

Mahua-Oil-Based Resins for the High-Temperature Curing of Fly Ash Coatings

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Received 22 March 2001; accepted 13 February 2002

ABSTRACT: We attempted to prepare medium-oil-length glycerol alkyds based on Mahua oil. Fatty acids were isolated from the oil and used in the preparation of alkyds by the fusion method. The resins were characterized by IR spectroscopic analysis. The physicochemical and film properties of these resins were also studied. IR analysis of the resins revealed the formation of phthalate esters showing characteristic peaks at 1720 cm^{-1} . The resin was modified with melamine formaldehyde, which cured at high temperatures. Alternatively, the resin was made to air dry with ester gum, and the curing behavior was studied. The suitability of these resins for high-temperature curing fly ash coating applications was established. Coatings were formu-

lated with these resins and with 40% fly ash as an extender. The coatings were characterized by standard techniques, particularly for their anticorrosive and antiabrasive properties. Resistance to corrosion was evaluated in humidity and in salt-spray conditions. We conducted a high-stress (two-body) abrasion test to test the abrasive wear resistance of the coatings. The Mahua-oil-resin-based fly ash coatings were suitable for application in moderately corrosive and abrasive environments. © 2002 Wiley Periodicals, Inc. *J Appl Polym Sci* 87: 110–120, 2003

Key words: resins; coatings; esterification

INTRODUCTION

Oils and fats constitute an important class of raw materials for the preparation of resinous binders for coatings. A number of seed oils have been used in various resin formulations. Some of the major seed oils used traditionally are linseed, castor, soyabean, and sunflower. In addition to these, there are certain nontraditional oils that have been used in surface coatings.¹ As reported, unmodified² and epoxidized Neem oil^{3,4} has been used to prepare varnish for coating. Tobacco seed oil has been reportedly used in alkyd preparation for wrinkled-finish paints.⁵ The preparation of modified alkyd⁶ and stoving enamels⁷ from Nahor (*Mesua ferrea linn*) oil has been reported. Kamala (*Mallotus philippinensis*) oil has been used for alkyd preparation.⁸ The use of other nontraditional oils, such as Gokharu seed oil,^{9,10} Undi (*Calophyllum inophyllum*) oil,¹¹ Karanja (*Pongania glabra*) oil,¹² Karinotta (*Samera indica*) oil,¹³ Nigerseed (*Guizotia abyssinica*) oil,¹⁴ and Babul (*Acacia arabica*) oil,¹⁵ have been reported.

Mahua is another nontraditional, inedible oil. It is obtained from the Mahua tree (*Madhuca indica*), which is a medium to large deciduous tree found abundantly in most parts of the world. The seeds are separated

from the fruit wall and then dried and shelled to get the kernel, which constitutes the Mahua seed of commerce. Mahua oil is mainly used in the manufacture of soaps, particularly for laundry purposes. The soap produced from Mahua tends to go rancid during storage due to the presence of oxidizable constituents in the unsaponifiable fraction. Its other uses are very limited.¹⁶

In this study, Mahua oil was used to prepare resins, which were further extended by fly ash. Fly ash is a waste generated by thermal power stations during the combustion of pulverized coal. As coal is a major source of energy, production of fly ash in huge quantities is inevitable.¹⁷ The problem of the disposal and utilization of fly ash has been worked on extensively throughout the world.^{18,19} In an earlier study, we developed fly ash coatings for anticorrosive and antiabrasive applications.²⁰ In this work, we aimed to develop novel resin systems based on Mahua, a nontraditional oil, for application in fly ash coatings.

This work involved the isolation of fatty acids from Mahua oil by the saponification method; these fatty acids were used to prepare medium-oil-length glycerol alkyds. The major component fatty acids of Mahua oil are myristic, palmitic, stearic, arachidic, oleic, and linoleic.¹⁶ The resins were prepared by a fusion process and were characterized with IR spectroscopic analysis. The physicochemical and film properties of the resins were determined. Fly ash coatings were prepared with the Mahua-oil-based resins.

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TABLE I
Properties of Mahua Oil

Serial number	Property	Observed value
1	Color	Light yellow
2	Specific gravity	0.86
3	Acid number	18.38
4	Iodine value	73.3
5	Saponification value	180

The coatings were characterized by standard methods with special reference to their anticorrosive and anti-abrasive character.

EXPERIMENTAL

Materials

Mahua oil was procured from a local source and had the characteristics listed in Table I.

Fly ash was collected from a thermal power station and had characteristics discussed in an earlier article.²⁰ Phthalic anhydride, for resin preparation, was procured from M/s Impex Chemical Corp. (Mumbai, India). Glycerol was obtained from M/s Godrej Soaps Pvt. Ltd. (Mumbai, India). Butylated melamine formaldehyde (MF) from M/s Resins and Plastics Ltd. (Mumbai, India) was used for alkyd modification. Air-drying alkyds were made by modification with ester gum (EG) prepared from gum rosin of M/s Howrah Chemical Works (Kolkata, India). A commercial resin, a medium-oil-length alkyd based on phthalic anhydride/glycerol/linseed fatty acid, hereafter referred to as ARC, was obtained from M/s. Resins and Plastics Ltd. (Mumbai, India), and had specifications as mentioned in Table VI (shown later).

Isolation of fatty acids from mahua oil

We isolated a mixture of fatty acids from the oil by carrying out saponification of the oil with sodium hydroxide in calculated amounts at high temperatures. The saponified oil was completely neutralized by concentrated HCl and was finally washed with water to remove any traces of unreacted HCl. The yield was approximately 97%. The acid value of the fatty acids was found to be 188. IR analysis of Mahua oil and Mahua oil fatty acid (MOFA) samples was

TABLE II
Formulation of MGAL Resin

Ingredients	Parts by weight (%)
Phthalic anhydride	27.0
MOFA	55.0
Glycerol	18.0

TABLE III
Modification of MGAL with MF

Serial number	Constituent	Parts by weight (%)
1	Resin (MGAL)	80
2	MF	20

carried out with a PerkinElmer (Norwalk, CT) IR spectrophotometer (model 1430).

