RESULTS

AND

DISCUSSION

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Alkyd resins are polyester-based materials that are normally modified with oils or fatty acids. These products are further modified with a variety of other chemical materials. Various polybasic acids, polyhydric alcohols, oils, fatty acids and modifying agents may be combined to produce alkyds with specifically designed properties.

Phthalic anhydride is the most important acid used in alkyd resin because of its low cost and the excellent properties. Isophthalic acid has become more extensively used. Its alkyd have the following characteristics, higher molecular weight, higher viscosity, better drying properties and harder and more durable films with better heat and chemical stability.

Also maleic and/or fumaric acids are used to replace part of the phthalic anhydride, these acids react with the unsaturation of the fatty acids, thus increase the molecular weight of alkyd resin. These alkyds dry more rapidly and gives harder films with better alkali resistance and better exterior durability.

The scope of the present investigation is the modification of alkyd by the partial replacement of the phthalic anhydride by tetrabromophthalic anhydride. This modification would expect to improve the performances of the dry films.

Although oil-modified alkyd resins have been known for quite along time, they have shown a remarkable ability to maintain their position as one of the major types of vehicles used in surface coating industry.

Another target of the present investigation is the formulation of long alkyds based on rice bran oil and evaluation of their varnish as a vehicle for surface coating.

Resin preparations:

Alkyds based on rice bran oil or fatty acid:

Glycerolysis of rice bran oil or fatty acids was carried out at 220°C in the presence of lead oxide as glycerolysis catalyst, the esterifiction reaction was conducted at 220°C to the end of the reaction. At the end of glycerolysis the reaction mixture was cooled to about 100°C, then phthalic anhydride and/or tetrabromophthalic anhydride were added. The replacement ratio of tetrabromophthalic anhydride are (0, 25, 50 and 100% respectively), without affecting the resin constant. The composition of different alkyd resins was listed in table (20).

Modification of long oil length from rice bran oil, linseed oil and its fatty acids:

In the following runs, a part of rice bran oil or its fatty acids was replaced by an equivalent amount of linseed oil or its fatty acids. Linseed oil was incorporated together with rice bran oil from the beginning of the glycerolysis reaction. The content of linseed oil in the oil mixture varied from Zero to 50 percent by weight. The reaction was followed by the method used previously for the unmodified rice bran oil.

The reaction was followed by measuring the acid value as shown in fig (1-12).

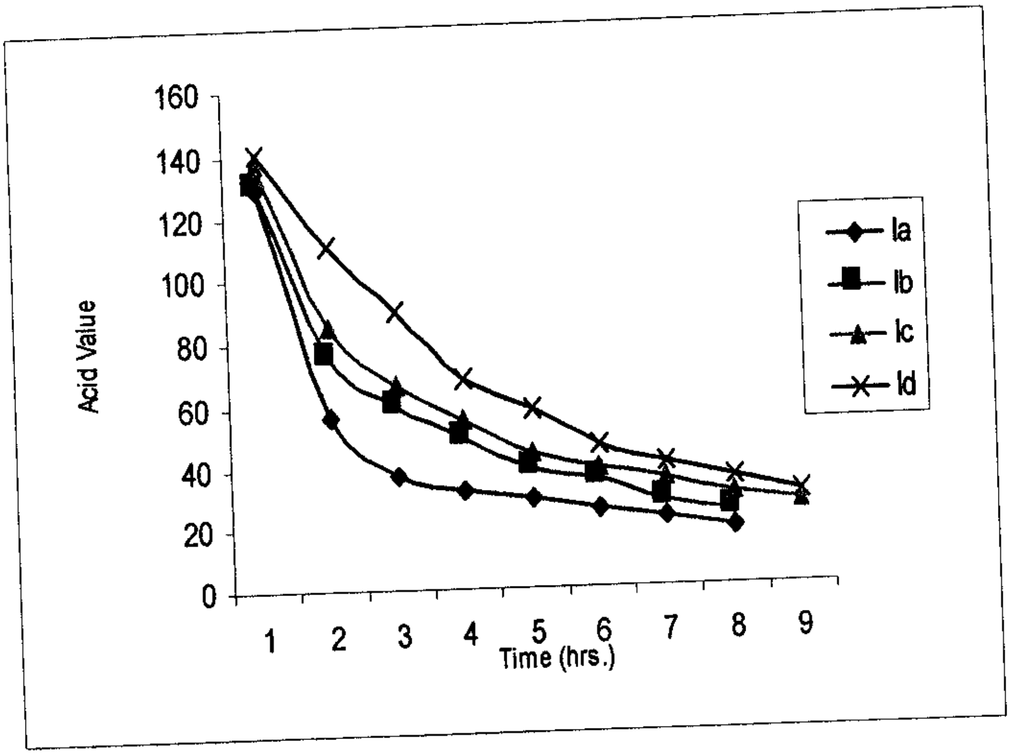


Fig. (1): Acid value of alkyd containing 100% RBO.

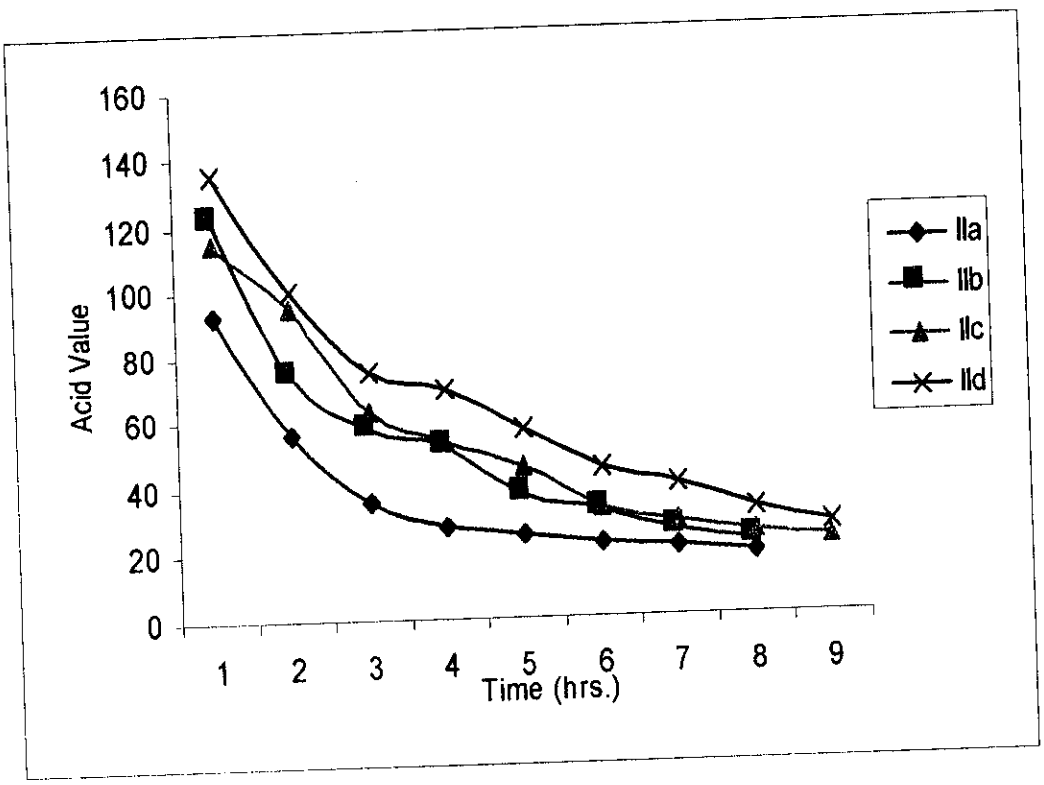


Fig. (2): Acid value of alkyd containing 90% RBO.

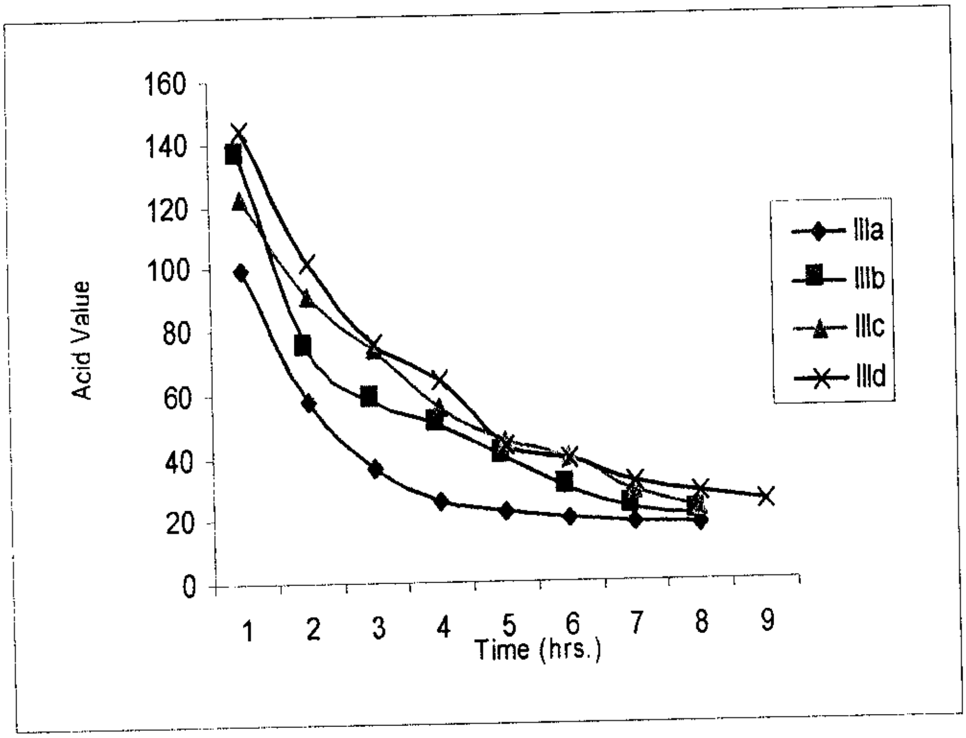


Fig. (3): Acid value of alkyd containing 80% RBO.

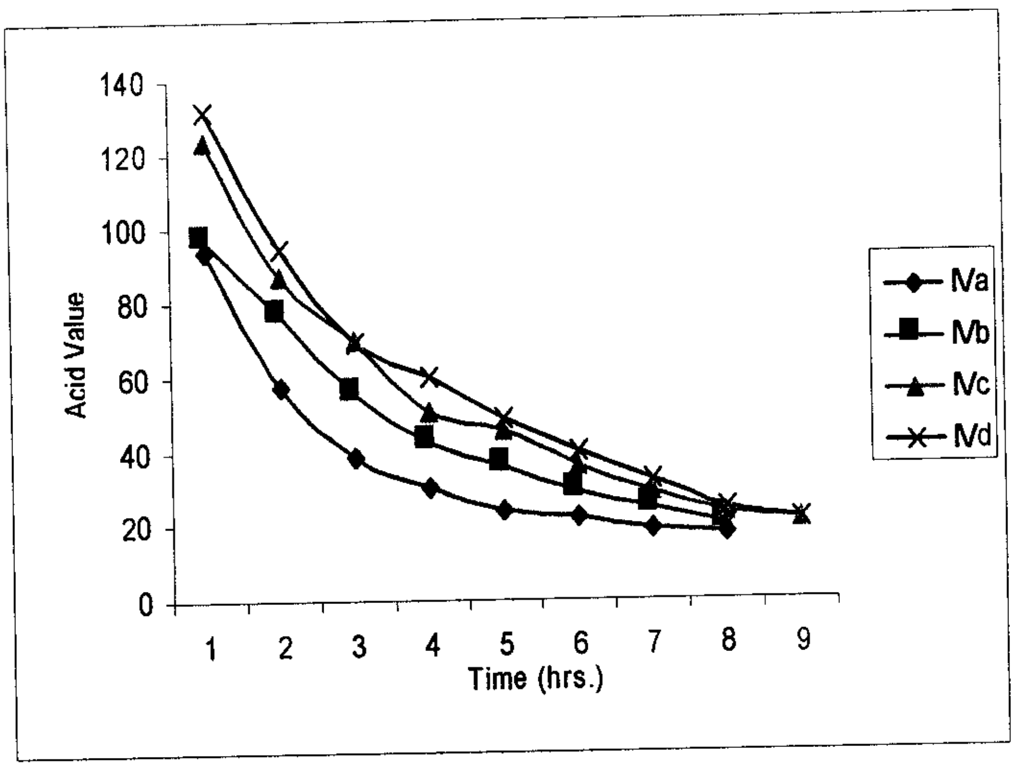


Fig. (4): Acid value of alkyd containing 70% RBO.

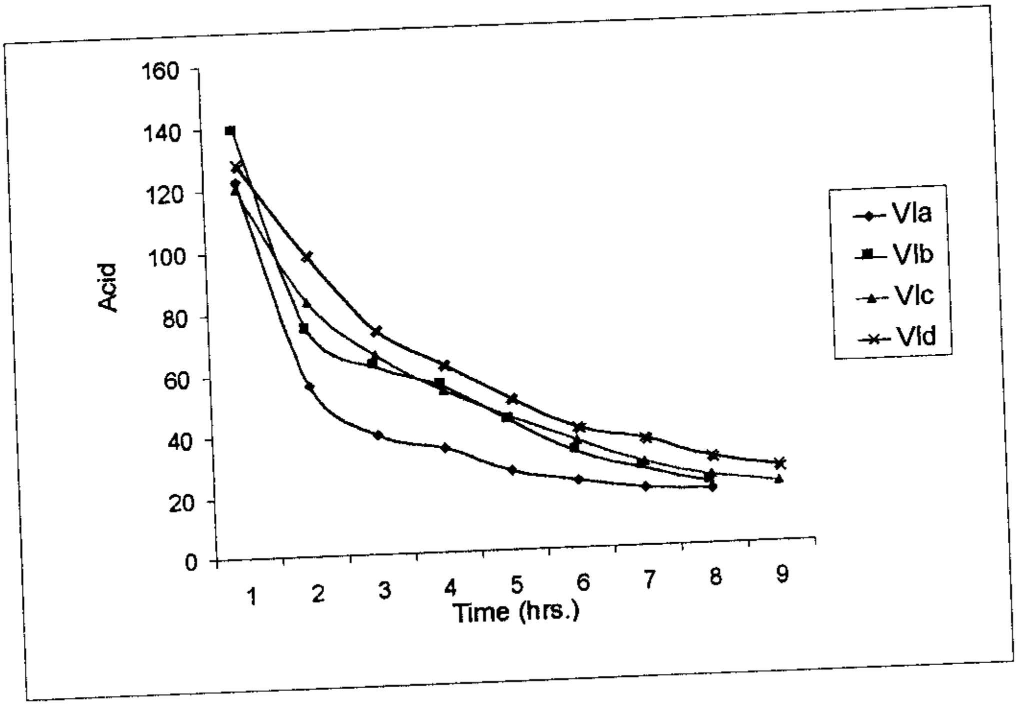


Fig. (5): Acid value of alkyd containing 60% RBO.

