SUMMARY AND CONCLUSIONS

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As has been mentioned before, water-soluble paints gained more importance in recent years after the world war II, due to their wide application in modern communities. They are characterised by their fast drying, ease of application and elimination of fire and health hazards.

Epoxy resins have not been described among the water-soluble industrial vehicles. This is attributed to high functionality of the resin. However, epoxy resins can be water-solubilized after reducing its functinality. The main techniques adapted in this investigation for producing water-soluble vehicles comprising epoxy resins, at least in the early stages of formation are briefly described as follows:

The produced epoxy ester were subjected to either maleinization, in case of completely defunctionalized epoxy ester, or reaction with poly-basic acid or anhydride in case of partial ester.

A- Maleinized Epoxy Esters:

The maleinization technique successfully applied on drying oils was borrowed for use in epoxy esters of drying oils fatty acids.

(1) The first stage involves the preparation of completely

esterified epoxy resins. This treatment permits complete defunctionalization of the resin.

Trials were conducted for this purpose results in the formation of a gel-like materials. In order to eliminate the possibility of gelation, it was thought desirable to use catalysts in the esterification reaction. The type of catalyst, its concentration and temperature of reaction were the parameters which studied. From the data obtained, it was able to classify the various catalysts according to their reactivity as follows:

Highly Reactive Catalysts	: Lithium hydroxide, Zinc oxide & Sodium carbonate.
Moderately Reactive Catalyst	: Lead oxide.
Weakly Reactive Catalysts	: Barium & Calcium hydroxides.

(2) The second stage involves maleinization of the completely defunctionalized epoxy resins. To produce suitable consistency adducts, it was necessary to incorporate drying oils prior to maleinization. The following table illustrates four suitable vehicle formulations based on maleinized adducts.

Formula No.	Composition
I	15% Maleinized L.O.
II	15% Maleinized L.O./D.C. oils mixture (70:30 by wt.).
III	15% Maleinized L.O./epoxy ester (3:1 by wt.).
IV	15% Maleinized L.O./D.C.O./epoxy ester (2:1:1 by wt).

Maleinization of the completely defunctionalized epoxy esters of linseed fatty acids results in the formation of gel materials. This tendency was eliminated by the incorporation of drying oils prior to the maleinization step.

The presence of epoxy ester in such formulations greatly improves their performances and film durability. Although the presence of D.C.O. improves the colour of the varnishes, yet it causes a slight tackness of the dried films.

B- Epoxy-Modified Alkyd Resins:

The other alternative method for producing water-soluble epoxy containing resin, consists of the following manufacturing stages:

1- Reduction of the functionality of epoxy resins:

This treatment permits reduction of the functionality of the parent epoxy resins from 6 to 3. The amount of monobasic acid used for the partial defunctionalization was calculated from the epoxy resin characteristics.

2- Alkyd cooking:

The partially defunctionalized epoxy ester produced in the preceding stage was considered as the source of the polyhydric alcohols in formulating resins similar to alkyds.

Two basic procedures were adapted for the formation of epoxy-modified alkyds. The first involves the use of fatty acids, while the second involves the use of the oil itself.

Various resin formulations covering a wide range of excess hydroxyl contents were computed using the average functionality method. The following table illustrats a suitable water-soluble resin formulations.

Formula No.	Composition
V	30% Excess OH epoxy-modified alkyd based on LFA & made by fatty acid method.
VI	20% Excess OH epoxy-modified alkyd based on LFA & made by fatty acid method.
VII	10% Excess OH epoxy-modified alkyd based on LFA & made by fatty acid method.
VIII	0% Excess OH epoxy-modified alkyd based on LFA & made by fatty acid method
IX	30% Excess OH epoxy-modified alkyd resin based on LFA and produced by monoglyceride method.

Formula No.	Composition
X	30% Excess OH epoxy-modified alkyd resin based on L.O./D.C.O. (1:1 by wt.) produced by monoglyceride method.
XI	30% Excess OH epoxy-modified alkyd resin based on D.C.F.A. and produced by monoglyceride method.

As a matter of fact, the increase of the excess hydroxyl content leads to the formation of resins of better film characteristics. For this reason, the 30% excess hydroxyl resin containing dehydrated castor fatty acids were included among the formulations studied.

The produced resin was then neutralized with a neutralizing base such as triethylamine or ammonium hydroxide to pH 8, followed by thinning with more water. Addition of ethyl alcohol was necessary to reduce the viscosity of the aqueous solution to the workable consistency. The following table represents the average composition.

Resin	30%
Water	35-55%
Ethyl alcohol	35-15%

Water soluble vehicles based on maleinized adducts required smaller alcohol concentration than vehicles based on epoxy-modified alkyds. This is attributed to the high molecular weight of the latter.

The work was extended to evaluate the selected vehicle formulations. The following generalization were drawn:

1- The colour of the vehicle depends on the presence of D.C. chain, i.e. those containing high percentages exhibet polar colour.

2- The viscosity of the aqueous solutions of the neutralized resins depends on pH of the medium, solid content as well as the percent of alcohol present.

3- The presence of water—soluble driers is necessary to shorten the drying time of these aqueous solutions.

4-Manganese acetate was proved to be the most efficient catalyst employed when used in amounts 0.03% based on metal/resin. Higher drier concentration leads to precipetation of the resin.

5- The gloss of the stoved films are of higher values for all types. The presence of epoxy ester in the resin formulation improves the hardness of the baked films. However, the presence of D.C.O. fatty chain in the resin formula reduces considerably the hardness due to their tackness properties. Complete film hardness was achieved after baking for two hours at 200°C.

6- The presence of epoxy ester improves considerably the water, acid and alkali resistances of the dried fills.

7- All films of the tested resins pass satisfactory the flexibility and adhesion tests.