Formulation of mahua-oil-based glycerol alkyd resin (MGAL)

MOFA was used to prepare a glycerol alkyd of medium oil length. The formulation of the resin is shown in Table II.

Preparation of resin (MGAL)

The preparation of the alkyd was carried out by a fusion process. The raw materials (phthalic anhydride, glycerol, and MOFA) were heated in a stainless steel reaction vessel fitted with a stirrer, a condensing system, a charge hole, and pipes for passing inert gas over the charge. We attached a water separator to the condenser to remove the water produced during the reaction. The resin sample was checked at regular intervals for viscosity and acid number. The temperature of the reaction was maintained between 180 and 220°C. The reaction was continued until the desired acid number and viscosity were achieved.

Modification of resin (MGAL) with MF

The alkyd resin based on MOFA was non-air-drying in nature. MF was, therefore, employed as a crosslinker. The combination, as shown in Table III, was prepared, which was cured by baking at 140°C for 4 h.

Modification of MGAL with rosin EG

To improve the drying property of the resin, rosin EG was used as an external modifier. The preparation of EG was carried out by esterification of gum rosin with glycerol. The formulation is shown in Table IV.

Gum rosin was heated to 245–260°C in a steel vessel. Glycerol was added slowly with stirring. After this addition, the temperature was raised to 273–287°C.

TABLE IV
Formulation of EG Rosin

Serial number	Ingredient	Parts by weight (%)
1	Gum rosin	906
2	Glycerol	92

TABLE V
Modification of MGAL Resin with EG

Serial number	Resin type	Parts by weight (%)
1	MGAL	56
2	EG	44

The reaction was continued until an acid number of less than 10 was obtained. EG was soluble in all the solvents except alcohol. The combinations of MOFA alkyds and EG shown in Table V gave air-drying resins.

Characterization of the resins

The developed alkyd resin and its modification with MF and EG were characterized with an IR spectrophotometer (PerkinElmer model 1430). Other characterizations included the determination of viscosity, specific gravity, solid content, acid value, drying time, film thickness, scratch hardness, impact resistance, and adhesion by standard techniques.²⁰ The resins were also subjected to immersion tests in distilled water, 5% Na₂CO₃, 1% NaOH, 2% H₂SO₄, and organic solvents such as toluene and mineral spirits, for different durations.²¹

Preparation and characterization of fly ash coatings based on mahua-oil-based alkyds

Coatings were formulated with various MOFA resins, each containing 40% fly ash. Preparation was done by conventional methods with a laboratory batch ball mill for dispersion (Mauli Fab Engineers, Ahmedabad, India).²² The dispersion process was continued until a reading of 6–7 was obtained on Hegman's scale. The coatings were characterized for physicochemical properties, film characteristics, resistance to corrosion, and abrasion by standard techniques.²⁰

RESULTS AND DISCUSSION

Characterization of MGAL

IR spectroscopic analysis of mahua oil and its fatty acids

A comparative observation of the IR spectra of Mahua oil and its fatty acids can be made from Figure 1. The characteristic bands associated with fatty oils²³ were seen in the IR spectral pattern of Mahua oil. A strong absorption band with a maximum at 1730 cm⁻¹ was visible for the C—O stretching of ester in oil. On the contrary, a band with a maximum at 1720 cm⁻¹ occurred in the IR spectrum of MOFA, which was attributed to the C—O stretching of the —COOH group in fatty acids.²⁴ The significant bands characterizing the oil appeared at 1380 cm⁻¹ (the symmetric bending of CH₃ of long-chain fatty oils)²⁵ and 1170 cm⁻¹ (C—O stretching), which are not found in the spectrum of fatty acids. Instead, other characteristic peaks for fatty acids were seen as a doublet at 1300–1250 cm⁻¹ (C—O stretching of acids) and a weak band at 940 cm⁻¹ (in- and out-of-plane vibration of the —OH of carboxyl groups). The IR pattern of Mahua oil and its fatty acid suggested existence of no or very low unsaturation.²⁶

IR analysis of alkyd (MGAL) and its modifications

The spectral pattern of alkyd is shown in Figure 1. The spectrum was compared with a long-chain fatty-oil-based glycerol alkyd, as reported by Shreve et al.²⁷ The characteristic band for alkyd occurs as a strong band with a maximum at 1740 cm⁻¹ for carbonyl group stretching. Another sharp and broad absorption in the 1340–1200 cm⁻¹ region with a maximum at 1265 cm⁻¹ and a doublet of medium intensity with maxima at 1120 and 1070 cm⁻¹ were observed, which were attributed to Ar—CO—O group vibrations. These three bands are characteristic of phthalate ester with