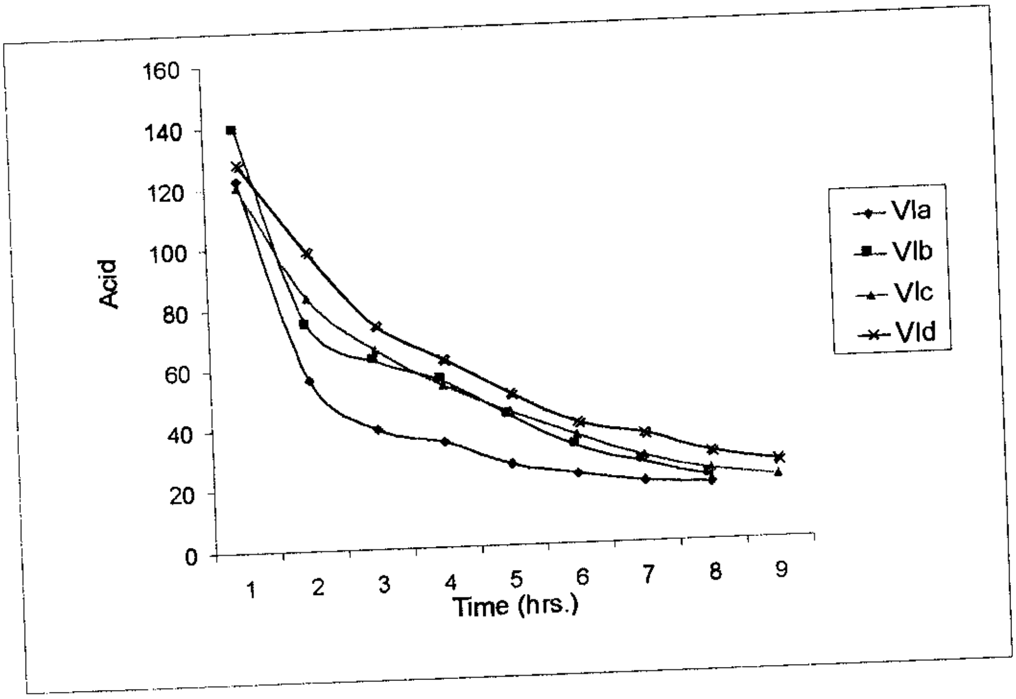


Fig. (6): Acid value of alkyd containing 50% RBO.

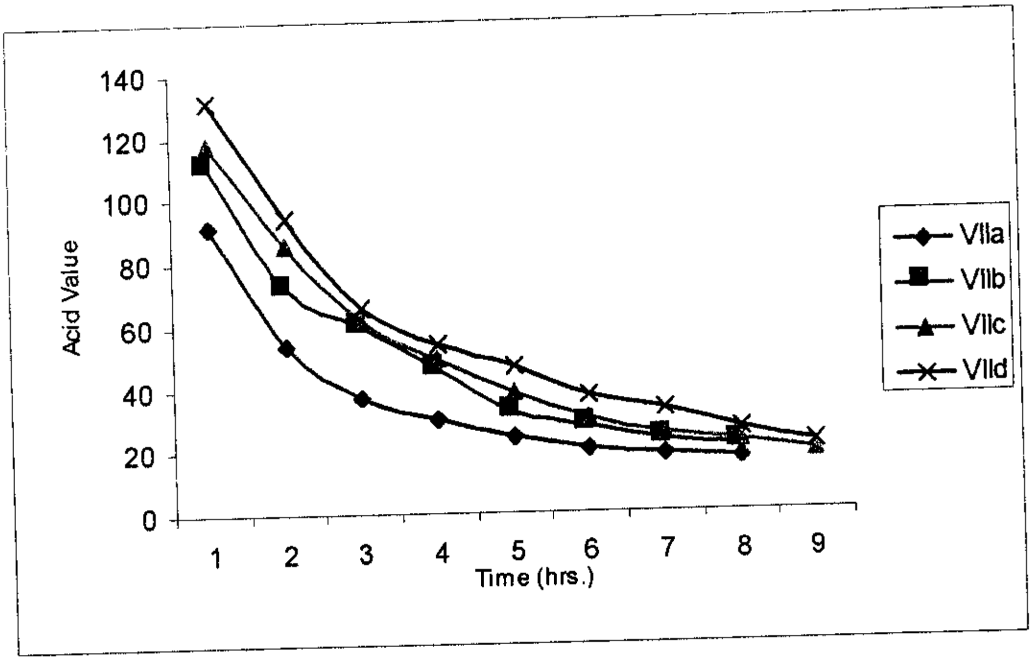


Fig. (7): Acid value of alkyd containing 100% LO

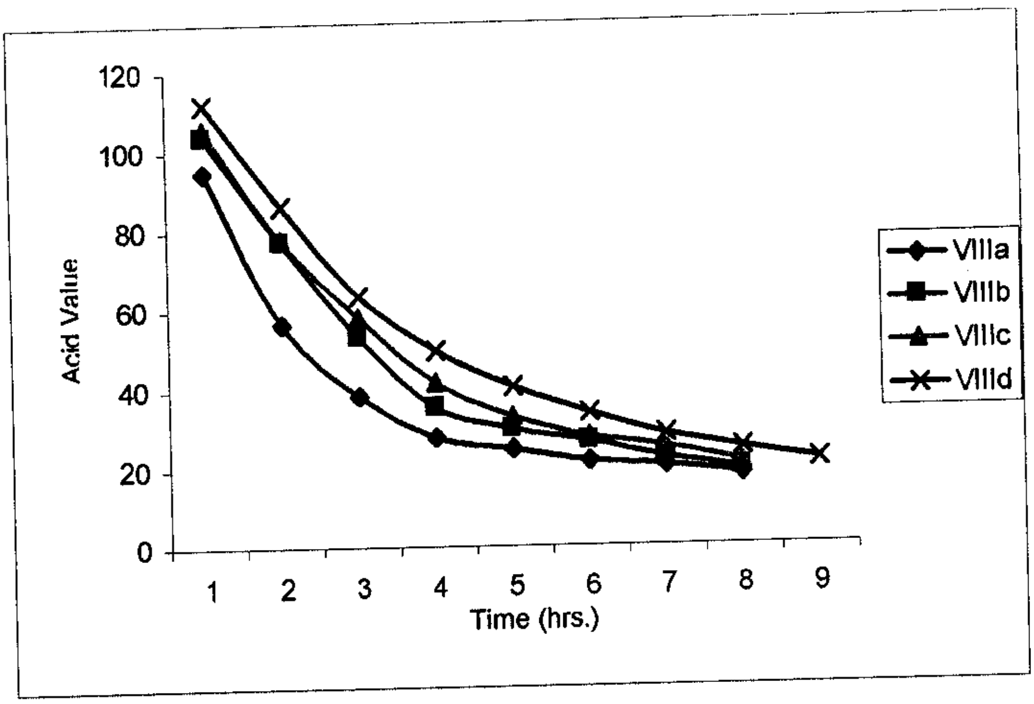


Fig. (8): Acid value of alkyd containing Oleic Acid.

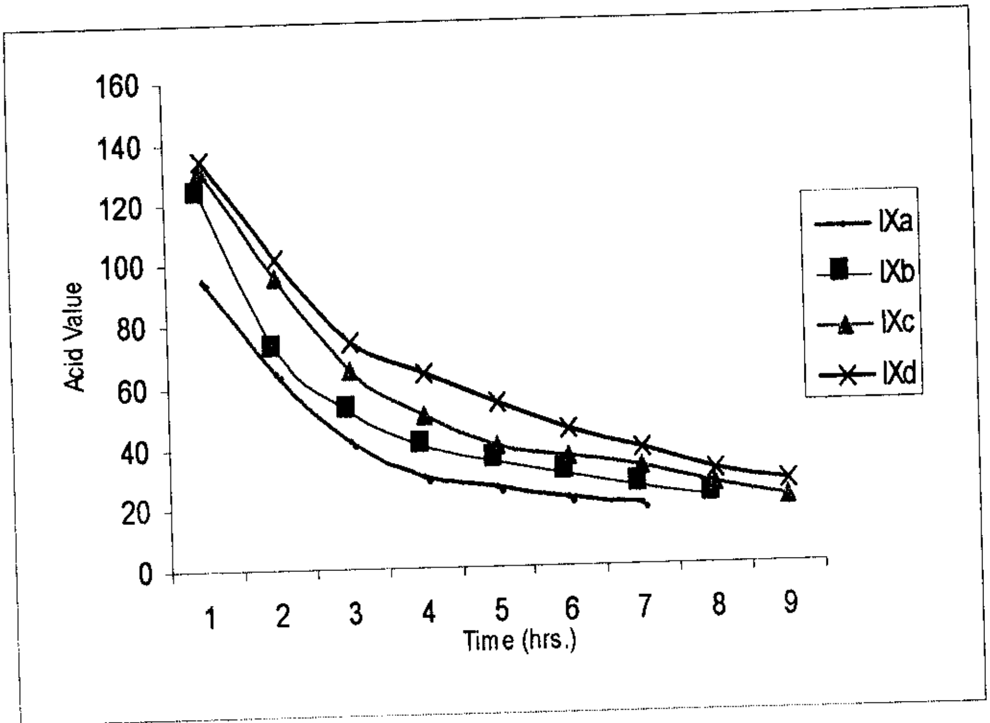


Fig. (9): Acid value of alkyd containing 100% RBFA.

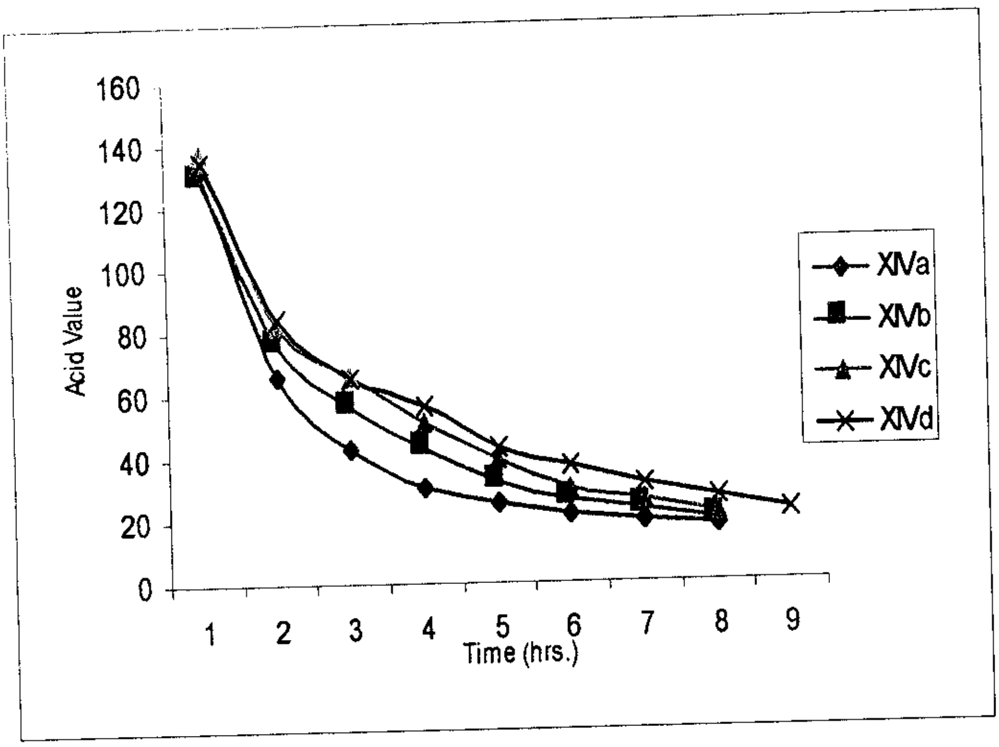


Fig. (10): Acid value of alkyd containing 50% RBFA.

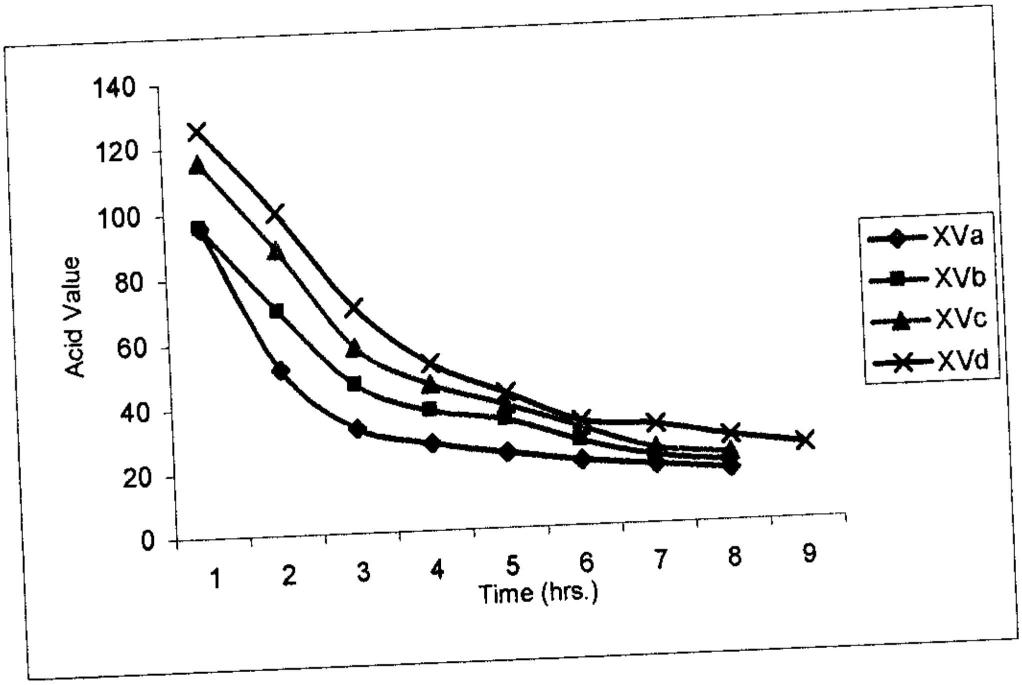


Fig. (11): Acid value of alkyd containing 100% LFA.

