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Manufacturing Enamel Resin Using Furancarboxalehyde-3 Compound

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Enamel is an important material in industry because it is used as a paint and an electrical insulator due to its properties of insulation. The goal of the study is to manufacture new enamel by polymerization of partially polymerized and entangled epoxy with Furancarboxalehyde-3 compound. The manufactured resin has been examined with FT-IR technology and compare the data with FT-IR data of pure compounds used in producing enamel before reaction so to find out formation of reaction and electrical conductivity to know the new enamel ability of electrical conductivity and insulation. The process can be achieved through using arithmetical equations of conductivity. It is found that the prepared enamel has properties of electrical insulation. Also, solubility testes have been made with a group of available solvents and solidification tests of prepared enamel in addition to measure the glass transition degree by calculating conductivity and applying that on the diagram that shows temperature and resin resistance to electrical conductivity of fixed time.

Keywords: Enamel Resin, Furancarboxalehyde-3, Paint, Epoxy, Resin, Polymer.

RESEARCH ARTICLE

1. INTRODUCTION

Polymer resins are classified into different types according to the nature of use as:[1] thermoplastics, thermo resins, fibers, rubber, adhesives, coatings and paints. Each category is subdivide into other subdivisions. The most important properties of polymer resins are the possibility to modify some of their characteristics or add new features through using technology of polymer compounds, mixtures and alloys. Coating can be classified, according to their use, into paints, enamel and varnish. The highly important classification depends on the chemical nature in which it is classified into[2]

1—Oil-based alkyd coatings
2—Cellulose coatings
3—Silicones coatings
4—Chlorinated rubber coating
5—Epoxy coating

Coatings also classified, according to application, into[3,4] paper coating, wood coating, fabric coating, metal furniture coating, wires coating, Tar Epoxy coating and Neoprene epoxy coating.[5,6]

1.1. Enamel

It is a coating used for covering metals surfaces to protect from weather conditions or to get favrouable appearance.[2] Also, it is used to protect some metals corrosion or electrical insulation. The coating used in covering wires is a result of polymer resin solved in a high temperature solvents like polyvinyl formal and poly(Ester-Amide).[7]

1.2. Epoxy Resin

It is the polymer that includes two or more of epoxide groups (Fig. 1).

Also, it is called **oxrane** and epoxy resins are classified as ether resins due to ether bonds. These resins have certain properties that make them the most important resins as viscosity and electrical insulation. These features have given epoxy resins a wide range of use in technological applications. The properties of epoxy resins are:

1—Easy to manufacture and handling due to low viscosity.
2—Appropriate mechanical properties.
3—Thermo and electrical insulation and high viscosity due to ether and hydroxyl terminal groups.
4—It does not undergo contraction after hardening because there are no residue during manufacturing.

Most of epoxy resins are manufacturing industrially from the reaction of Epichlorohydrin with two active atoms of hydrogen compounds like Phenols, Mono and secondary amines.[8]

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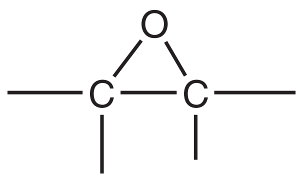


Fig. 1. Polymer with two or more of epoxide groups.

1.3. Epoxy Resin Hardeners

Among the properties of epoxy resins is the ability to transform resins from liquid state to solid one through adding some active compounds known as hardening or quenching agents. The hardening conditions depend on the type of hardener agent. The function of the hardener is to cause entanglement to form infusible entangle, heat and power non-conducting polymer.[9] Hardening agents are classified into:

1—hardening agents of active groups lead to form hardened resins that include two types of bonding groups. So, their work is similar to monomer in polymerization thus it produces heterogeneous polymers due to its content of groups of different bonds like carboxyl acids.

2—Catalyst hardened agents to catalyze polymerization and produce homopolymer like tertiary amines and ammonium salt.

2. THE STUDY AIMS

Due to the importance of enamel, the present study aims to produce enamel of useful and important properties through using epoxy resin with 3-Furancarboxalehyde because the produced enamel is quasi aromatic, thermal stability and high polarity, which increases polymer viscosity. Also, the produced polymer is non-oxidizable or dissociated in high temperature, which can be used for a longer period of time.

Table I. The solubility of enamel in different solvents.

Enamel	Solvent
Acetone	Dissolved
Dioxane	Undissolved
Cloroform	Undissolved
Ethanol	Undissolved
Toluene	Undissolved
Ether	Undissolved
Benzne	Undissolved
Xylene	Undissolved

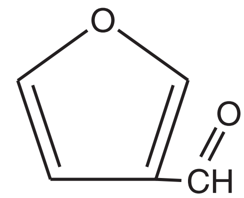


Fig. 4. Furancarboxalehyde-3 chemical composition.

3. THE STUDY TOOLS

1—US made FTIR-7600 is used to measure infrared spectra of the manufactured compounds.

2—Spanish made Electrical conductivity device by Crison Company is used to measure conductivity. The device includes a source of alternate current, reagents, capacitor and alternating capacitor to balance capacity.