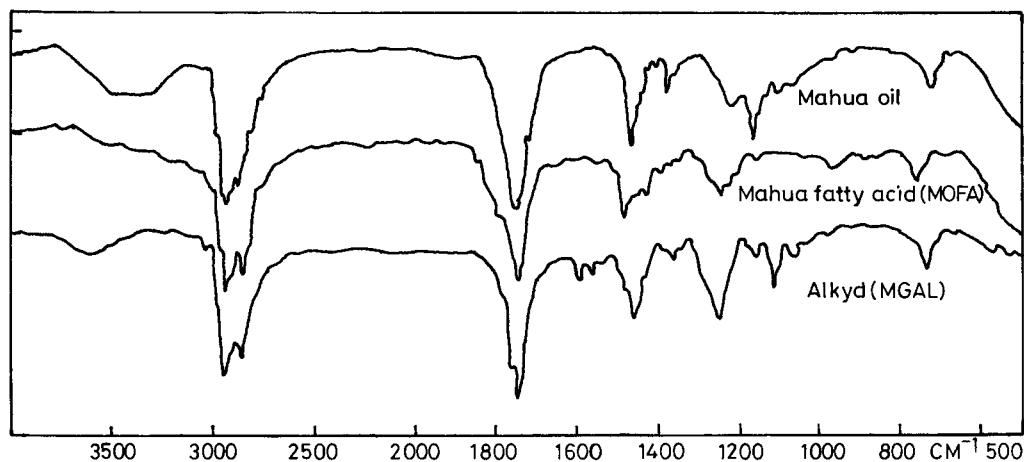


Figure 1 Comparative IR spectra of Mahua oil, MOFA, and MOFA-modified alkyd (MGAL).

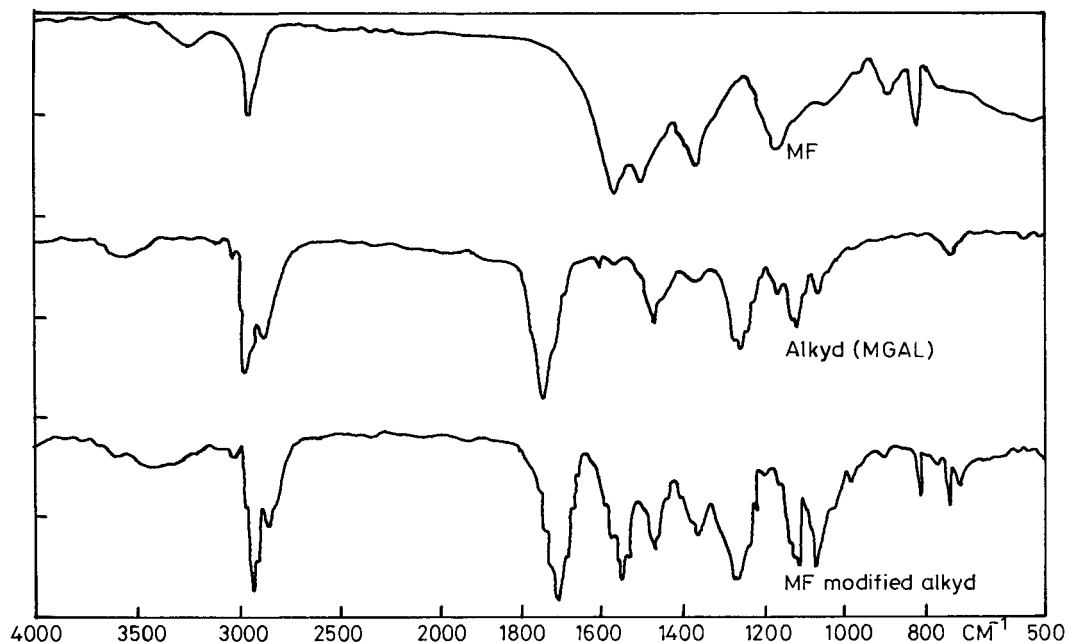


Figure 2 IR spectra of MF, alkyd (MGAL), and MF-modified alkyd.

some contributions from the ester linkages of the oil modifier.²³

The alkyd, after modification with MF, gave the spectral pattern as seen in Figure 2. The chemical reactions for the preparation of the alkyd and its curing with melamine (MF) are shown in Figures 3 and 4, respectively. The curing of alkyd with MF gave resultant ether linkages. These ether linkages were seen in the IR of the cured alkyd at 1170 cm^{-1} for C—O stretching of the crosslinked ether.²⁸ The presence of a

triazine ring of melamine was confirmed from the bands at $1650\text{--}1500\text{ cm}^{-1}$ (a broad doublet of medium intensity) for C=N stretching and at 810 cm^{-1} for out-of-plane deformation vibration of the triazine ring.²⁹

The IR spectrum of the EG-modified alkyd is also illustrated in Figure 5. The significant bands included a sharp band with a maximum at 1700 cm^{-1} due to C=O vibration of the acidic group, which shifted to a higher wavenumber at 1745 cm^{-1} of ester.³⁰ Unsaturation

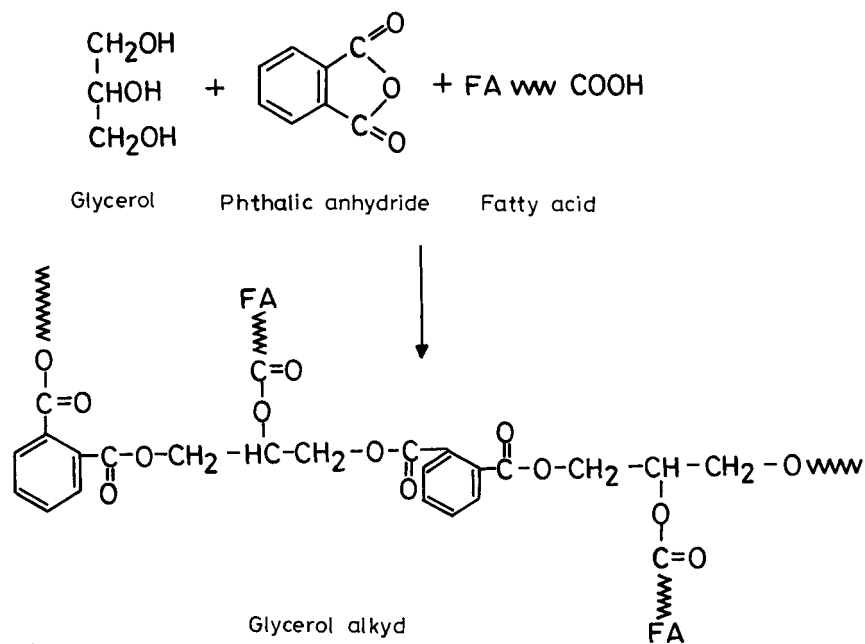
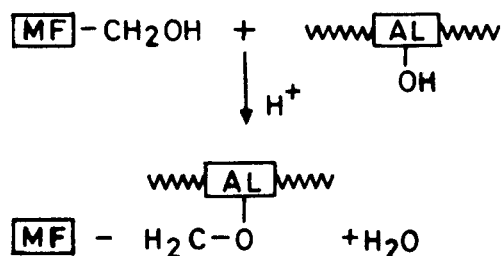