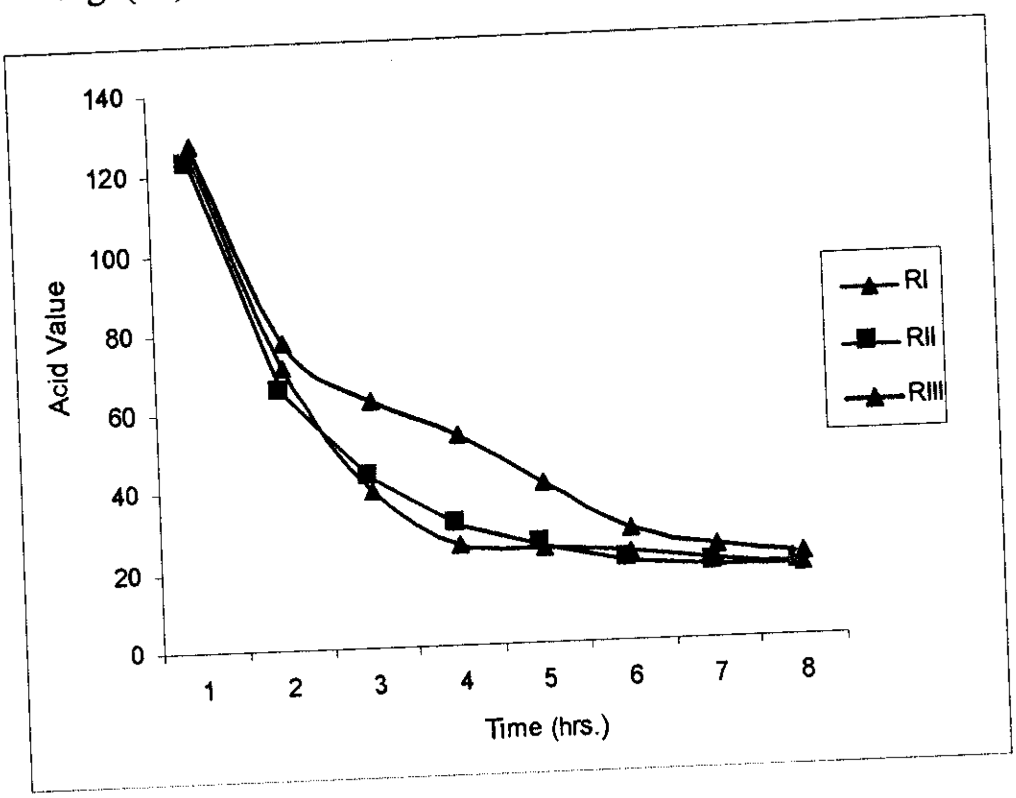


Fig. (12): Acid values of alkyd containing 50% RBO with Itaconic.

The following observations were noticed during the resin preparations:

1- The time of the esterification reaction increase by increasing the percent of rice bran oil and tetrabromophthalic anhydride. .

2- The colour of the prepared resin usually increases by increasing the percent of tetrabromophthalic anhydride in most cases.

3- As the percentage of tetrabromophthalic anhydride increases the acid value of final resin increased.

Mass spectra studies:

The fatty acid composition effect of each component in the prepared alkyd resin was investigated by a comparative analysis of I_a, I_c, IV_c and V_c respectively (cf. Fg 13-16). For a given oil type, the relative abundance of high-molecular weight species, increases when the oil length decreases. The main fragmentation ions of the monomer pattern, showed in figures (13-16), were detected in all spectra. Ions with a loss of two, four or six protons corresponded to fragments that contained polyunsaturated fatty acids, for example, the molecular ion at m/z = 881 corresponding to oleic acid, ions at m/z = 879 (R= linoleic acid), and m/z = 877 (R: linolenic acid) [55].The mass spectrum of (I_a) showed peaks at m/z (relative intensity %) 968 (0.01), 824 (0.07), 486 (5.45) and 338 (10.13). This resin contains rice bran oil, phthalic anhydride and glycerol, where the molcular ion at m/z =824 (R = oleic acid), molcular ion at m/z =822 (R = linoleic acid) and m/z =820 (R = linolenic acid). Where as the mass spectrum of (I_c,IV_c and V_c) these resin resins which containing rice bran oil, linseed oil, phthalic anhydride, tetrabromophthalic anhydride and glycerol, showed peaks at m/z =993.6 with relative intensity (0.01), (0.01), and (0.01), 815.6 (0.01), (0.02), and (0.01) and 493.6 (2.51), (7.26), and (9.09) respectively.

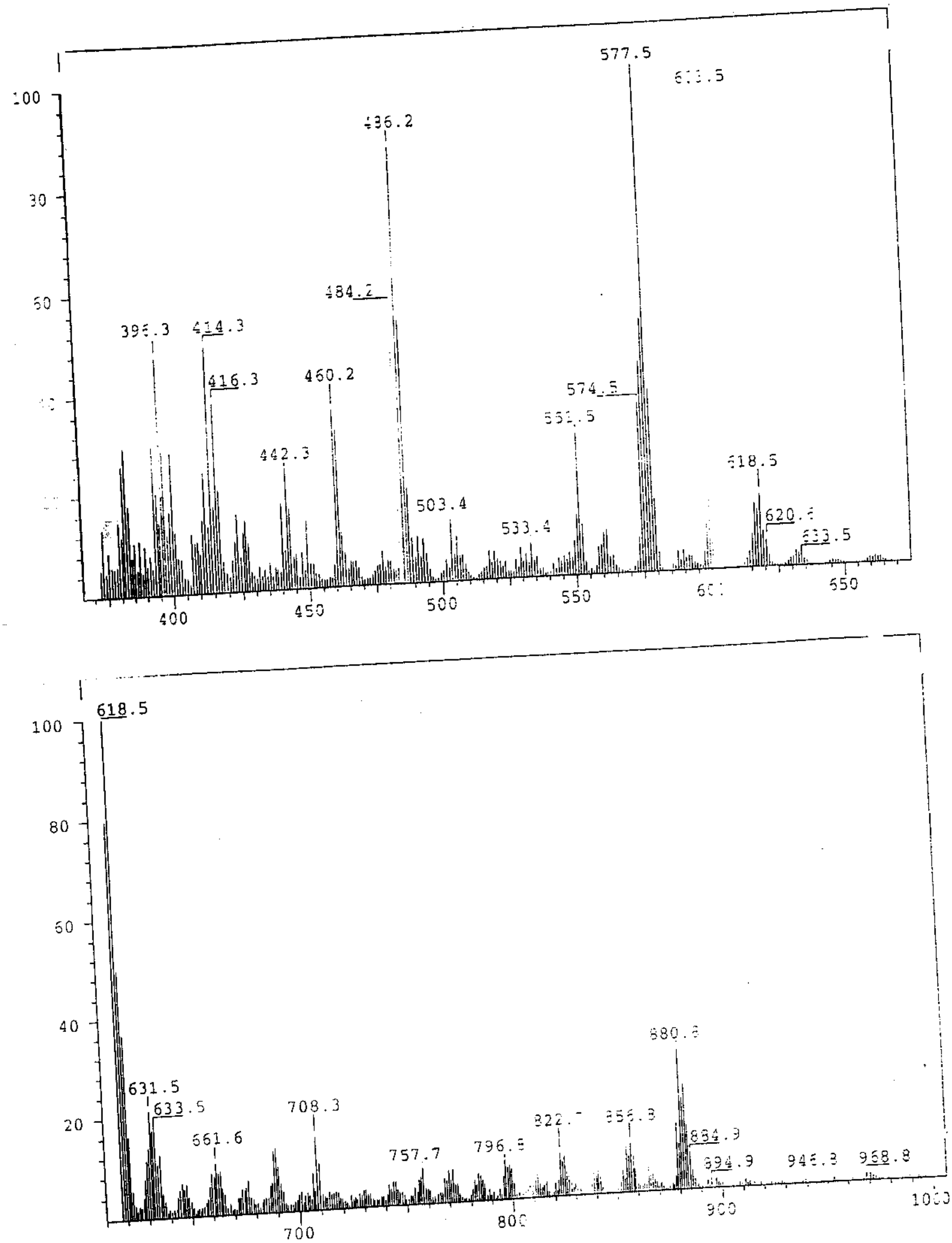


Fig. (13): Mass spectra of I_a .

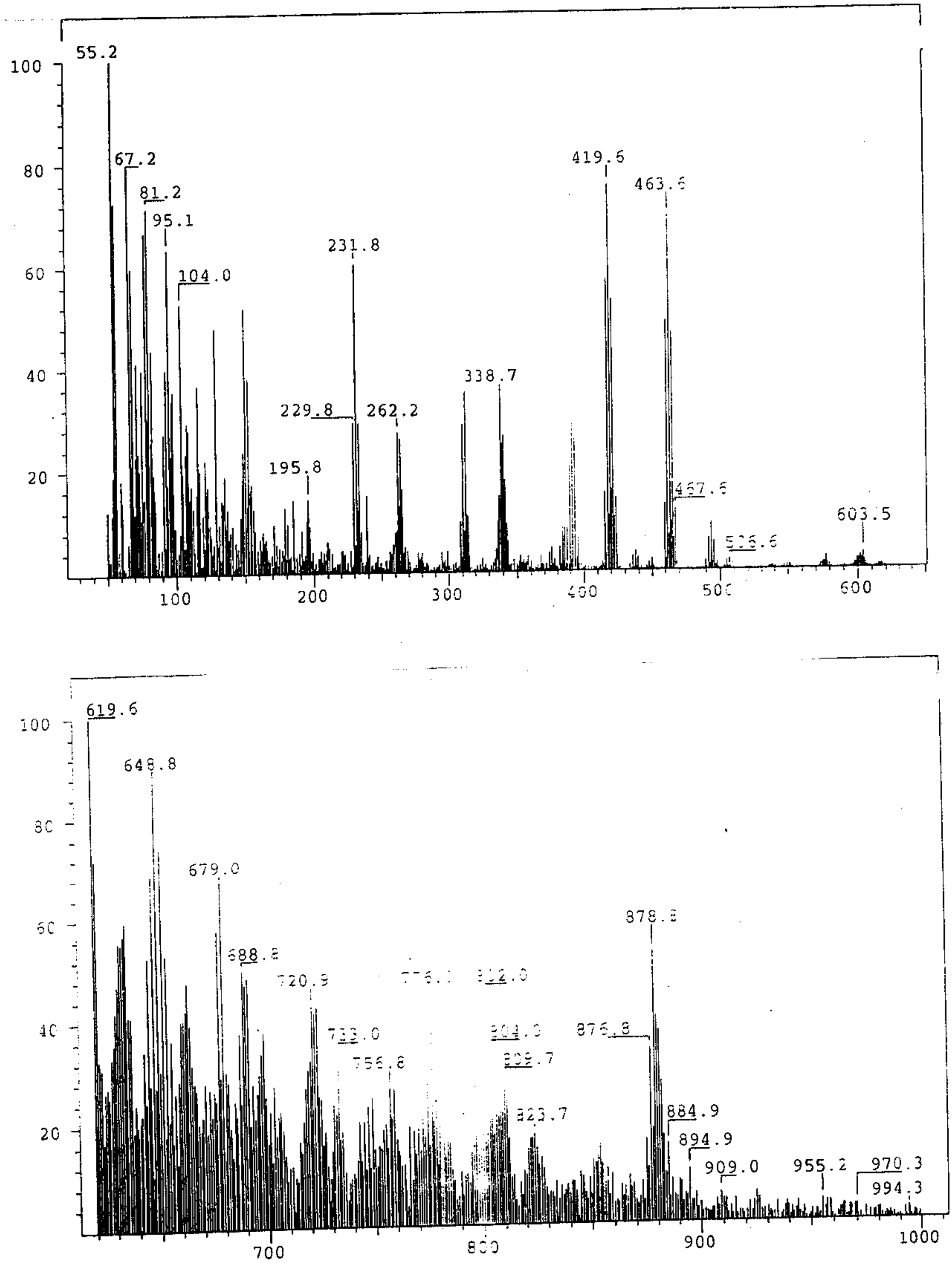


Fig. (15) : Mass spectra of IV_c .

