The temperature was then raised to 220°C, and maintained there till the acid value fell to the desired level, as determined in alcohol benzene mixture. The condensation reaction was carried out in an atmosphere of carbondioxide, and the water of esterification was removed azeotropically with xylene.

Properties of the Resins

The hydroxyl value of the resins was determined by pyridine — acetic anhydride method,[4] and the phthalic anhydride content by the method recommended by the Surface Coating Synthetic Resin Manufacturer's Association.[5] The resin was then thinned down with xylene to 50 per cent in the case of long and medium oil length and 35 per cent in case of short oil length and the viscosity of the solutions determined by Ford Cup. Results are given in table 1.

TABLE I

Composition and physical properties of oil modified alkyds

Formulation No.	1	2	3	4	5	6
Raw linseed oil ...	140.25 g	107.7 g	82.75 g	112.25 g	86.2 g	70.35 g
Dehydrated Castor oil ...	—	—	—	28.0 g	21.55 g	12.4 g
Glycerol ...	35.1 g	27.0 g	20.7 g	35.1 g	27.0 g	20.7 g
Pb. naphthenate ...	0.14 g	0.107 g	0.82 g	0.14 g	0.107 g	0.82 g
Phthalic Anhydride	71.25 g	95.62 g	114.25 g	71.25 g	95.62 g	114.25 g
Glycerol	3.4 g	19.65 g	32.05 g	3.5 g	19.7	32.05 g
Appearance of resin ...	Clear	Clear	Slightly dark	Slightly dark	dark	dark
Acid value mgKoH/g.	4.3	6.1	35.5	3.9	7.07	42.25
Viscosity 50% solution in Xylol by Ford Cup ...	23.8 Sec.	207 Sec.	115 Sec. (35% solid)	31 Sec.	360 Sec	52 Sec (35% solid)
% OH	1.69	2.64	1.7	0.77	2.25	0.996
% Phthalic Anhydride	44.5%	37.0	27.2	43.5	36.8	27

Preparation of Varnish

A further quantity of lead naphthenate equal to 0.4 per cent and cobalt naphthenate equal to 0.05 per cent both calculated as metal on the weight of the oil content, were mixed with each of the resin solutions and their viscosity adjusted to 110 Secs Ford Cup. The varnishes conformed to Indian Standard specification 101:1950. 60° specular gloss was measured with a gloss meter after 300 hours weathering in a twin arc weatherometer and the values are given in table 2.

Discussion of the Results

The water absorption of a compound depends upon its polarity. The polarity of glyceryl phthalate is decreased by introducing drying oil residues. This also results in increasing the complexity of crosslinkage in the varnish film and its resistance to water absorption. Further, the increase in resistance to water absorption will depend on the extent of oil added, and on the carboxyl and hydroxyl groups present in the final condensation product. It can be seen from fig. 1, that 20 per cent replacement of linseed oil by D.C.O. considerably decreases the water absorption of the film when the acid and hydroxyl values of the resins are more or less equal. In short oil length alkyds, the D.C.O. modification shows more water uptake because of its higher acid value (curves 3 & 6). Medium oil length alkyd modified with D.C.O. (curve No. 5) shows slightly less water uptake than even long oil length alkyd modified with linseed oil only (curve No. 1). Therefore, in order to increase the resistance of linseed oil modified alkyd to water absorption, one can re-

TABLE II

Accelerated weathering, Atlas "Weatherometer" Twinarc, 102 min. dry 18 min wet Cycle