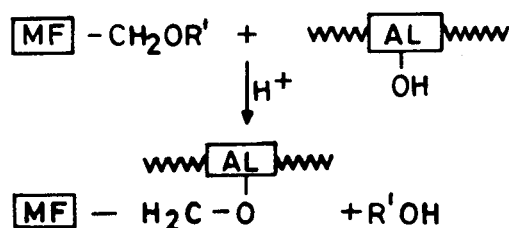
Figure 3 Chemical reaction for the preparation of glycerol alkyd with MOFA.

PART I

(i) Reaction of -OH group of alkyd (AL) with CH_2OH (methylol) groups of MF



(ii) Reaction of -OH group of alkyd (AL) with $-\text{CH}_2\text{OR}'$ (etherified methylol) groups of MF



PART II

(iii) Reaction of residual-COOH group in alkyd (AL) with $-\text{CH}_2\text{OR}'$ of MF

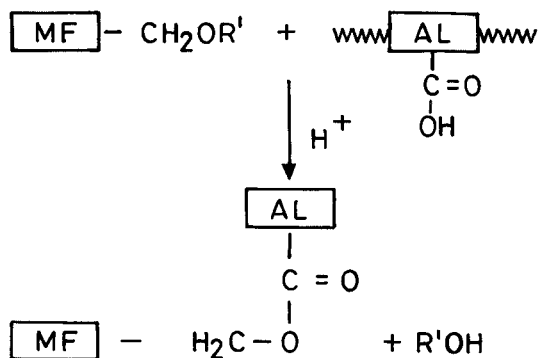


Figure 4 Schematic representation of possible reactions for curing alkyds (AL) with MF.

tion or conjugation occurred as a weak band near 1610 cm^{-1} .

Physicochemical characterization

Properties such as viscosity and acid number of the resin are important in assessing the progress of the reaction during preparation and were, therefore, assessed at regular intervals during the course of the

reaction. When the raw materials, such as glycerol, phthalic acid, and MOFA, were initially charged into the reactor, the acid number of the reaction mixture was very high. As the reaction progressed, the acid number of the resin fell, and the viscosity increased, indicating an increase in the degree of polymerization. The degree of polymerization was, thus, measured as described previously, and the reaction was stopped

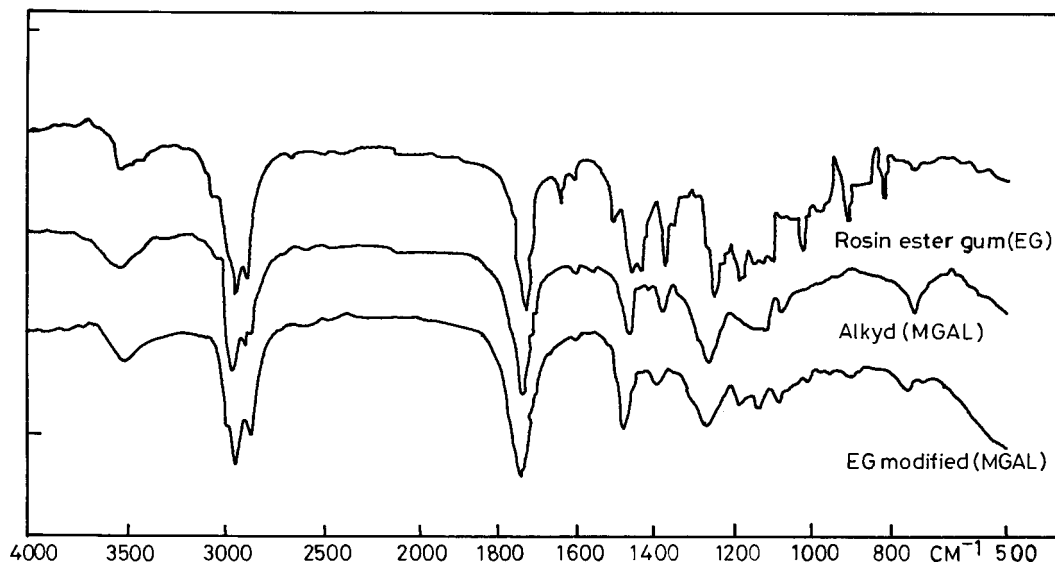


Figure 5 Comparative IR spectra of rosin EG, alkyd (MGAL), and EG-modified alkyd.

when the acid number of the resin MGAL was 1.11, indicating near completion of the reaction.

The viscosity of the MOFA-based glycerol alkyd after preparation was 10.76 Poise. The solid content of the resin was adjusted to 60% with mineral spirits. The specific gravity of the resin (MGAL) as determined by conventional methods was 0.99. All physicochemical characteristics are given in Table VI.