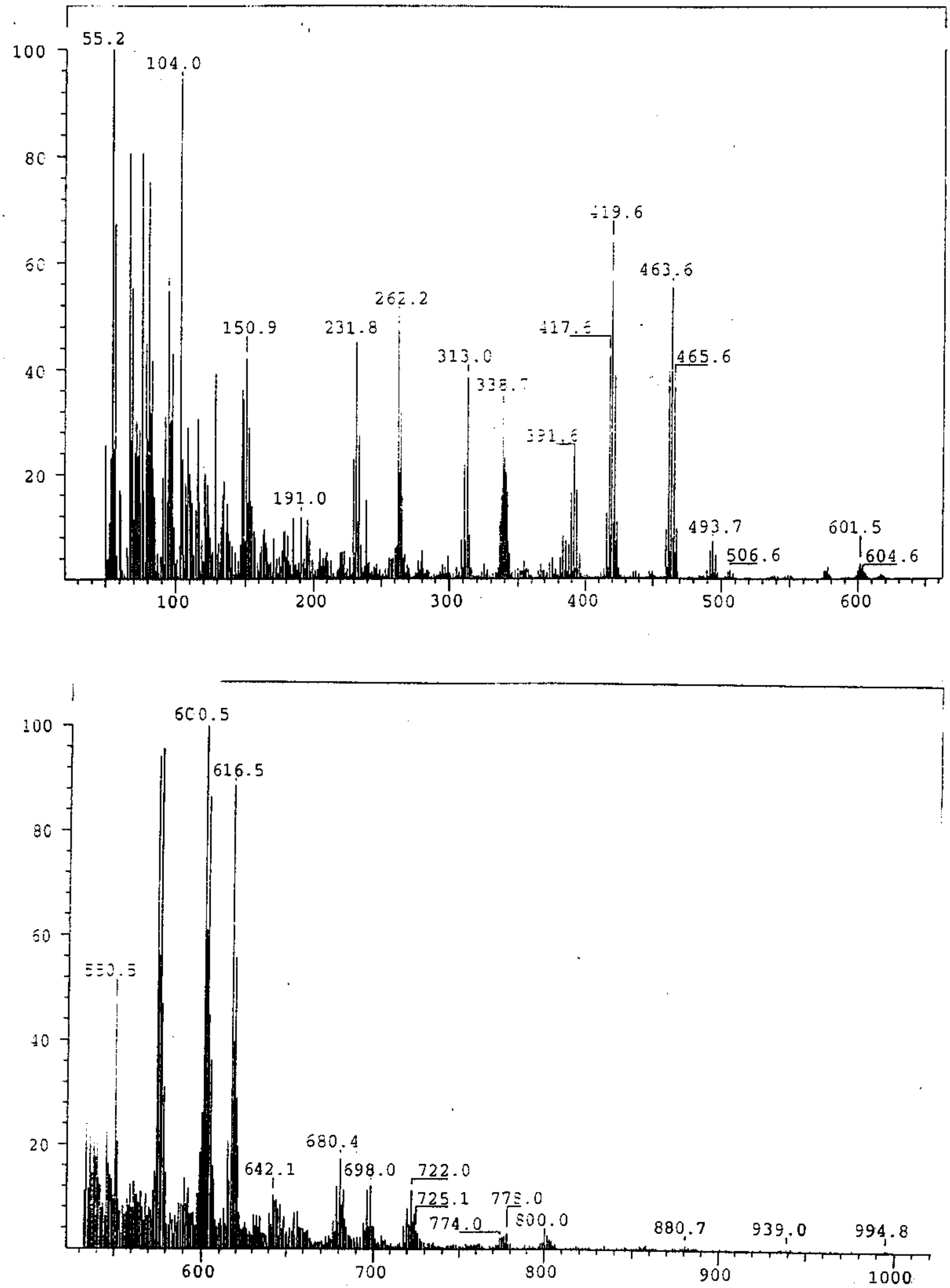
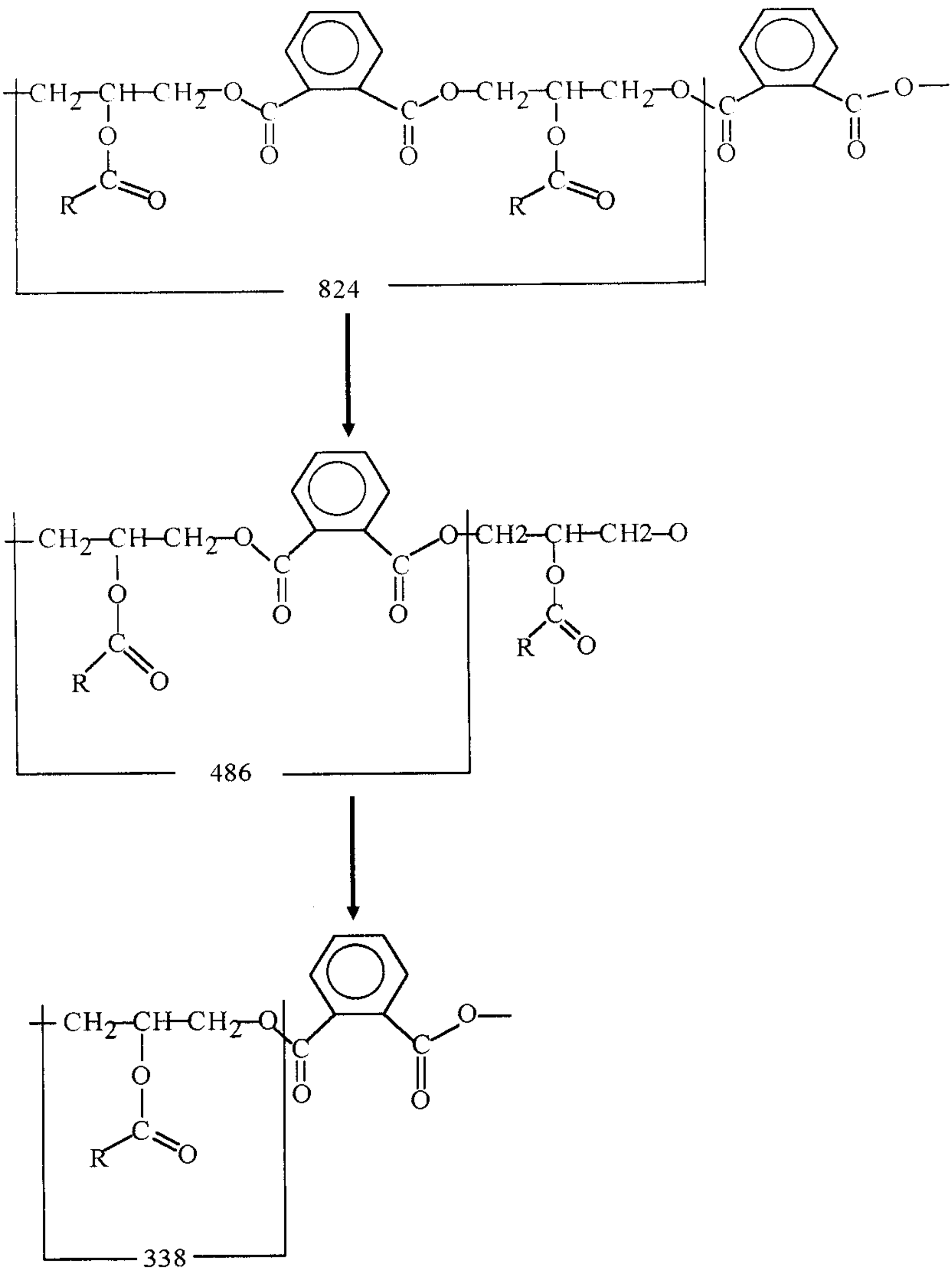
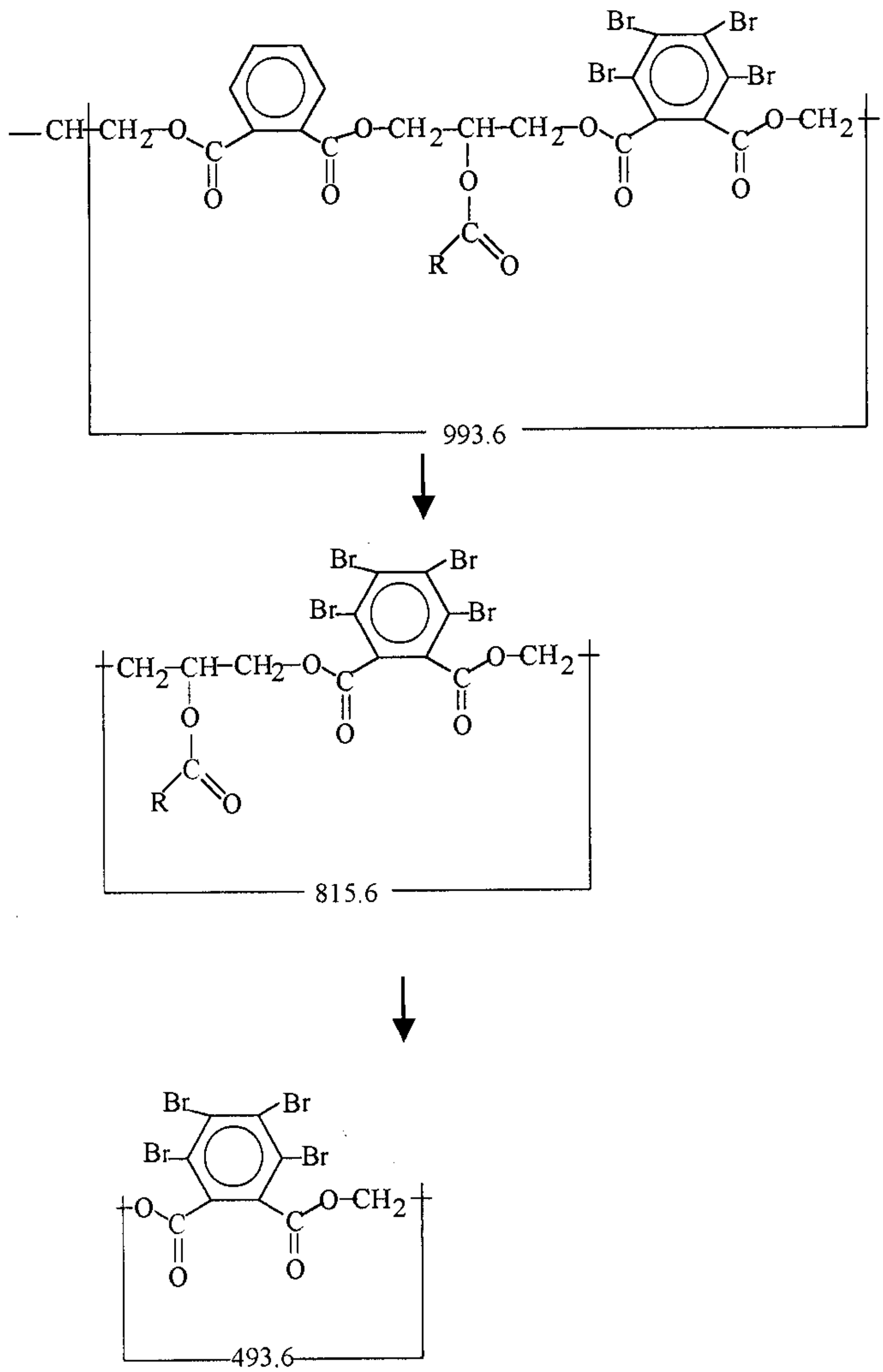


Fig. (16) : Mass spectra of V_c .

The possible fragmentation for I_a shown as the following scheme:



The possible fragmentation for I_c, IV_c and V_c can be shown as the following scheme:



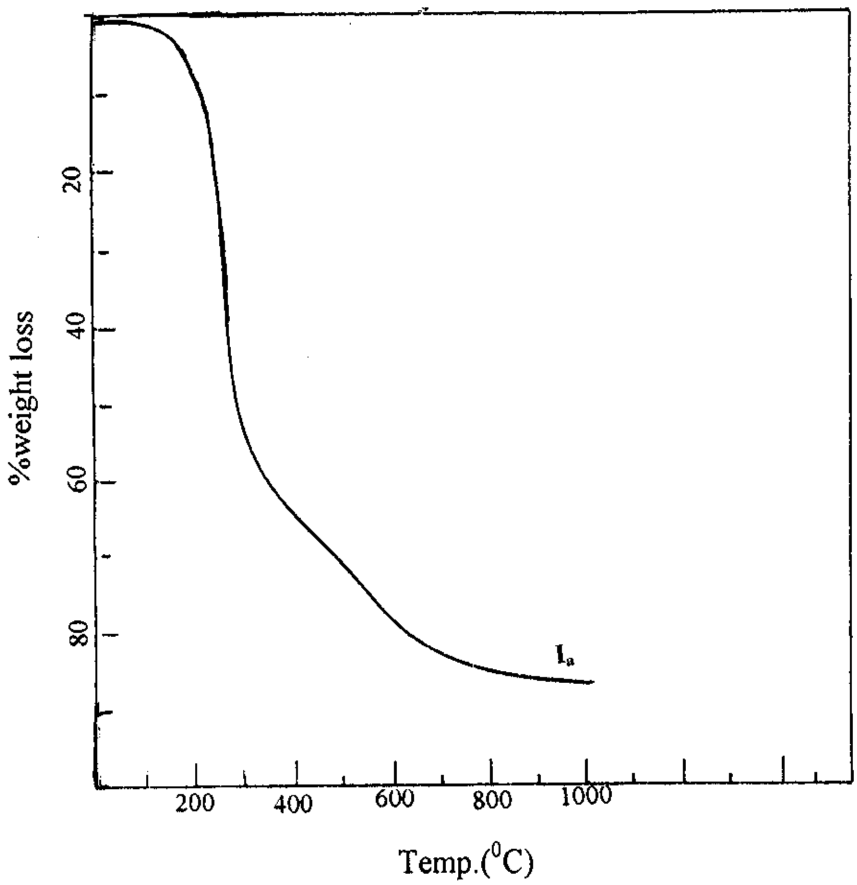
Thermal analysis :

Thermal analysis is the measurement of changes in physical properties of substance as a function of temperature whilst the substance is subjected to a controlled temperature programm.

Thermogravimetry (TG) measures the changes in sample mass with temperature. The TGA curves give information about the various unexpected phenomena observed during heat treatment. It is important to take into account that the TGA is concerned with calorific phenomena which aften occur with no deletable weight change [(83)].

The present investigation included the thermogravimetric behavior of some selected compounds under study.

The thermogravimetric (TG) analysis of the prepared alkyd resins($\mathbf{I_a}$ and $\mathbf{I_c}$) are repersented in (fig.17) in nitrogen atmosphere, heating rate of $15^0C.m^{-1}$. From the figure, it is clear that, the alkyd resin ($\mathbf{I_a}$) with fragement of molecular ion (968.8) loses its weight in two steps, while the alkyd resin ($\mathbf{I_c}$) with fragement of molecular ion (993) loses its weight in three steps . From the above data it is clear that the polymers have no stability over 150^0C.


%weight loss
20
40
60
80
200
400
600
800
1000
Temp.(°C)
I_a

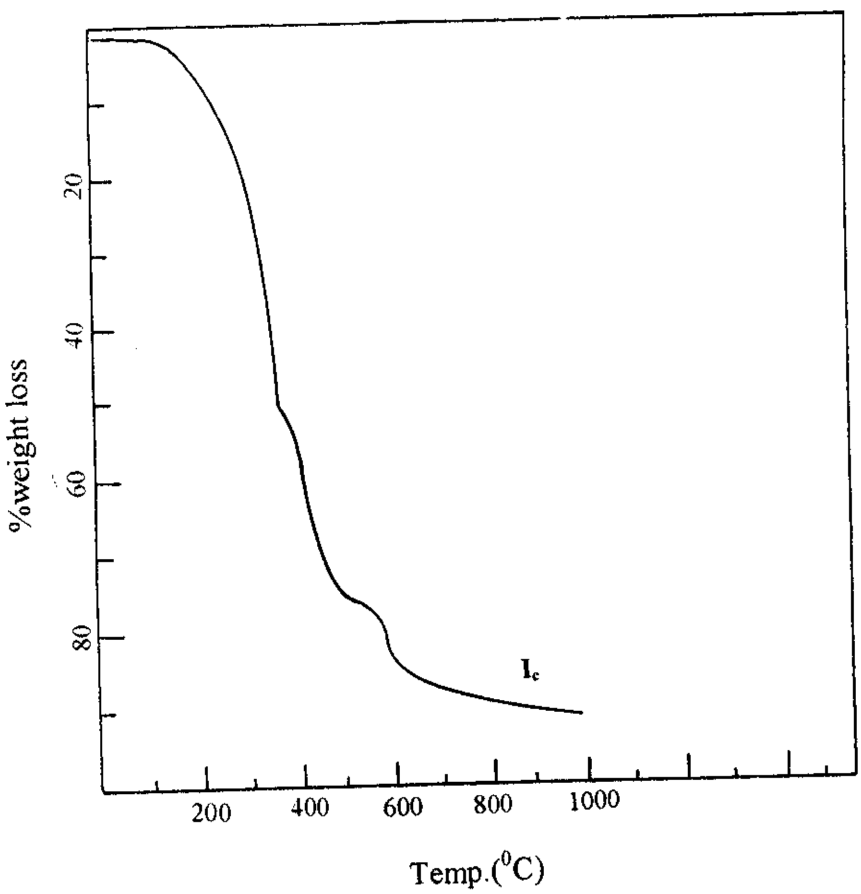

%weight loss
20
40
60
80
200
400
600
800
1000
Temp.(°C)
I_c

Fig.(17)

Evaluation studies:

The solid content of the prepared resins was diluted by xylene to 60% solids.The following driers combination were added to resins solution:

Cobalt octoate 0.05% (metal/resin)

Zerconium octoate 0.10% (metal/resin)

Manganese octoate 0.02% (metal/resin)

Varnishes characteristics:

The characteristics of various varnishes were evaluated and were recorded in tables (21,22) .

From the tables it is clear that :

The colour of varnish increases by increasing the amount of tetrabromophthalic anhydride and rice bran oil or its fatty acids, the viscosity of the prepared alkyds slightly increased by increasing the percentage of tetrabromophthalic anhydride .Finally the acid value of resins prepared by tetrabromophthalic anhydride are higher than those prepared by phthalic anhydride.