4. PRACTICAL PART

4.1. Preparing Enamel Resin

The laboratory tools are three-necked glass flask, thermometer, mechanical stirrer and oil bath.

1—600 g of untangled polymerized epoxy is put in the vessel reaction (Fig. 1) with 100 ml of dioxane solvent.

2—3.56 ml of 3-Furancarboxalehyde is added (Fig. 3)

3—0.3 mole of N2 is added.

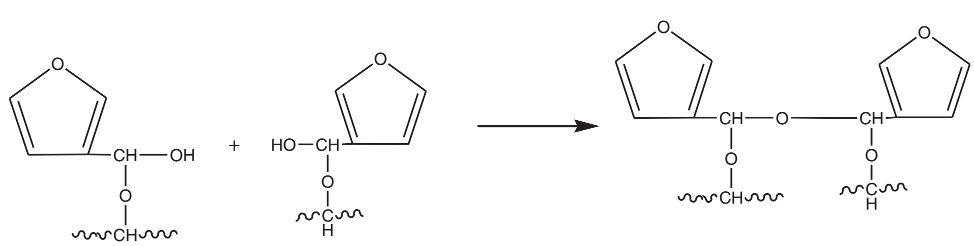


Fig. 2. Furancarboxalehyde compound reacted with epoxy resin.

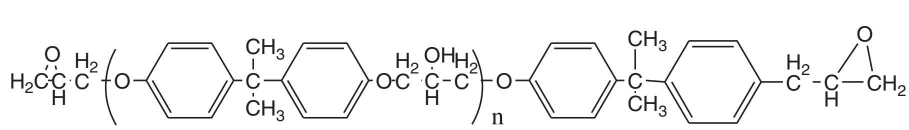


Fig. 3. Epoxy resin chemical composition.

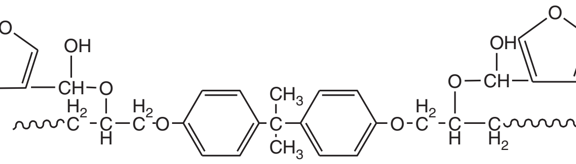


Fig. 5. Chemical composition of prepared enamel.

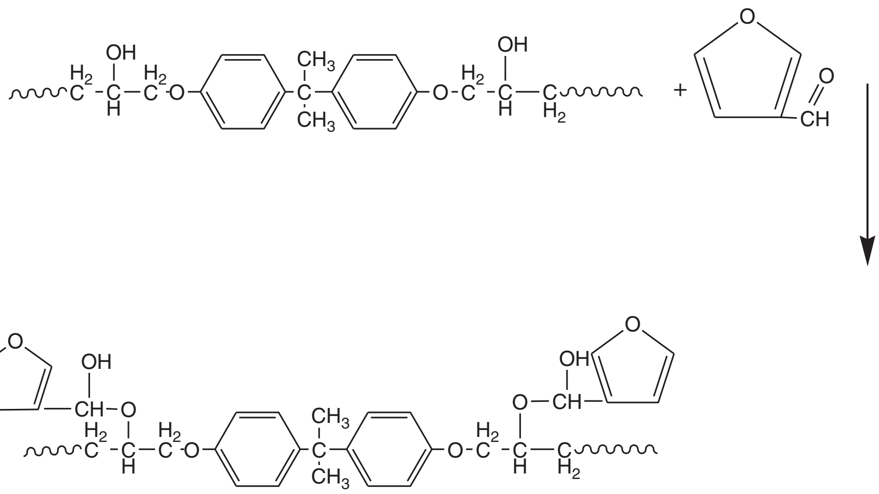


Fig. 6. Chemical equation to prepare enamel.

4—The reaction temperature is fixed on 100 °C.

5—After the end of the reaction, the mixture is left to cool the product is separated then washed with cold water. The product is the enamel resin (Fig. 4).

6—The product is left to dry for other processes.

7—The reaction is completed according to the equation (Fig. 5).

5. DISCUSSION

The solubility of enamel has been investigated in different solvents as shown the Table I:

5.1. Solidification Ability

It is noticed that the prepared enamel is hardened and becomes non-plasticity when exposed to temperature.

5.2. Infrared Spectra

As shown in (Fig. 6), it is noted the emergence of the following bands: a wide band at (3500–3200) cm belongs to the absorption of stretched hydroxyl group OH, the band (1150–1200) cm is for stretching C–O bond that includes Furancarboxalehyde-3 and epoxy molecules, the band (760) cm belongs to the absorption of stretched C–O group of epoxy rings, the band of the absorption of stretched CH group at 2900 cm and the band of CH group at 770 cm.

5.3. Hardening the Manufactured Resin

The hardening process can be achieved through entanglement among polymers chains by hydroxyl groups that are existed in 3-Furancarboxalehyde compound reacted with epoxy resin as shown the following reaction in Figure 2.

The entanglement might be along the polymer chains due to the compensating groups of hydroxyl existed in 3-Furancarboxalehyde. This gives hardened resin good mechanical properties as being solid, resistant to temperature and undissolved in most of chemical materials.