Film properties

The resin prepared with MOFA was nondrying in nature as Mahua oil contained most of the saturated fatty acids, as inferred from the IR spectral analysis. The resin was, therefore, modified with MF. The modified resin was dried by baking at 140°C for 4 h. We also subjected the resins to external modification with rosin EG to obtain air-dry resins. The MOFA-based glycerol alkyd cured with MF and EG was characterized for film properties by standards techniques.

The average film thickness of the dried resin films on a mild steel panel, as assessed with a nondestructive

technique, was 46 and 48 μm for MF and EG modified resins, respectively (Table VII). The film thicknesses of the MOFA based resins were found to be comparable to that of the commercial alkyd (ARC), that is, 49 μm .

The maximum scratch hardness value of the glycerol alkyd cured with EG was 1.1 kg. The scratch hardness value showed a marked improvement to 1.4 kg for MF-cured glycerol alkyd. This improvement in the hardness property could be attributed to the formation of a three-dimensional network during the curing of the alkyd (MGAL) with MF. The residual hydroxyl groups of the alkyd reacted with methylol and the etherified methylol groups of MF to form a crosslinked structure offering improved hardness to the resin films. The alkyd cured with EG dried due to oxidation of unsaturation in the structure of EG. There was, as such, no crosslinking or three-dimensional network formations, and the resins cured with EG, therefore, exhibited inferior hardness properties. The maximum scratch hardness of the commercial resin (ARC) was intermediate between MF- and EG-modified MOFA alkyds, that is, 1.3 kg. Both the Mahua-oil-

TABLE VI
Comparison of the Physicochemical properties of Mahua-Oil-Based and Commercial Alkyds

Serial number	Property	Observation	
		MGAL	ARC
1	Acid Value (mg KOH/g)	1.11	10
2	Hydroxyl value	74.9	Not available
3	Solid content (%)	60	60
4	Oil length (%)	55	52
5	Viscosity (60% in mineral spirit)	10.76	11.00
6	Specific gravity	0.99	0.98

TABLE VII
Comparison of the Film Properties of Mahua-Oil-based and Commercial Alkyds

Serial number	Property	Observation		
		MGAL + MF	MGAL + EG	ARC
1	Drying time (h)	Baking at 140°C for 4 h	Air drying, 2 h	Air drying, 2 h
2	Average film thickness (μm)	46	48	49
3	Scratch hardness (kg)	1.4	1.1	1.3
4	Impact resistance (2 lb/12 in)			
	Direct	Passed	Passed	Passed
	Indirect	Passed	Passed	Passed
5	Adhesion (kg/cm^2)	40	30	30

based alkyds and the commercial one passed a direct and indirect impact of 2 lb/2 in.

The MF-modified alkyds also exhibited superior adhesion properties in comparison to the commercial and the EG-modified alkyds. The adhesion value of the MF-modified glycerol alkyd was found to be 40 kg/cm^2 compared to 30 kg/cm^2 for both the commercial and the EG-modified MGAL.

Water, chemical, and solvent resistance

The visual changes occurring in the resin samples were recorded by immersion in distilled water, 5% Na_2CO_3 , 1% NaOH , 2% H_2SO_4 , mineral spirits, and toluene. The performance of MOFA-based alkyd resins cured with MF and EG was compared with the commercial alkyd. From the observations shown in Table VIII, it is evident that resins cured with EG exhibited inferior alkali and solvent resistance compared to those cured with MF. This may have been due to the hydrolysis of the EG-cured alkyd. The EG-cured alkyds remained unaffected in toluene. However, they exhibited dullness of gloss and film dissolution in mineral spirits. The films swelled when immersed in distilled water.

Also, the MF-cured alkyd offered better performance than the EG-cured alkyd with reference to its alkali and solvent resistance. However, MF-cured films developed blisters in 2% H_2SO_4 solution. The commercial alkyd showed satisfactory resistance to

water, 5% Na_2CO_3 , 1% NaOH , and toluene but showed poor resistance to the acidic medium, where the film detached from the substrate. Film dissolution was observed in mineral spirits. The chemical and solvent resistance offered by the resins depended solely on the relative inertness of the molecular structure and the degree of crosslinking between the molecules. The alkyds had poor water and alkali resistance due to the presence of ester groups, which are easily hydrolyzed. Modification with EG increased the number of ester groups in the molecules, thereby, rendering the alkyds more prone to water and alkali hydrolysis. This resulted in poorer resistance against water and alkali. On the contrary, crosslinking with melamine improved the alkali and solvent resistance of the resins.

Characterization of fly ash coatings based on mahua oil alkyds

We studied the suitability of novel MOFA-based alkyds for fly ash coating applications by assessing the performance of the coatings as follows.

Coating properties

Properties of coatings such as viscosity and bulk density were measured in the liquid state before application as film on the substrate. Viscosity is an important property, which affects application and appearance

TABLE VIII
Comparison of the Performance of Mahua-Oil-Based Alkyds with Commercial Alkyds Against Water, Chemical and Solvents

Serial number	Immersion in	Visual observation		
		MGAL + MF	MGAL + EG	ARC
1	Distilled water	Slight swelling of the film and blistering	Swelling of the film	Slight blistering
2	5% Na_2CO_3	Not affected	Film detachment from the substrate	Yellowing of solution
3	1% NaOH	Not affected	Detachment of the film	Yellowing of solution
4	2% H_2SO_4	Dissolution and blistering of the film	Blistering and film detachment	Film removal from the substrate
5	Mineral spirit	Not affected	Not affected	Dullness of gloss
6	Toluene	Not affected	Loss of gloss and color	Not affected