Table (21)Varnish characteristic data of various modified alkyd resins from oils:

Resin NO.	*Acid Value (mg KOH/g)*	*Colour "Gardener"*	*Viscosity "Gardener"*
I_a	18.9	15	<D
I_b	23.3	16	>D
I_c	27.1	17	>D
I_d	28.6	>18	>E
II_a	18.1	15	<D
II_b	20.5	-17	>D
II_c	22.4	17	<E
II_d	25.3	>18	>E
III_a	18.0	14	<D
III_b	20.7	16	<D
III_c	21.9	-17	>D
III_d	24.9	18	>E
IV_a	17.6	+15	>C
IV_b	20.2	-16	<D
IV_c	21.6	-17	>D
IV_d	21.3	18	E
V_a	19.0	13	>C
V_b	20.3	15	>C
V_c	20.7	17	>D
V_d	27.1	-18	<E
VI_a	18.1	13	<C
VI_b	19.6	-15	>C
VI_c	19.4	16	<D
VI_d	24.9	17	<E
VII_a	17.1	12	<C
VII_b	19.1	13	C
VII_c	19.0	-15	<D
VII_d	20.1	17	<E
R_I	18.5	16	>C
R_{II}	18.0	16	C
R_{III}	20.9	-17	D

Where:(C= 0.85, D=1.00, E= 1.25)

Table (22) Varnish characteristic data of various modified alkyd resins from fatty acids:

Resin NO.	*Acid Value (mg KOH/g)*	*Colour "Gardener"*	*Viscosity "Gardener"*
VIII_a	18.0	12	<C
VIII_b	19.1	-13	C
VIII_c	20.3	15	<D
VIII_d	21.3	16	<E
IX_a	18.1	14	C
IX_b	20.6	-16	>C
IX_c	21.6	17	>C
IX_d	26.9	>18	<E
X_a	17.4	15	<D
X_b	18.0	16	>D
X_c	19.7	17	>D
X_d	22.9	>18	>E
XI_a	18.0	-15	>C
XI_b	18.5	16	D
XI_c	19.7	17	>D
XI_d	23.1	>18	E
XII_a	17.9	14	>C
XII_b	18.7	-16	>C
XII_c	19.5	-17	>D
XII_d	23.1	18	<E
XIII_a	18.0	13	<D
XIII_b	19.0	+16	<D
XIII_c	21.5	-17	D
XIII_d	23.0	17	<E
XIV_a	17.9	13	<C
XIV_b	19.1	15	>C
XIV_c	20.8	+16	>C
XIV_d	23.3	17	<E
XV_a	16.1	12	C
XV_b	18.6	13	C
XV_c	20.1	15	>D
XV_d	22.6	17	<E

Film Performance

A- Drying characteristics :

The drying reactivity of drying oil is determined by linoleic and linolenic acid content, and thereby can be quantified from the drying index.

D.I = linoleic % + 2 linolenic %

Where D.I is the drying index, linoleic % and linolenic % are expressed in weight percentage [84].

The drying characteristics of various varnishes were determined after the preparation of its films. These films were subjected to dry in air and also for stoved dry. The data are given in tables (23,24).

The main conclusion derived from drying characteristics data of various alkyd resins are:

1- Modification by either tetrabromophthalic anhydride or linseed oil or its fatty acids decreases the air drying time.

2- The alkyds based on linseed oil and its fatty acids are air dried.

3- Formulations containing rice bran oil and its fatty acids give air dried film only when the phthalic anhydried is totally replaced by tetrabromophthalic anhydried.

4- The stoved films improved by increasing the amount of tetrabromophthalic anhydride and linseed oil or its fatty acids.

5-The presence of rice bran oil or its fatty acids increases the air and stoved drying times, which may be due to the high percentage of saturated fatty acids in the oil composition [53].

Table (23) Drying characteristic data of various modified alkyd resins from oils:

Resin No	Air drying time (hr)	Stoving			
		90°c		110°c	
		1hr	2hr	1hr	2hr
I_a	-	T	VST	VST	HD
I_b	-	T	VST	HD	-
I_c	-	T	VST	HD	-
I_d	48	VST	HD	-	-
II_a	-	T	VST	HD	-
II_b	-	VST	HD	-	-
II_c	-	VST	HD	-	-
II_d	17	VST	HD	-	-
III_a	-	T	VST	HD	-
III_b	-	VST	HD	-	-
III_c	-	VST	HD	-	-
III_d	11	VST	HD	-	-
IV_a	-	T	VST	HD	-
IV_b	-	VST	HD	-	-
IV_c	-	VST	HD	-	-
IV_d	11	VST	HD	-	-
V_a	-	T	VST	HD	-
V_b	-	VST	HD	-	-
V_c	-	VST	HD	-	-
V_d	9hr	HD	-	-	-
VI_a	-	ST	VST	HD	-
VI_b	-	VST	HD	-	-
VI_c	-	VST	HD	-	-
VI_d	5hr	HD	-	-	-
VII_a	6	VST	HD	-	-
VII_b	5	VST	HD	-	-
VII_c	4	HD	-	-	-
VII_d	2: 30	HD	-	-	-
R_{I}	-	ST	VST	HD	-
R_{II}	-	ST	VST	HD	-
R_{III}	-	VST	D	-	-

Table (24) Drying characteristic data of various modified alkyd resins from fatty acids:

Resin No	Air drying time (hr)	Stoving			
		90°c		110°c	
		1hr	2hr	1hr	2hr
$VIII_a$	-	T	T	ST	HD
$VIII_b$	-	T	ST	VST	HD
$VIII_c$	-	T	ST	HD	-
$VIII_d$	-	ST	VST	HD	-
IX_a	-	T	T	VST	HD
IX_b	-	T	ST	HD	-
IX_c	-	T	ST	HD	-
IX_d	46	ST	VST	HD	-
X_a	-	T	VST	HD	-
X_b	-	VST	HD	-	-
X_c	-	VST	HD	-	-
X_d	17	VST	HD	-	-
XI_a	-	ST	VST	HD	-
XI_b	-	VST	HD	-	-
XI_c	-	VST	HD	-	-
XI_d	12	VST	HD	-	-
XII_a	-	T	ST	HD	-
XII_b	-	VST	HD	-	-
XII_c	-	VST	HD	-	-
XII_d	10	VST	HD	-	-
$XIII_a$	-	ST	VST	HD	-
$XIII_b$	-	VST	HD	-	-
$XIII_c$	-	VST	HD	-	-
$XIII_d$	8	VST	HD	-	-
XIV_a	-	ST	VST	HD	-
XIV_b	-	VST	HD	-	-
XIV_c	-	VST	HD	-	-
XIV_d	5	HD	-	-	-
XV_a	5	VST	HD	-	-
XV_b	4.5	HD	-	-	-
XV_c	4	HD	-	-	-
XV_d	2:30	HD	-	-	-

B- Acid, Solvent, Water and Alkali Resistance :

The resistance of various modified alkyd resins towards acid, solvent, water and alkali were conducted according to standard methods on actual coated films.

To determine the extent to which the film breaks down and to show how far the film will withstand various chemical effects, stored and air dried films were subjected to acid and alkali resistance for 30 days or until complete film failure occurred. The data obtained are shown in tables (25-32).

From the data listed in tables (25-32) we can conclude that:

1- Acid and solvent resistance tests for all films examined showed excellent performance within experimental conditions employed, So it can not predict the effect of the modification on acid and solvent resistance.

2- The modification of resins using teterabromophthalic anhydride are affected by water than those made by phthalic anhydride, where loss of gloss values were observed in case of teterabromophthalic anhydride.

3- Films prepared from oleic acid give excellent resistance to water except those modified by tetrabromophthalic anhydride which were affected by water and least resistance to alkali than other resins.

4- The alkali resistance is highly improved by modification with tetrabromophthalic anhydride and linseed oil or its fatty acids, where films of the resins prepared from linseed oil or its fatty acids gives the best resistance to alkali.

5- Stoved films showed improved chemical resistance when compared to the air dried films of the same resin content.

6- Rice bran oil and its fatty acids produced alkyds with lower alkali resistance than that of linseed oil and linseed oil fatty acids, which may be due to the saturation nature of rice bran fatty acids.

From this data, we can note that the introduction of tetrabromophthalic anhydride in the resin preparation improves the chemical resistance of its films.

Table (33) shows the chemical resistance for the varnish's films in which itaconic acid was used in its composition.

From the data it is obvious that the films give better resistance to water, acid and solvent, where the alkali resistance of these films was satisfactory, and also showed the increasing percent of tetrabrmophthalic anhydride improved the alkali resistance.

Table (25) Acid resistance data of modified alkyd resins from oils in 20% H_2SO_4

Resin No.	Immersion period "days"																									
	Air dried film													Stoved film												
	1	3	5	7	9	13	15	19	21	23	25	29	30	1	3	5	7	9	13	15	19	21	23	25	29	30
I_a	-	-	-	-	-	-	-	-	-	-	-	-	-	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex
I_b	-	-	-	-	-	-	-	-	-	-	-	-	-	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex
I_c	-	-	-	-	-	-	-	-	-	-	-	-	-	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex
I_d	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex
II_a	-	-	-	-	-	-	-	-	-	-	-	-	-	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex
II_b	-	-	-	-	-	-	-	-	-	-	-	-	-	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex
II_c	-	-	-	-	-	-	-	-	-	-	-	-	-	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex
II_d	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex
III_a	-	-	-	-	-	-	-	-	-	-	-	-	-	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex
III_b	-	-	-	-	-	-	-	-	-	-	-	-	-	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex
III_c	-	-	-	-	-	-	-	-	-	-	-	-	-	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex
III_d	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex
IV_a	-	-	-	-	-	-	-	-	-	-	-	-	-	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex
IV_b	-	-	-	-	-	-	-	-	-	-	-	-	-	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex
IV_c	-	-	-	-	-	-	-	-	-	-	-	-	-	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex
IV_d	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex

Resin No.	Immersion period "days"																									
	Air dried film													Stoved film												
	1	3	5	7	9	13	15	19	21	23	25	29	30	1	3	5	7	9	13	15	19	21	23	25	29	30
V_a	-	-	-	-	-	-	-	-	-	-	-	-	-	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex
V_b	-	-	-	-	-	-	-	-	-	-	-	-	-	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex
V_c	-	-	-	-	-	-	-	-	-	-	-	-	-	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex
V_d	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex
VI_a	-	-	-	-	-	-	-	-	-	-	-	-	-	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex
VI_b	-	-	-	-	-	-	-	-	-	-	-	-	-	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex
VI_c	-	-	-	-	-	-	-	-	-	-	-	-	-	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex
VI_d	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex
VII_a	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	G	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex
VII_b	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	G	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex
VII_c	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	G	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex
VII_d	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex

Table (26) Acid resistance data of modified alkyd resins from fatty acids in 20% H_2SO_4

Resin No.	Immersion period "days"																									
	Air dried film													Stoved film												
	1	3	5	7	9	13	15	19	21	23	25	29	30	1	3	5	7	9	13	15	19	21	23	25	29	30
$VIII_a$	-	-	-	-	-	-	-	-	-	-	-	-	-	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex
$VIII_b$	-	-	-	-	-	-	-	-	-	-	-	-	-	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex
$VIII_c$	-	-	-	-	-	-	-	-	-	-	-	-	-	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	G
$VIII_d$	-	-	-	-	-	-	-	-	-	-	-	-	-	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex
IX_a	-	-	-	-	-	-	-	-	-	-	-	-	-	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex
IX_b	-	-	-	-	-	-	-	-	-	-	-	-	-	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex
IX_c	-	-	-	-	-	-	-	-	-	-	-	-	-	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex
IX_d	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex
X_a	-	-	-	-	-	-	-	-	-	-	-	-	-	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex
X_b	-	-	-	-	-	-	-	-	-	-	-	-	-	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex
X_c	-	-	-	-	-	-	-	-	-	-	-	-	-	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex
X_d	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex
XI_a	-	-	-	-	-	-	-	-	-	-	-	-	-	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex
XI_b	-	-	-	-	-	-	-	-	-	-	-	-	-	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex
XI_c	-	-	-	-	-	-	-	-	-	-	-	-	-	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex
XI_d	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex

Resin No.	Immersion period "days"																									
	Air dried film													Stoved film												
	1	3	5	7	9	13	15	19	21	23	25	29	30	1	3	5	7	9	13	15	19	21	23	25	29	30
XII$_a$	-	-	-	-	-	-	-	-	-	-	-	-	-	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex
XII$_b$	-	-	-	-	-	-	-	-	-	-	-	-	-	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex
XII$_c$	-	-	-	-	-	-	-	-	-	-	-	-	-	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex
XII$_d$	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex
XIII$_a$	-	-	-	-	-	-	-	-	-	-	-	-	-	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex
XIII$_b$	-	-	-	-	-	-	-	-	-	-	-	-	-	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex
XIII$_c$	-	-	-	-	-	-	-	-	-	-	-	-	-	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex
XIII$_d$	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex
XIV$_a$	-	-	-	-	-	-	-	-	-	-	-	-	-	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex
XIV$_b$	-	-	-	-	-	-	-	-	-	-	-	-	-	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex
XIV$_c$	-	-	-	-	-	-	-	-	-	-	-	-	-	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex
XIV$_d$	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex
XV$_a$	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex
XV$_b$	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex
XV$_c$	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex
XV$_d$	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex

Table (27) Solvent resistance data of modified alkyd resins from oils.

Resin No.	Immersion period "days"																									
	Air dried film													Stoved film												
	1	3	5	7	9	13	15	19	21	23	25	29	30	1	3	5	7	9	13	15	19	21	23	25	29	30
I_a	-	-	-	-	-	-	-	-	-	-	-	-	-	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex
I_b	-	-	-	-	-	-	-	-	-	-	-	-	-	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex
I_c	-	-	-	-	-	-	-	-	-	-	-	-	-	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex
I_d	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex
II_a	-	-	-	-	-	-	-	-	-	-	-	-	-	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex
II_b	-	-	-	-	-	-	-	-	-	-	-	-	-	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex
II_c	-	-	-	-	-	-	-	-	-	-	-	-	-	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex
II_d	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex
III_a	-	-	-	-	-	-	-	-	-	-	-	-	-	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex
III_b	-	-	-	-	-	-	-	-	-	-	-	-	-	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex
III_c	-	-	-	-	-	-	-	-	-	-	-	-	-	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex
III_d	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex
IV_a	-	-	-	-	-	-	-	-	-	-	-	-	-	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex
IV_b	-	-	-	-	-	-	-	-	-	-	-	-	-	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex
IV_c	-	-	-	-	-	-	-	-	-	-	-	-	-	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex
IV_d	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex

Resin No.	Air dried film: 1	3	5	7	9	13	15	19	21	23	25	29	30
V_a	-	-	-	-	-	-	-	-	-	-	-	-	-
V_b	-	-	-	-	-	-	-	-	-	-	-	-	-
V_c	-	-	-	-	-	-	-	-	-	-	-	-	-
V_d	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex
VI_a	-	-	-	-	-	-	-	-	-	-	-	-	-
VI_b	-	-	-	-	-	-	-	-	-	-	-	-	-
VI_c	-	-	-	-	-	-	-	-	-	-	-	-	-
VI_d	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex
VII_a	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex
VII_b	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex
VII_c	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex
VII_d	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex

Resin No.	Stoved film: 1	3	5	7	9	13	15	19	21	23	25	29	30
V_a	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex
V_b	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex
V_c	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex
V_d	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex
VI_a	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex
VI_b	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex
VI_c	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex
VI_d	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex
VII_a	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex
VII_b	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex
VII_c	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex
VII_d	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex

Table (28) Solvent resistance data of modified alkyd resins from Fatty acids .