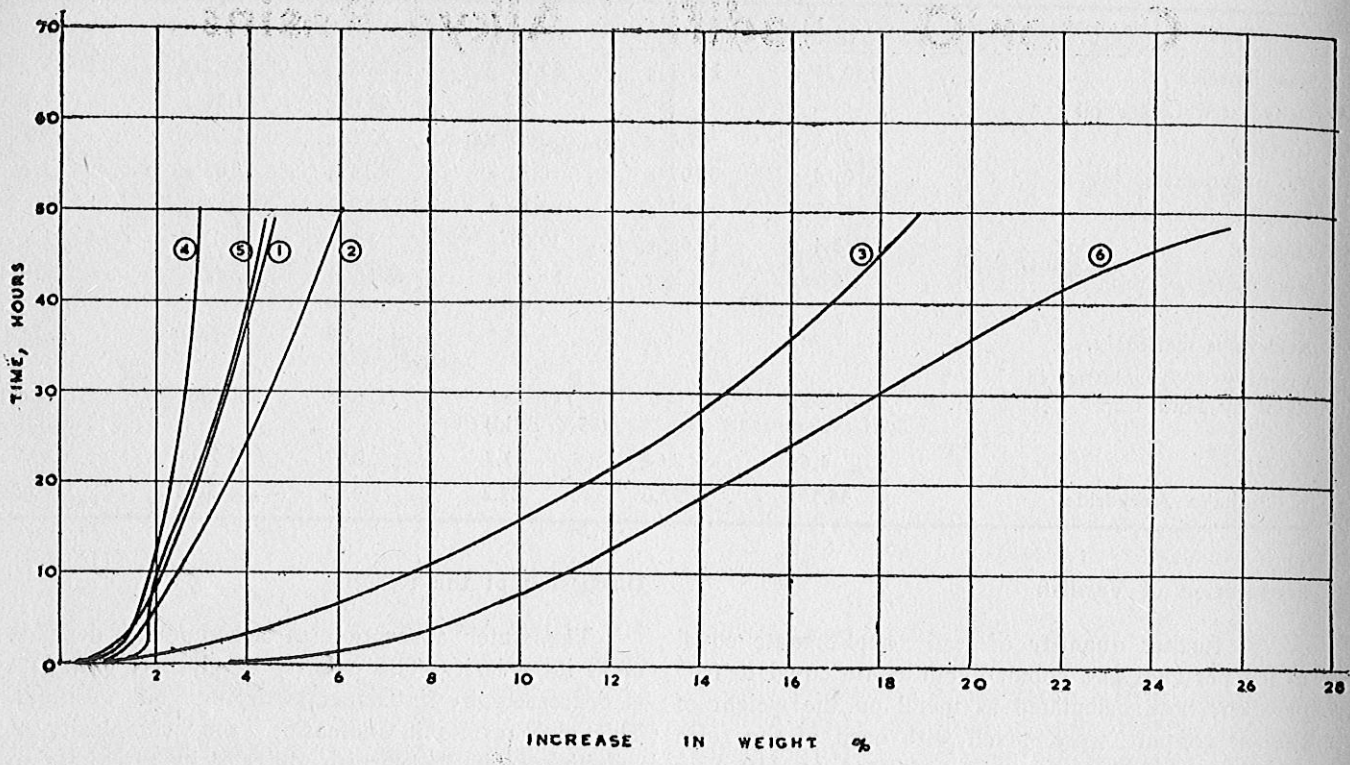
Formulations	1	2	3	4	5	6
Gloss, initial	95.5	96.5	100	100.0	97.0	97.5
Gloss, 300 hours weathering	34.5	37.6	46.5	43.5	48.4	48

Water Absorption

The varnishes were applied to weighed glass panels, 15 x 7.5 cm, allowed to dry for seven days under diffused sunlight, weighed again and immersed in distilled water. At different intervals of time the panels were removed from water, blotted to surface dry and weighed. The increase in weight due to absorption of water was calculated as the percentage of the dry weight of the film, and plotted against time (fig. 1 on next page).

WATER ABSORPTION OF MODIFIED ALKYD RESIN FILMS

(Curve number corresponds to composition number in Table I)



place part of the linseed oil by D.C.O. rather than increase the oil length. The latter course would have the disadvantage of lowering the viscosity of the resin and the resistance of the film to weathering. The higher resistance to water absorption exhibited by D.C.O. modified resins is fully in conformity with expectation based on the structure of the components, although, as reported,[2] D.C.O. modified films show more whitening than linseed oil modified resins in the conventional test.

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