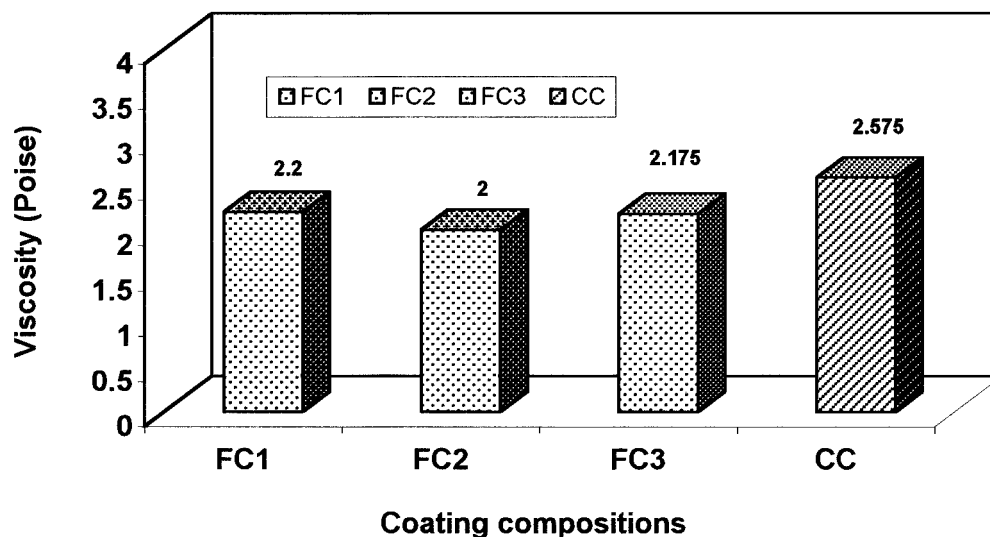


Figure 6 Comparative viscosity values of fly ash coatings based on MOFA resins.

properties of coatings such as the ease of brushing and the flow or leveling.³¹ It can be defined as the measure of the resistance to the flow of a coating or other liquids when a shearing stress is applied.³²

A comparative illustration of viscosity values of the various fly ash coatings prepared with MOFA alkyds is given in Figure 6. The viscosity of coatings containing fly ash were observed in the range 2.0–2.2 Poise. The commercial coating (CC) had a viscosity of 2.575 Poise. This value was higher compared to the viscosity of compositions containing fly ash. Relatively lower viscosities of fly-ash-containing formulations allows easy application by brush or by spraying. The lower viscosity of fly ash coatings is a desirable property, which can be attributed to the particle shape and size of fly ash, as discussed elsewhere.²⁰ The density val-

ues of MOFA-based fly ash coatings were in a desirable range of 1.19–1.20 g/cc compared to the commercial-resin-based composition (Fig. 7).

Film properties

We determined the film properties of MOFA-resin-based fly ash coatings to assess the suitability of the resins for fly ash coatings. The formulation of coatings and their respective film properties are shown in Tables IX and X, respectively. The drying time of the coatings varied with the type of resin used but was unaffected by the use of fly ash. The compositions based on glycerol alkyd cured with EG air dried within 2 h, similar to the CC, whereas we baked melamine-crosslinked alkyd in an oven at 140°C for

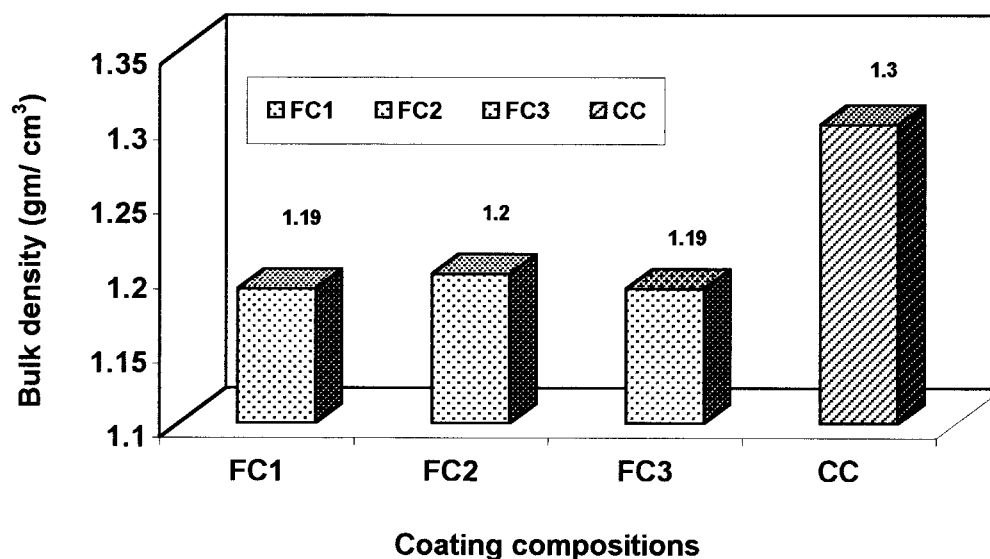


Figure 7 Comparative bulk densities of fly ash coatings based on MOFA resins.

TABLE IX
Formulation of Fly Ash Coatings based on Mahua Oil Alkyds

Ingredients	Parts by weight (%)		
	FC1	FC2	FC3
MGAL + MF	35	—	—
MGAL + EG	—	35	—
ARC	—	—	35
Mineral spirit	13	13	13
Xylene	1.9	1.9	1.9
Fly ash	40	40	40
Talc	9	9	9
Co naphthenate	0.15	0.15	0.15
Pb naphthenate	0.45	0.45	0.45
Duroxime	0.50	0.50	0.50

4 h to achieve complete curing. The coatings possessed film thicknesses varying from 50 to 52 μm . The commercial primer had a film thickness of 49 μm .