Resin No.	Immersion period "days"																									
	Air dried film													Stoved film												
	1	3	5	7	9	13	15	19	21	23	25	29	30	1	3	5	7	9	13	15	19	21	23	25	29	30
$VIII_a$	-	-	-	-	-	-	-	-	-	-	-	-	-	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex
$VIII_b$	-	-	-	-	-	-	-	-	-	-	-	-	-	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex
$VIII_c$	-	-	-	-	-	-	-	-	-	-	-	-	-	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	G
$VIII_d$	-	-	-	-	-	-	-	-	-	-	-	-	-	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex
IX_a	-	-	-	-	-	-	-	-	-	-	-	-	-	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex
IX_b	-	-	-	-	-	-	-	-	-	-	-	-	-	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex
IX_c	-	-	-	-	-	-	-	-	-	-	-	-	-	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex
IX_d	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex
X_a	-	-	-	-	-	-	-	-	-	-	-	-	-	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex
X_b	-	-	-	-	-	-	-	-	-	-	-	-	-	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex
X_c	-	-	-	-	-	-	-	-	-	-	-	-	-	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex
X_d	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex
XI_a	-	-	-	-	-	-	-	-	-	-	-	-	-	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex
XI_b	-	-	-	-	-	-	-	-	-	-	-	-	-	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex
XI_c	-	-	-	-	-	-	-	-	-	-	-	-	-	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex
XI_d	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex

Resin No.	Immersion period "days"																									
	Air dried film													Stoved film												
	1	3	5	7	9	13	15	19	21	23	25	29	30	1	3	5	7	9	13	15	19	21	23	25	29	30
XII_a	-	-	-	-	-	-	-	-	-	-	-	-	-	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex
XII_b	-	-	-	-	-	-	-	-	-	-	-	-	-	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex
XII_c	-	-	-	-	-	-	-	-	-	-	-	-	-	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex
XII_d	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex
$XIII_a$	-	-	-	-	-	-	-	-	-	-	-	-	-	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex
$XIII_b$	-	-	-	-	-	-	-	-	-	-	-	-	-	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex
$XIII_c$	-	-	-	-	-	-	-	-	-	-	-	-	-	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex
$XIII_d$	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex
XIV_a	-	-	-	-	-	-	-	-	-	-	-	-	-	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex
XIV_b	-	-	-	-	-	-	-	-	-	-	-	-	-	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex
XIV_c	-	-	-	-	-	-	-	-	-	-	-	-	-	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex
XIV_d	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex
XVa	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex
XVb	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex
XVc	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex
XVd	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex

Table (29) Water resistance data of modified alkyd resins from oils

Resin No.	Immersion period "days"																									
	Air dried film													Stoved film												
	1	3	5	7	9	13	15	19	21	23	25	29	30	1	3	5	7	9	13	15	19	21	23	25	29	30
I_a	-	-	-	-	-	-	-	-	-	-	-	-	-	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex
I_b	-	-	-	-	-	-	-	-	-	-	-	-	-	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex
I_c	-	-	-	-	-	-	-	-	-	-	-	-	-	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex
I_d	Ex	Ex	G	F	F	P	-	-	-	-	-	-	-	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	G
II_a	-	-	-	-	-	-	-	-	-	-	-	-	-	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex
II_b	-	-	-	-	-	-	-	-	-	-	-	-	-	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex
II_c	-	-	-	-	-	-	-	-	-	-	-	-	-	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	G
II_d	Ex	Ex	G	F	P	-	-	-	-	-	-	-	-	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	G	G	G
III_a	-	-	-	-	-	-	-	-	-	-	-	-	-	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex
III_b	-	-	-	-	-	-	-	-	-	-	-	-	-	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex
III_c	-	-	-	-	-	-	-	-	-	-	-	-	-	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	G
III_d	Ex	Ex	G	F	P	-	-	-	-	-	-	-	-	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	G	G
IV_a	-	-	-	-	-	-	-	-	-	-	-	-	-	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex
IV_b	-	-	-	-	-	-	-	-	-	-	-	-	-	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex
IV_c	-	-	-	-	-	-	-	-	-	-	-	-	-	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	G
IV_d	Ex	Ex	G	G	F	P	-	-	-	-	-	-	-	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	G	G

Table (30): Water resistance data of modified alkyd resins from fatty acids

Resin No.	Immersion period "days"																									
	Air dried film													Stoved film												
	1	3	5	7	9	13	15	19	21	23	25	29	30	1	3	5	7	9	13	15	19	21	23	25	29	30
$VIII_a$	-	-	-	-	-	-	-	-	-	-	-	-	-	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex
$VIII_b$	-	-	-	-	-	-	-	-	-	-	-	-	-	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	G	G
$VIII_c$	-	-	-	-	-	-	-	-	-	-	-	-	-	Ex	Ex	Ex	Ex	F	P	-	-	-	-	-	-	-
$VIII_d$	-	-	-	-	-	-	-	-	-	-	-	-	-	Ex	Ex	Ex	Ex	G	F	P	-	-	-	-	-	-
IX_a	-	-	-	-	-	-	-	-	-	-	-	-	-	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex
IX_b	-	-	-	-	-	-	-	-	-	-	-	-	-	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex
IX_c	-	-	-	-	-	-	-	-	-	-	-	-	-	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex
IX_d	Ex	Ex	G	G	F	F	P	-	-	-	-	-	-	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex
X_a	-	-	-	-	-	-	-	-	-	-	-	-	-	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex
X_b	-	-	-	-	-	-	-	-	-	-	-	-	-	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex
X_c	-	-	-	-	-	-	-	-	-	-	-	-	-	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex
X_d	Ex	Ex	Ex	G	G	F	F	P	-	-	-	-	-	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex
XI_a	-	-	-	-	-	-	-	-	-	-	-	-	-	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex
XI_b	-	-	-	-	-	-	-	-	-	-	-	-	-	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex
XI_c	-	-	-	-	-	-	-	-	-	-	-	-	-	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex
XI_d	Ex	Ex	Ex	G	G	F	F	P	-	-	-	-	-	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex

Resin No.	Air dried film 1	3	5	7	9	13	15	19	21	23	25	29	30	Stoved film 1	3	5	7	9	13	15	19	21	23	25	29	30
XII$_a$	-	-	-	-	-	-	-	-	-	-	-	-	-	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex
XII$_b$	-	-	-	-	-	-	-	-	-	-	-	-	-	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex
XII$_c$	-	-	-	-	-	-	-	-	-	-	-	-	-	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex
XII$_d$	Ex	Ex	Ex	G	G	F	F	P	-	-	-	-	-	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	G
XIII$_a$	-	-	-	-	-	-	-	-	-	-	-	-	-	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex
XIII$_b$	-	-	-	-	-	-	-	-	-	-	-	-	-	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex
XIII$_c$	-	-	-	-	-	-	-	-	-	-	-	-	-	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex
XIII$_d$	Ex	Ex	Ex	Ex	G	G	F	F	P	-	-	-	-	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex
XIV$_a$	-	-	-	-	-	-	-	-	-	-	-	-	-	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex
XIV$_b$	-	-	-	-	-	-	-	-	-	-	-	-	-	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex
XIV$_c$	-	-	-	-	-	-	-	-	-	-	-	-	-	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex
XIV$_d$	Ex	Ex	Ex	Ex	G	G	F	F	P	-	-	-	-	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex
XV$_a$	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	G	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex
XV$_b$	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	G	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex
XV$_c$	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	G	F	F	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex
XV$_d$	Ex	Ex	Ex	Ex	Ex	Ex	Ex	G	G	G	F	F	F	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex

Table (31) Alkali resistance data of modified alkyd resins from oils

Resin No.	Immersion period "days"																												
	Air dried film										Stoved film																		
	1	3	5	7	9	11	13	15	19	23	1	2	3	4	5	6	7	8	9	11	13	15	20	21	23	25	27	29	30
I_a	-	-	-	-	-	-	-	-	-	-	Ex	Ex	Ex	Ex	G	G	F	F	F	P	-	-	-	-	-	-	-	-	-
I_b	-	-	-	-	-	-	-	-	-	-	Ex	Ex	Ex	Ex	Ex	G	G	F	F	P	-	-	-	-	-	-	-	-	-
I_c	-	-	-	-	-	-	-	-	-	-	Ex	Ex	Ex	Ex	Ex	G	G	G	G	G	F	F	F	P	-	-	-	-	-
I_d	Ex	Ex	G	F	P	-	-	-	-	-	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	G	G	F	F	P	-	-	-
II_a	-	-	-	-	-	-	-	-	-	-	Ex	Ex	Ex	G	G	G	F	F	P	-	-	-	-	-	-	-	-	-	-
II_b	-	-	-	-	-	-	-	-	-	-	Ex	Ex	Ex	Ex	Ex	G	G	G	F	F	P	-	-	-	-	-	-	-	-
II_c	-	-	-	-	-	-	-	-	-	-	Ex	Ex	Ex	Ex	Ex	Ex	Ex	G	G	G	G	F	F	P	-	-	-	-	-
II_d	Ex	Ex	Ex	G	F	F	P	-	-	-	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	G	G	F	F	P	-	-
III_a	-	-	-	-	-	-	-	-	-	-	Ex	Ex	Ex	Ex	G	G	G	F	F	P	-	-	-	-	-	-	-	-	-
III_b	-	-	-	-	-	-	-	-	-	-	Ex	Ex	Ex	Ex	Ex	G	G	F	F	P	-	-	-	-	-	-	-	-	-
III_c	-	-	-	-	-	-	-	-	-	-	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	G	G	G	F	F	P	-	-	-	-	-
III_d	Ex	Ex	Ex	Ex	G	G	G	F	P	-	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	G	G	F	F	P	-	-	-
IV_a	-	-	-	-	-	-	-	-	-	-	Ex	Ex	Ex	Ex	G	G	G	G	F	F	P	-	-	-	-	-	-	-	-
IV_b	-	-	-	-	-	-	-	-	-	-	Ex	Ex	Ex	Ex	Ex	Ex	G	G	F	F	F	P	-	-	-	-	-	-	-
IV_c	-	-	-	-	-	-	-	-	-	-	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	G	G	F	F	P	-	-	-	-
IV_d	Ex	Ex	Ex	Ex	G	F	P	-	-	-	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	G	G	G	F	F	F	F

Resin No.	Immersion period "days"																												
	Air dried film										Stoved film																		
	1	3	5	7	9	15	19	21	25	30	1	2	3	4	5	6	7	8	9	11	13	15	19	21	23	25	27	29	30
V_a	-	-	-	-	-	-	-	-	-	-	Ex	Ex	Ex	Ex	G	G	G	F	F	F	P	-	-	-	-	-	-	-	-
V_b	-	-	-	-	-	-	-	-	-	-	Ex	Ex	Ex	Ex	Ex	Ex	Ex	G	G	F	F	F	P	-	-	-	-	-	-
V_c	-	-	-	-	-	-	-	-	-	-	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	G	G	G	F	F	P	-	-	-	-
V_d	Ex	Ex	Ex	Ex	Ex	G	F	P	-	-	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	G	G	G	F	F	P
VI_a	-	-	-	-	-	-	-	-	-	-	Ex	Ex	Ex	Ex	Ex	Ex	G	G	G	G	F	F	P	-	-	-	-	-	-
VI_b	-	-	-	-	-	-	-	-	-	-	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	G	G	F	F	P	-	-	-	-	-	-
VI_c	-	-	-	-	-	-	-	-	-	-	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	G	G	F	F	P	-	-	-
VI_d	Ex	Ex	Ex	Ex	Ex	G	G	F	P	-	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	G	G	G	F	F	P	-	-
VII_a	Ex	Ex	G	G	F	P	-	-	-	-	Ex	Ex	Ex	G	G	G	F	F	F	P	-	-	-	-	-	-	-	-	-
VII_b	Ex	Ex	Ex	G	G	P	-	-	-	-	Ex	Ex	Ex	Ex	Ex	G	G	G	G	G	G	G	F	P	-	-	-	-	-
VII_c	Ex	Ex	Ex	G	G	F	P	-	-	-	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	G	F	F	P	-	-	-	-
VII_d	Ex	Ex	Ex	Ex	Ex	Ex	G	G	G	F	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	G	G	G	F	F	F	F

Table (32) Alkali resistance data of modified alkyd resins from fatty acids

Resin No.	Immersion period "days"																										
	Air dried film											Stoved film															
	1	3	5	7	9	13	15	19	22	25	30	1	3	5	7	8	9	11	13	15	20	21	23	25	27	29	30
$VIII_a$	-	-	-	-	-	-	-	-	-	-	-	Ex	Ex	G	F	F	P	-	-	-	-	-	-	-	-	-	-
$VIII_b$	-	-	-	-	-	-	-	-	-	-	-	Ex	Ex	G	F	F	P	-	-	-	-	-	-	-	-	-	-
$VIII_c$	-	-	-	-	-	-	-	-	-	-	-	Ex	Ex	Ex	G	F	F	P	-	-	-	-	-	-	-	-	-
$VIII_d$	-	-	-	-	-	-	-	-	-	-	-	Ex	Ex	Ex	G	F	F	P	-	-	-	-	-	-	-	-	-
IX_a	-	-	-	-	-	-	-	-	-	-	-	Ex	Ex	Ex	Ex	G	G	F	F	P	-	-	-	-	-	-	-
IX_b	-	-	-	-	-	-	-	-	-	-	-	Ex	Ex	Ex	Ex	G	G	G	F	P	-	-	-	-	-	-	-
IX_c	-	-	-	-	-	-	-	-	-	-	-	Ex	Ex	Ex	Ex	Ex	Ex	G	F	F	P	-	-	-	-	-	-
IX_d	Ex	Ex	Ex	G	G	F	P	-	-	-	-	Ex	Ex	Ex	Ex	Ex	Ex	G	G	F	F	F	P	-	-	-	-
X_a	-	-	-	-	-	-	-	-	-	-	-	Ex	Ex	Ex	Ex	G	F	F	F	P	-	-	-	-	-	-	-
X_b	-	-	-	-	-	-	-	-	-	-	-	Ex	Ex	Ex	Ex	Ex	G	G	F	F	P	-	-	-	-	-	-
X_c	-	-	-	-	-	-	-	-	-	-	-	Ex	Ex	Ex	Ex	Ex	Ex	G	G	F	F	F	P	-	-	-	-
X_d	Ex	Ex	Ex	G	G	F	F	P	-	-	-	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	G	G	G	F	F	P	-	-
XI_a	-	-	-	-	-	-	-	-	-	-	-	Ex	Ex	Ex	Ex	G	G	F	P	-	-	-	-	-	-	-	-
XI_b	-	-	-	-	-	-	-	-	-	-	-	Ex	Ex	Ex	Ex	Ex	G	G	F	F	P	-	-	-	-	-	-
XI_c	-	-	-	-	-	-	-	-	-	-	-	Ex	Ex	Ex	Ex	Ex	Ex	Ex	G	G	F	F	F	P	-	-	-
XI_d	Ex	Ex	Ex	Ex	G	G	F	F	P	-	-	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	G	G	F	F	P	-	-