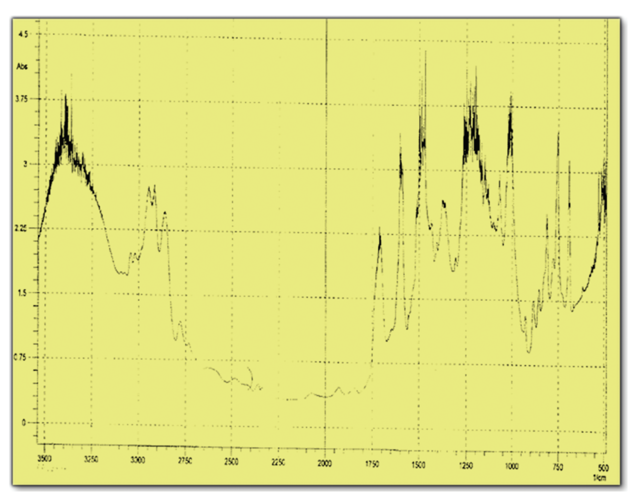
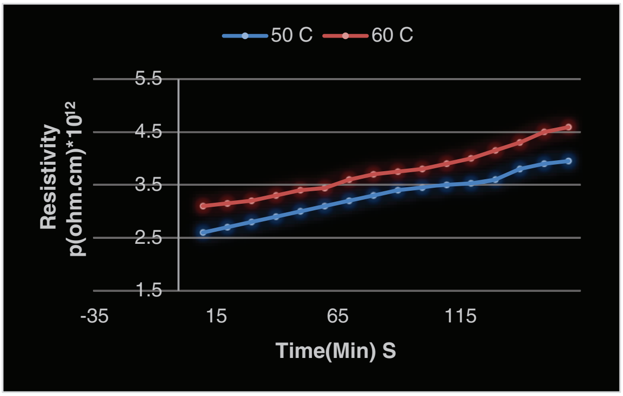
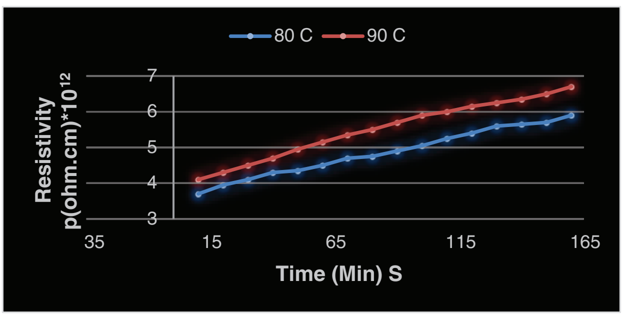


Fig. 7. Infrared spectrum for recorded enamel.



(a)



(b)

Fig. 8. Change the resistant with time for recorded enamel with constant temperature.

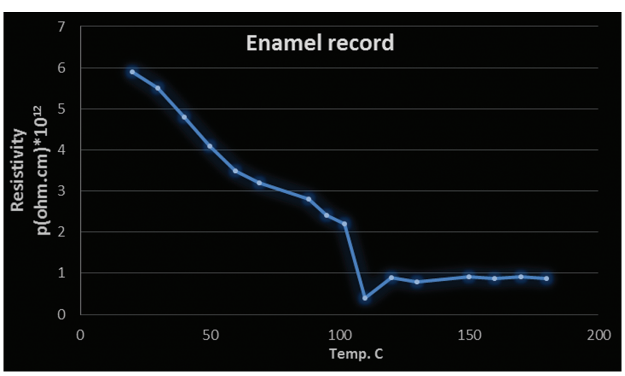


Fig. 9. T_g for enamel.

Epoxy resins have good viscosity due to some groups like hydroxyl terminal, aromatic and ether groups that include electronic couplers resulted from oxygen or Pi bond. So, all these properties cause viscosity of epoxy resin and used to coat electrical wires and metal pipes that used underground to protect them from corrosion. It is found that the best weight percentage to mix Furancarboxalehyde-3 with epoxy resin is %40 which produces resin of high viscosity and adhesiveness where heating increases solidification and entanglement.

5.4. Measuring Electrical Conductivity Enamel Resin in Solid State

Samples of enamel in the form of discs (2 cm) and (0.5 cm) thickness have been prepared through pressing in a special moulds. The conductivity and capacity are measured in 30–120 °C and after measuring enamel resistance in a form of graphical method that relates resistance to time at fixed temperature (Figs. 8(a, b)), it is noted that the resistance values with time increased at fixed temperature. It indicates that the qualitative conductivity with time decreased since they have inverse relationship and in turn it refers to decrease in the values of electrical conductivity with time.

5.5. Measuring Glass Transition Temperature

T_g values that are measured by electrical techniques more accurate than those measured by DSC processes. Through drawing the resistance with temperature at zero time, the sudden change in the value of resistance at 110 °C is noted and it is the degree of glass transition of prepared enamel (Fig. 9).

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