The mechanical film properties of the coatings such as scratch hardness and impact resistance were determined by standard methods. In MF-cured coatings, the maximum scratch hardness was 1.4 kg, whereas the coatings prepared with EG-cured resins offered a scratch hardness of 1.2 kg. The reason for better scratch hardness in melamine-cured coatings was the formation of a crosslinked structure that was lacking in EG-cured resins. The scratch hardness value for coatings based on the commercial resin was 1.3 kg. All the coatings were able to pass the standard impact of 2 lb/12 in., as no cracking or peeling off was observed in any of the samples during direct or indirect impact. Adhesion values obtained for MOFA-resin-based fly ash coatings was 40 and 35 kg/cm^2 for MF- and EG-cured coatings, respectively. The adhesion of these coatings was better than the that of the CC, which showed an adhesion of 30 kg/cm^2 . The adhesion value of MF-cured coatings was found superior to that of the EG-cured one. All the previous characteristics were in desirable limits compared to the standard coating based on the commercial resin.

Corrosion resistance

The visual observations for the corrosion resistance test conducted for resistance to humidity and salt spray are illustrated in Figure 8. The fly ash coatings based on melamine-cured MOFA alkyds (FC1) showed no blistering or corrosion after exposure to either humidity or salt-spray conditions for the specified time. The coatings based on EG-cured MOFA alkyds (FC2) developed slight to medium blistering after 7 days of exposure, whereas the coating based on the commercial alkyd (FC3) showed no blistering in salt spray but developed negligible blisters in the humidity test. The better corrosion resistance properties of coatings based on MF-cured resins may be attributed to the good adhesion and crosslinked structure of the resins, which acted as a barrier to the moisture penetrating the coating film. The anticorrosive property of the coating was substantiated by the presence of fly ash, which itself delays corrosion due to its composition of inert constituents, as reported earlier.²⁰

Abrasion resistance

Resistance to abrasion was studied by plotting graphs of wear rate versus sliding distance and wear rate versus load applied for various coating compositions. Figure 9 gives the wear rate versus sliding distance plot for MOFA-resin-based fly ash coatings at a constant load of 1 N. In this test, lesser wear rates indicated better abrasion resistance of paints. The least wear rate was observed for FC1 (fly ash coating based on the melamine-cured glycerol alkyd). The formulations modified with EG (FC2) exhibited inferior abrasion resistance properties compared to those cured with melamine (FC1). The maximum wear rate was observed for the commercial primer. The abrasion properties of the coatings were also assessed by comparison of the distance at which the coating was first removed exposure of the substrate. The composition modified with EG and the CC were abraded first at a distance of 13 m, whereas the coating cured with MF

TABLE X
Film Properties of Fly Ash Coatings Based on Mahua Oil Alkyds

Serial number	Property	Observation		
		FC1	FC2	FC3
1	Drying time (h)	Baking at 140°C for 4 h	Air drying, 2 h	Air drying, 2 h
2	Average film thickness (μm)	25	25	24
3	Scratch hardness (kg)	50	52	51
4	Impact resistance (2 lb/12 in)			
	Direct	Passed	Passed	Passed
	Indirect	Passed	Passed	Passed
5	Adhesion (kg/cm^2)	40	35	30

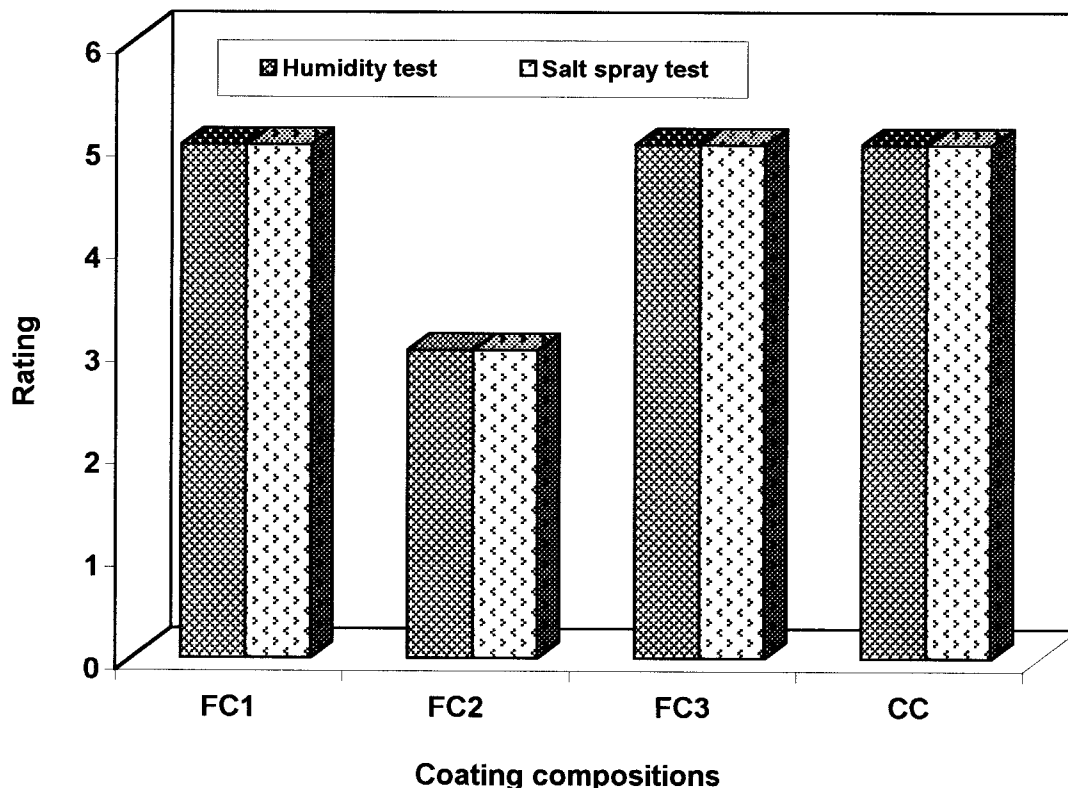


Figure 8 Corrosion resistance of fly ash coatings based on MOFA resins.

was intact up to a distance of 29.25 m, after which it left the substrate, indicating comparatively better abrasion resistance properties.