Immersion period "days" — Air dried film

Resin No.	1	3	5	7	9	13	19	21	23	25	30
XII_a	-	-	-	-	-	-	-	-	-	-	-
XII_b	-	-	-	-	-	-	-	-	-	-	-
XII_c	-	-	-	-	-	-	-	-	-	-	-
XII_d	Ex	Ex	Ex	Ex	G	G	G	F	F	P	-
$XIII_a$	-	-	-	-	-	-	-	-	-	-	-
$XIII_b$	-	-	-	-	-	-	-	-	-	-	-
$XIII_c$	-	-	-	-	-	-	-	-	-	-	-
$XIII_d$	Ex	Ex	Ex	Ex	Ex	G	G	F	F	P	-
XIV_a	-	-	-	-	-	-	-	-	-	-	-
XIV_b	-	-	-	-	-	-	-	-	-	-	-
XIV_c	-	-	-	-	-	-	-	-	-	-	-
XIV_d	Ex	Ex	Ex	Ex	Ex	G	G	G	F	F	P
XV_a	Ex	Ex	Ex	Ex	G	G	F	P	-	-	-
XV_b	Ex	Ex	Ex	Ex	G	G	F	F	P	-	-
XV_c	Ex	Ex	Ex	Ex	Ex	G	F	F	P	-	-
XI_d	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	G	G	F

Immersion period "days" — Stoved film

Resin No.	1	3	5	7	8	9	11	13	15	20	21	23	25	27	29	30
XII_a	Ex	Ex	Ex	Ex	Ex	G	G	G	F	F	P	-	-	-	-	-
XII_b	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	G	G	F	F	P	-	-	-
XII_c	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	G	G	F	F	P	-	-	-
XII_d	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	G	G	F	F	P	-
$XIII_a$	Ex	Ex	Ex	Ex	Ex	Ex	G	G	G	F	P	-	-	-	-	-
$XIII_b$	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	G	F	F	P	-	-	-
$XIII_c$	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	G	G	F	P	-	-	-
$XIII_d$	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	G	G	G	F	P	-
XIV_a	Ex	Ex	Ex	Ex	Ex	Ex	G	G	F	F	P	-	-	-	-	-
XIV_b	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	G	F	F	P	-	-	-	-
XIV_c	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	G	G	F	P	P	-	-	-
XIV_d	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	G	F	F	F	P	-
XV_a	Ex	Ex	Ex	Ex	G	G	G	F	F	F	P	-	-	-	-	-
XV_b	Ex	Ex	Ex	Ex	Ex	G	G	F	F	F	P	-	-	-	-	-
XV_c	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	G	F	F	P	-	-
XI_d	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	G	G	G	F	F	F

Table (33) Chemical resistant for alkyd contaning itaconic acid

Resin No.	Immersion period "Days" Stoved film													
	1	3	5	7	9	13	15	19	21	23	25	27	29	30
Acid res.														
RI	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex
RII	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex
RIII	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex
Solvent res.														
RI	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex
RII	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex
RIII	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex
Water res.														
RI	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex
RII	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex
RIII	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex	Ex
Alkali res.														
RI	Ex	Ex	Ex	Ex	G	G	G	G	F	F	P	-	-	-
RII	Ex	Ex	Ex	Ex	G	G	G	F	F	F	P	-	-	-
RIII	Ex	Ex	Ex	Ex	Ex	Ex	Ex	G	G	G	F	F	P	-

C- Mechanical properties of dried films:

In the present investigation, films were applied over glass or tin panels and allowed to dry in both air and oven to prepare air-dried and stoved films. Film thickness, hardness, gloss, scratch hardness and adhesion, were measured according to the standard methods and the results are given in tables (34,35) and figures (18-21)..

Hardness:

Hardness is a conceptual term, and means different things when used to describe different materials. When organic coatings are examined for hardness, several variables must be considered. One of them is the substrate to which the coating has been applied. The second is the film thickness of the coating itself. The hardness of organic coating cannot be defined quantitatively as mass, length and gravity. The measurement of hardness of organic coating is based on practical concepts. Hardness then can be defined as a resistance to indentation and scratching (85).From tables *(34,35)*, we noticed that:

1- The hardness of dry films improved by increasing the percentage of linseed oil or its fatty acids and tetrabromophthalic anhydride.
2- The film hardness decreases as the percentage of rice bran oil or its fatty acids increases. This behaviour is due to the low degree of unsaturation of rice bran oil (53).
3- Modification of alkyd by either linseed oil or its fatty acids or tetrabromophthalic anhydride improves the scratch hardness.

Adhesion:

Adhesion is the state in which two surfaces are held together by forces, which may be consisted of valence attraction, or interfacial forces or a combination of both. Interfacial forces could be defined as physical bonds, where as valence attractions are chemical in nature. The interfacial forces are too small to be measured by any mechanical device and if they could be measured, it would be found that most "adhesive" failures are cohesive failures of the film tested [85]. From tables *(34,35)*, we can observv that the adhesion of modified alkyds showed outstanding performance similar to that of unmodified alkyds.

Gloss:

Gloss is often described as giving the lustrous or shiny appearance to an object. *Specular gloss* or *Specular reflectance* is the fraction of the incident light reflected from a surface in the mirror direction within a specified angular tolerance. The aspect gloss is the most widely used and numerous instruments have been constructed for this purpose. The *ASTM method D523*, *Specular Gloss*, provides for measurments at three different angles of incidence, namely 20,60 and 85 degree from the perpendicular to the specimen surface. The 85-degree reading is used for the low-gloss specimens, 60-degree gloss reading is used for the evaluation of specimens over the entire range and 20-degree angle is employed when a higher differentiation is requred such as automotive finishes or other specimens having readings over 70 when 60 degree geometry is used [85]. From the collected results in tables *(34,35)*, the gloss of dried films investigated were satisfactory. However, it slightly increases by increasing the amount of tetrabromophthalic anhydride.

From the above mentioned results, we can observe that the presence of tetrabromophthalic anhydride improve the mechanical properties of the dried film, also increasing the percentage of linseed oil or its fatty acids improves these properties. Moreover, the stoved films showed better performance than the air dried films of the same resin content.

On the other hand, we tried to improve the character of some prepared alkyds by using itaconic acid. The introduction of itaconic in the alkyd resins doesn't give the predicted results, where all samples give less hardness compared to the prepared alkyds, but the gloss, scratching and adhesion are satisfactory.

Table (34) Film characteristics of modified alkyd resins from oils

Resin no.	Film thickness (μ)		Film hardness (Sec)		Film gloss at 20°		Film scratch (Kg)		Film adhesion	
	a	s	a	s	a	s	a	s	a	s
I_a	-	25	-	35	-	88	-	>½	-	Gt_1
I_b	-	30	-	48	-	86	-	>½	-	Gt_0
I_c	-	30	-	54	-	91	-	>1	-	Gt_0
I_d	35	35	97	109	95	92	>2	>2	Gt_0	Gt_0
II_a	-	25	-	38	-	91	-	>½	-	Gt_0
II_b	-	26	-	50	-	93	-	>1	-	Gt_0
II_c	-	30	-	95	-	98	-	>2	-	Gt_0
II_d	34	35	110	112	97	100	>2	>2	Gt_0	Gt_0
III_a	-	24	-	40	-	93	-	>½	-	Gt_0
III_b	-	26	-	48	-	92	-	>1	-	Gt_0
III_c	-	29	-	90	-	96	-	>2	-	Gt_0
III_d	33	31	112	116	97	97	>2	>2	Gt_0	Gt_0
IV_a	-	27	-	45	-	88	-	>½	-	Gt_0
IV_b	-	30	-	50	-	93	-	>1	-	Gt_0
IV_c	-	32	-	94	-	93	-	>2	-	Gt_0
IV_d	35	35	120	133	97	96	-	>2	Gt_0	Gt_0

Resin no.	Film thickness (µ)		Film hardness (Sec)		Film gloss at 20°		Film scratch (Kg)		Film adhesion	
	a	s	a	s	a	s	a	s	a	s
V_a	-	25	-	49	-	86	-	>1	-	Gt_0
V_b	-	27	-	57	-	92	-	>1	-	Gt_0
V_c	-	31	-	95	-	96	-	>2	-	Gt_0
V_d	33	33	118	135	96	97	>2	>2	Gt_0	Gt_0
VI_a	-	25	-	46	-	91	-	>1	-	Gt_0
VI_b	-	27	-	48	-	93	-	>1	-	Gt_0
VI_c	-	30	-	105	-	96	-	>2	-	Gt_0
VI_d	35	32	139	144	96	100	>2	>2	Gt_0	Gt_0
VII_a	25	20	49	55	92	92	>1	>1	Gt_0	Gt_0
VII_b	25	25	56	89	93	95	>1	>1	Gt_0	Gt_0
VII_c	27	35	116	122	95	96	>2	>2	Gt_0	Gt_0
VII_d	30	32	120	134	97	98	>2	>2	Gt_0	Gt_0
R_I	-	25	-	41	-	82	-	>1	-	GT_0
R_{II}	-	25	-	40	-	76	-	>1	-	GT_0
R_{III}	-	25	-	72	-	86	-	>1	-	GT_0

Table (35)Film characteristics of modified alkyds from fatty acids.

Resin no.	Film thickness (μ)		Film hardness (Sec)		Film gloss at 20°		Film scratch (Kg)		Film adhesion	
	a	s	a	s	a	s	a	s	a	s
$VIII_a$	-	20	-	39	-	96	-	>1	-	Gt_0
$VIII_b$	-	20	-	42	-	93	-	>1	-	Gt_1
$VIII_c$	-	25	-	89	-	95	-	>1	-	Gt_0
$VIII_d$	-	30	-	105	-	97	-	>2	-	Gt_0
IX_a	-	20	-	40	-	86	-	>½	-	Gt_0
IX_b	-	22	-	50	-	93	-	>½	-	Gt_0
IX_c	-	25	-	58	-	92	-	>1	-	Gt_0
IX_d	27	30	97	109	94	95	-	>2	Gt_0	Gt_0
X_a	-	23	-	47	-	88	-	>½	-	Gt_1
X_b	-	25	-	49	-	90	-	>1	-	Gt_0
X_c	-	30	-	93	-	92	-	>2	-	Gt_0
X_d	34	33	103	115	96	97	>2	>2	Gt_0	Gt_0
XI_a	-	25	-	41	-	83	-	>½	-	Gt_0
XI_b	-	25	-	50	-	84	-	>1	-	Gt_0
XI_c	-	27	-	89	-	92	-	>2	-	Gt_0
XI_d	32	30	108	110	95	97	>2	>2	Gt_0	Gt_0

Resin no.	Film thickness (µ)		Film hardness (Sec)		Film gloss at 20°		Film scratch (Kg)		Film adhesion	
	a	s	a	s	a	s	a	s	a	s
XII_a	-	25	-	43	-	84	-	>½	-	Gt_0
XII_b	-	30	-	53	-	82	-	>1	-	Gt_0
XII_c	-	30	-	92	-	88	-	>2	-	Gt_0
XII_d	35	33	131	140	91	93	>2	>2	Gt_0	Gt_0
$XIII_a$	-	25	-	45	-	85	-	>1	-	Gt_0
$XIII_b$	-	28	-	60	-	86	-	>1	-	Gt_0
$XIII_c$	-	32	-	98	-	95	-	>2	-	Gt_0
$XIII_d$	33	33	122	139	98	97	-	>2	Gt_0	Gt_0
XIV_a	-	20	-	44	-	91	-	>1	-	Gt_0
XIV_b	-	25	-	56	-	92	-	>1	-	Gt_0
XIV_c	-	30	-	101	-	94	-	>2	-	Gt_0
XIV_d	35	33	134	148	96	99	>2	>2	Gt_0	Gt_0
XIV_a	22	20	50	57	93	95	>1	>1	Gt_0	Gt_0
XIV_b	25	20	56	85	94	96	>1	>1	Gt_0	Gt_0
XIV_c	30	27	110	120	95	97	>2	>2	Gt_0	Gt_0
XIV_d	30	33	120	130	99	98	>2	>2	Gt_0	Gt_0