The plot of wear rate versus load applied at a constant sliding distance is shown in Figure 10. The MF-cured coating tolerated a load of 3 N when the coating was first removed to expose the substrate, whereas the

EG-cured coating and the one based on the commercial resin were removed at a 2-N load, exhibiting inferior resistance to abrasion. These results substantiated the observations obtained in the previous case. Earlier reported work suggests an improvement in the abrasion resistance properties of fly ash coatings due to the presence of abrasive constituents in fly ash.²⁰

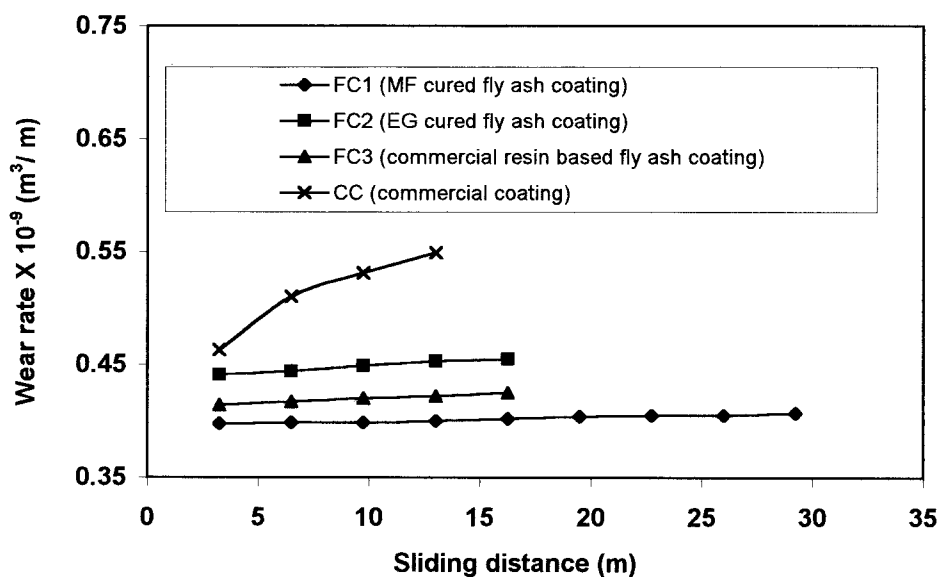


Figure 9 Wear rate versus sliding distance plots of fly ash coatings based on MOFA resins.

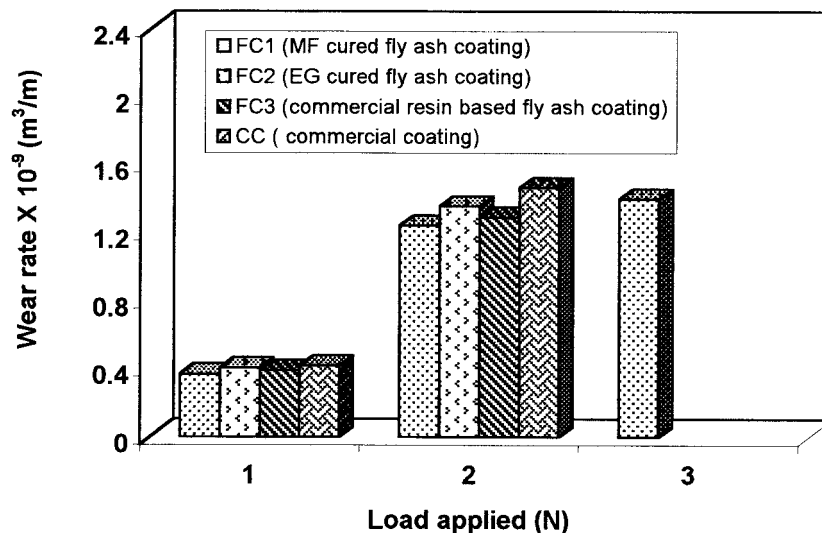


Figure 10 Wear rate versus load applied plot of fly ash coatings based on MOFA resins.

CONCLUSIONS

Mahua oil is a nondrying and inedible oil of abundant availability. It has much potential for use in the preparation of resins for surface coatings. The medium-oil-length glycerol alkyd based on MOFAs cured at 140°C with 20% melamine. The cured resin offered better mechanical properties and adhesion than the commercial alkyd. It also possessed good water and alkali resistance. The properties of MOFA resin modified with EG were somewhat inferior, which could be used where mild protection is required. The MOFA resin performed well when used in high-temperature-cure fly ash coatings. These coatings are suited for application in moderately corrosive and abrasive environments.

The authors are grateful to Professor T. C. Rao, Director of the Regional Research Laboratory, Bhopal, India, for providing institute facilities. Thanks are also due to Mr. A. K. Basu, Mr. J. M. Modawel, and Mr. Rajkumar, Bharat Heavy Electricals Limited, Bhopal, for extending laboratory facilities and necessary help in synthesizing resins. Sangeeta Tiwari is also thankful to Council of Scientific and Industrial Research, New Delhi, India for the award of a fellowship.

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