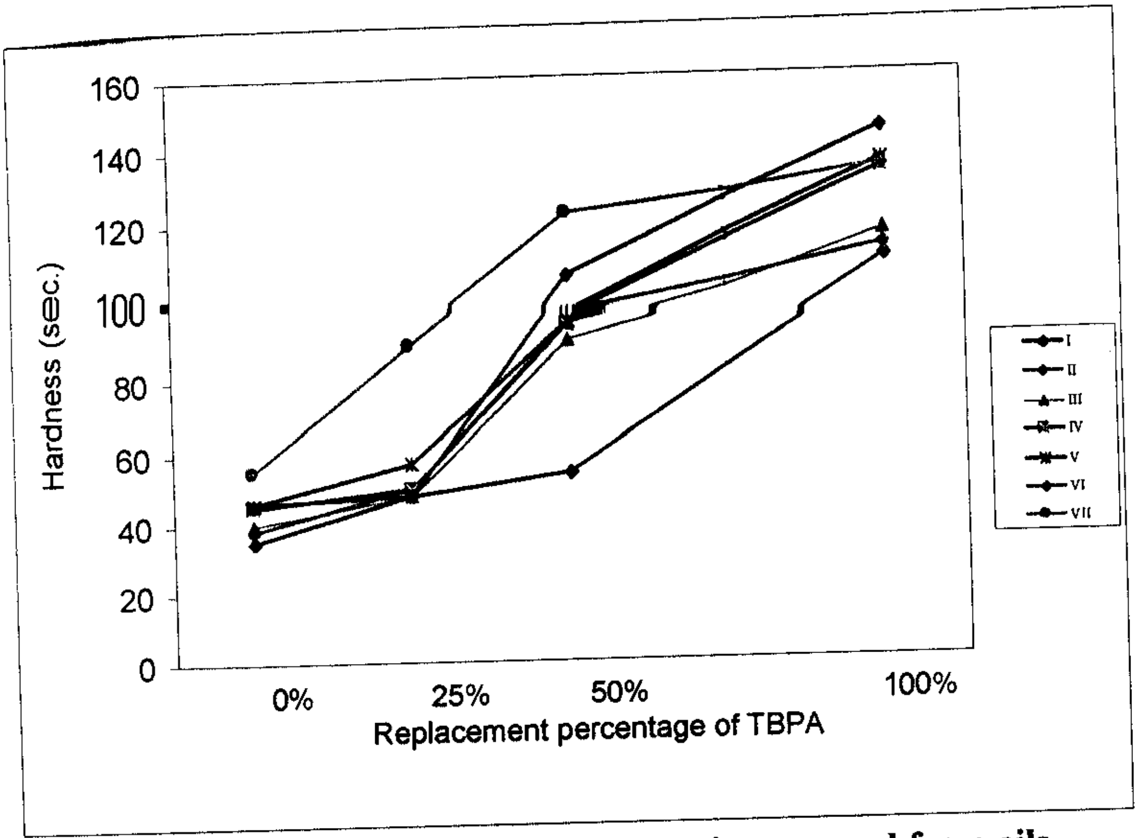


Fig. (18): Hardness of Alkyd Resin prepared from oils

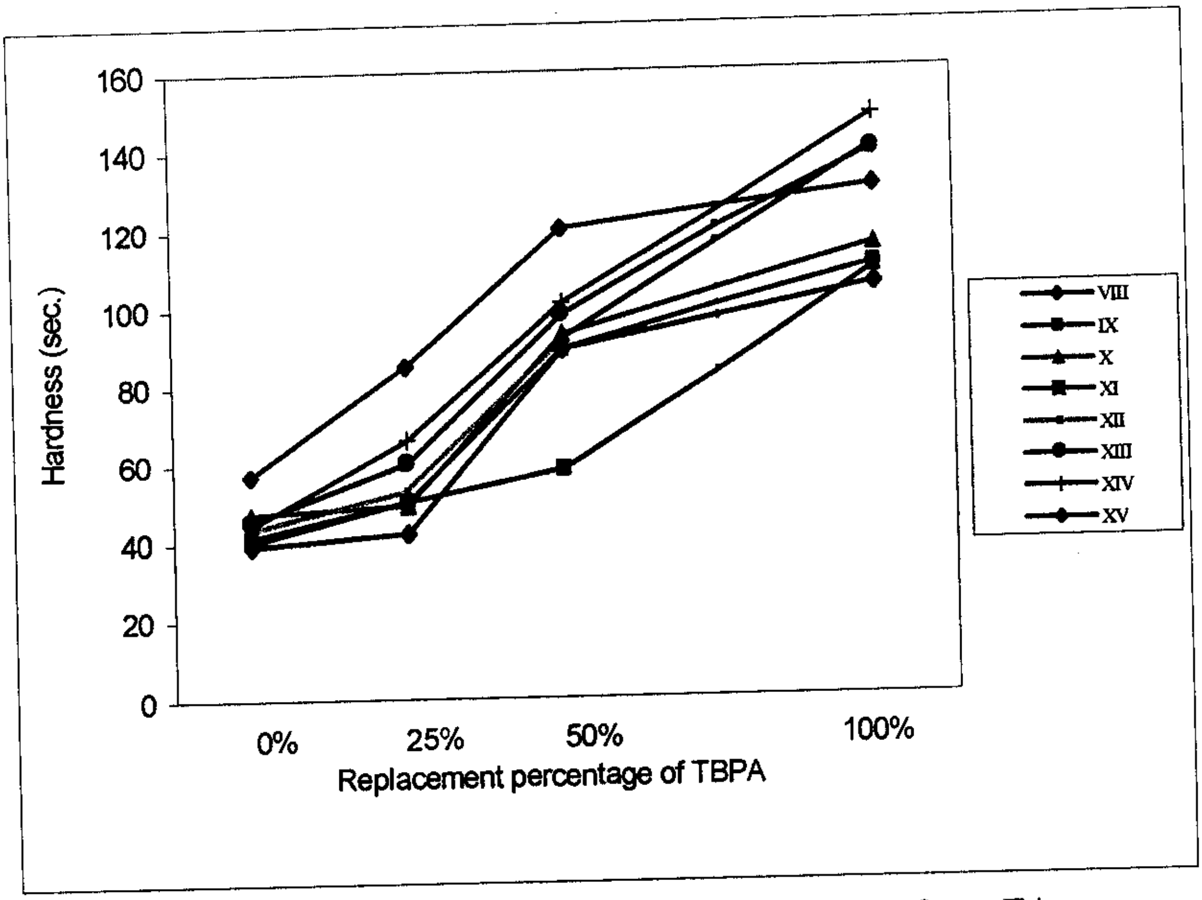


Fig. (19): Hardness of Alkyd Resin prepared from FA.

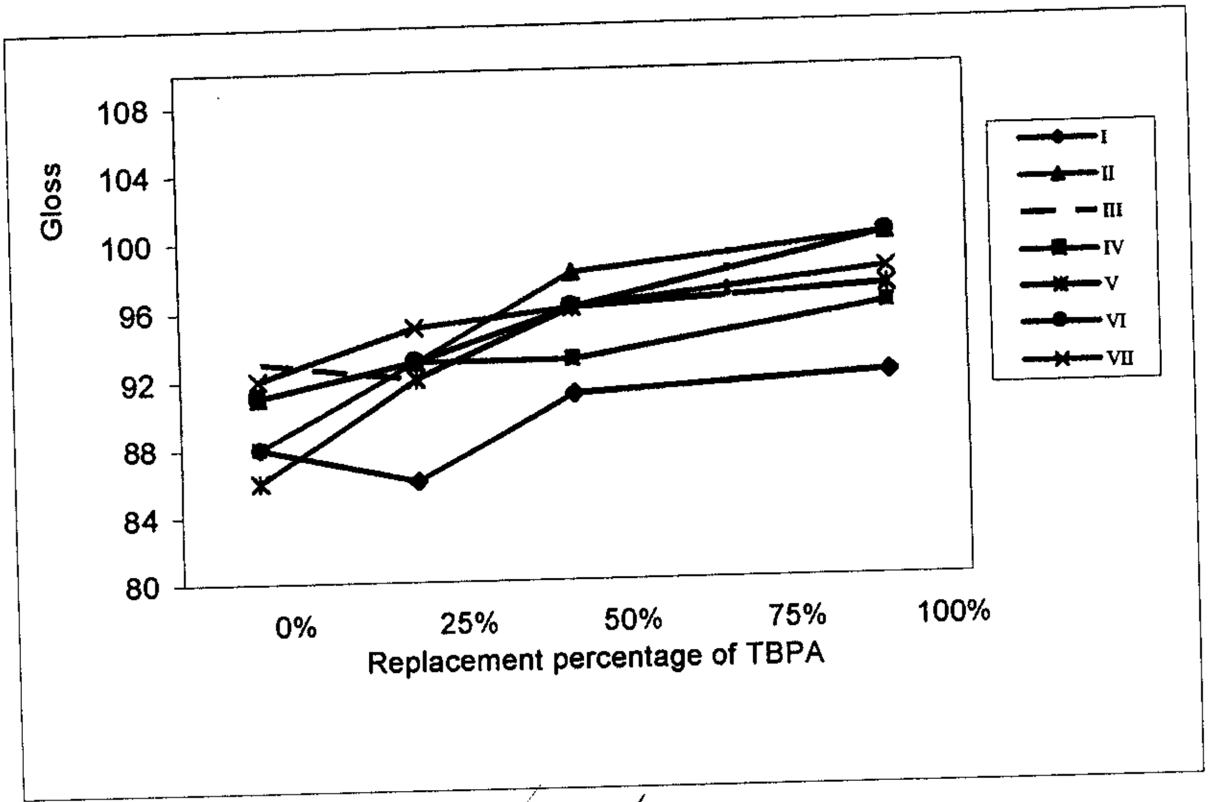


Fig. (20): Gloss of Alkyd Resin prepared from oils.

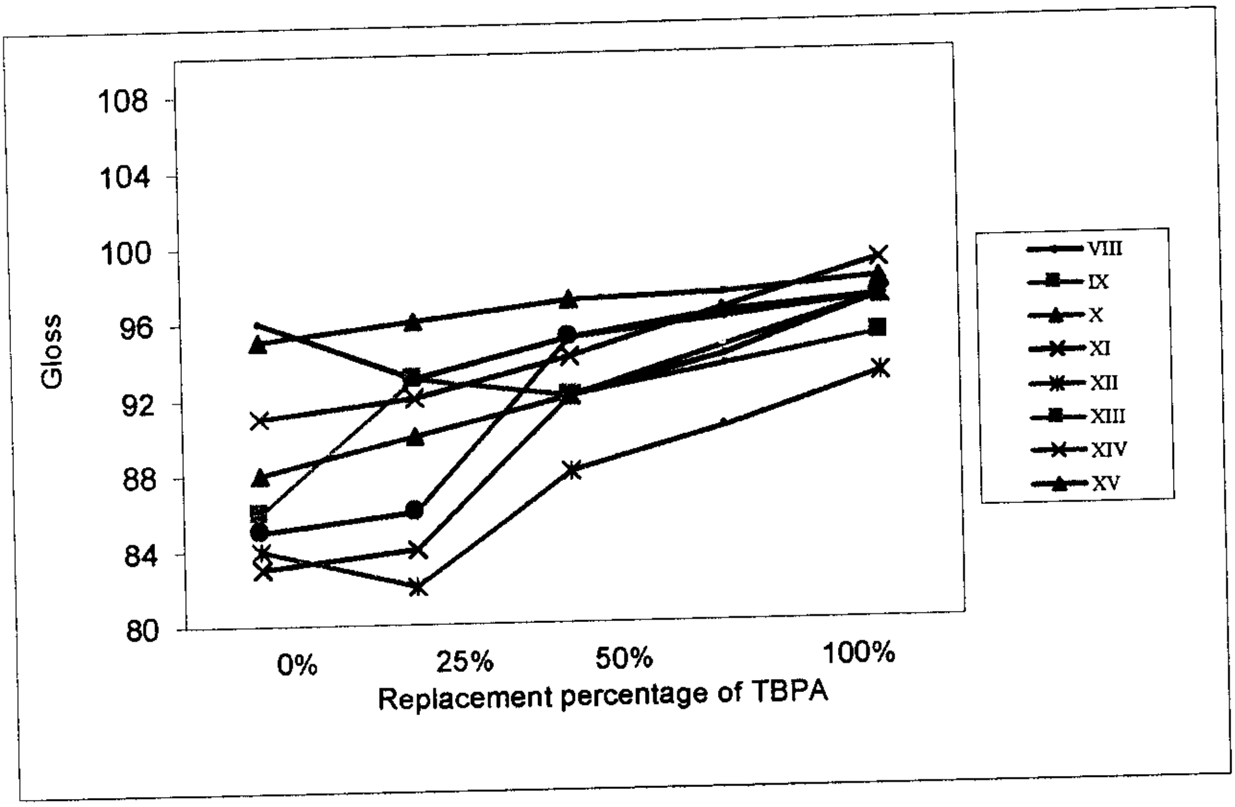


Fig. (21): Gloss of Alkyd Resin prepared from fatty acid.

Water soluble alkyd resins

A water-dispersible or emulsifiable alkyd to serve as a basis for water-thinned paints was obtained by cooking a surfactant into the alkyd so that it will disperse readily when water is added (86,87).

The most common method for producing water-soluble alkyds consists of interrupting the esterification reaction of a conventional alkyd at some intermediate acid value in the range of 30-80 followed by addition of ammonia or a volatile amine to produce a soluble polymer soap. On application of this water vehicle to a substrate, the amine gradually volatilizes, leaving behind, the high acidity alkyd polymer. Drying is effected either by air drying or heat curing (88).

Water-dispersible resins may be prepared by the introduction of polyethylene glycol into an otherwise conventional oil-modified alkyd resin. A typical formulation (89) consists of linseed fatty acid,1605 parts, pentaerythritol 555, polyethylene glycol of approximately 1500 molecular weight 336, phthalic anhydride 711,styrene 336.

A modified alkyd resin (Z_I, Z_{II}, Z_{III} and Z_{IV}) was prepared by introduction of polyethylene glycol of approximately 600 molecular weight to the alkyd resins.

Where:

Z_I : 50% RBO + 50% LO + 50% PA + 50% TBPA + 75% G + 25% PEG.

Z_{II} : 50% RBO + 50% LO + 50% PA + 50% TBPA + 50% G + 50% PEG.

Z_{III} : 50% RBO + 50% LO + 50% PA + 50% TBPA + 25% G + 75% PEG.

Z_{IV} : 50% RBO + 50% LO + 50% PA + 50% TBPA + 100% PEG.

The surface active properties of the prepared water soluble alkyd resin were evaluated to estimate the suitable application and tabulted in table (36,37).

Table (36): The surface properties of water soluble alkyd resins :

Comp. no.	S.T. 0.1% (dyne/cm)	I.F.T 0.1% (dyne/cm)	Emul. Stab. 20 mmol min sec	Cloud point (1%) ^{0}C	Foam height 0.1% (mm)	Wetting time 0.1% (sec)
Z_I	35	12	25 : 30	29	48	19
Z_{II}	36	20	13 : 27	32	100	15
Z_{III}	36	21	10 : 15	47	180	13
Z_{IV}	38	24	4 : 35	56	200	11

Surface and interfacial tensions:-

Surface and interfacial tension [90] of the prepared water soluble alkyd resin are recorded in table (36).The surface and interfacial tension of the synthesized water soluble alkyd resin (Z_I, Z_{II}, Z_{III} and Z_{IV}) were measured using a Du-Nouy tensiometer [90] [Kruss Type 8451] at 25°C. These values are in the range (35-38 dyne/cm); and (12-24 dyne/cm), respectively.It is evident that; the surface and interfacial tensions increase with increasing the % of PEG (600 M.wt.) unit, on the other hand, the solubility increases by increasing the % of PEG in the formulation of water-soluble alkyd resin.

$$Z_{IV} > Z_{III} > Z_{II}$$

Also Z_I has the lower solubility ,surface and interfacial values.

Cloud point [91] :-

The cloud point rsulting data cited in table (36). It is clear that, the cloud point increases with increasing the % of PEG (hydrophile) unit in the formulation of the prepared alkyd resin. So, Z_{IV} afforded the higher cloud point than all prepared water soluble alkyd resins.

Foam height [92] and Wetting time[93]:-

On the other hand, the foam height increases and wetting time decreases with increasing the percentage of PEG unit.

Emulsion stabilities [94] :-

Emulsion stabilites were measured using standard procedures. The data tabulated in the table(36) revealed that Z_{IV}showed lower emulsifying stabilities than those of ZIII, ZII and ZI respectively.

Biodegradability [95] :-

Finally; the biodegradation data of the prepared water-soluble alkyd resins are recorded in table (37).

Table (37): Biodegradability of water soluble alkyd resins :-

Compd. No.	1st day	2nd day	3rd day	4th day	5th day	6th day	7th day
Z_I	48.27	53.80	57.93	66.20	67.57	75.86	77.24
Z_{II}	49.65	53.10	55.86	66.90	67.59	74.48	75.17
Z_{III}	49.65	55.17	56.55	66.90	71.03	77.24	78.62
Z_{IV}	51.03	56.55	63.45	69.66	71.72	73.10	80.00

The biodegradation was expressed by increasing the surface tension values by days. From the data shown in table (37) we can notice that, the biodegradability percentage increases by increasing the percentage of PEG in their molecules.