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A Review of Four Kinds of Resin Production Technologies Based On Recent Developments

Malek Hassanpour

Department of Environmental science, UCS, Osmania University, Telangana State, India
ORCID address: 0000-0001-9662-0623

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Abstract

The green chemistry industry is the main achievement of humans in the present era. The production of petrol-based materials moved towards eco-friendly products in the modern world. Therefore, conducting a review of participating technologies in the way of Bakelite, Alkyd, Epoxy resins, and Urea-Formaldehyde (UF) adhesive production technologies can be an objective sought in the best technology selection procedure. The present review discussed the four kinds of resin production technologies from industrial project identification towards recent technologies posed in this regard. To present the technologies in a relevant way was attempted to collect the main concepts and definitions from scientific and important databases all over the world. The findings proceeded to present bio-based resin production practices with a glance view into materials demands in the resin production technologies. The tabulated data were acquired from the initial assessment of the Iranian evaluator team in the Environmental Impact Assessment (EIA) plan. It can be concluded that the awareness of knowledge in the field of materials stream assists the stockholders in figuring out which technology is relevant and economically viable in resin production industries.

***Keyword**: Resin Industries, Technologies, EIA, Screening, Projects*

I. Introduction

The configuration of resin products depends on curing and hardener agents such as polyamines, acid anhydrides, or Lewis acids or bases. The main origin of resin curing products refers to petroleum sources, even in building blocks and their additives. Therefore, the circumstances of polymer production are a very prominent aspect of resin production operation [1-5]. There are a variety of components to be an initial feedstock for producing epoxy resin and other types of resins. Biomass is recognized as a prominent feedstock in this regard. Studies noticed the main role of vegetable oil, soybean oil, linseed oil, castor oil, canola oil, Karanja oil, and palm oil, etc., for epoxidation of double bonds with active oxygen (like hydrogen peroxide or peracid). The famous procedure for resin synthesis operation is chemical reactions and crosslinking processes. The epoxy resins are mixed with curing indicators to promote the heat withstanding properties, mechanical and similar characteristics. The curing agents also interfere with the bio-based structure of resins. Their structure lacks the aromatic components in their backbone. The applications of this group of resins comprised stabilizer/the plasticizer, modifier, reactive diluent/the flexibility, coatings, composite materials, castables, adhesives, molding materials, and injection molding materials and paint applications. To escalate the property improvement and the function enhancement has been suggested to employ various materials such as clay, plant fiber, and organic-inorganic hybrid materials [6, 7]. The polymeric matrices are classified into two classes such as thermoset (polyester, epoxy, phenolic, and vinyl ester) and thermoplastic (polystyrene, nylon, acrylic, and polyethylene) polymers. The use of thermosetting resins is encouraged in too many nations over the world. The application of epoxy resins got an escalation as they account for 8% of the thermosetting resin generation. One of the important characteristics of epoxy resins in wide application refers to their possibility of adaptability with different types of fillers [8].

An adhesive is a connector between two surfaces of matting substrates that attach and hold together intermediate chemicals via physical interactions. Adhesion means the phenomenon of joining substrates to stay together. The studies declared that the greatest existing adhesive market is devoted to Asia-Pacific, Europe, North America, and Latin America, approximately 34%, 32%, 27%, and 4% of the whole market demand respectively. The remaining 3% allocated to other nations [9, 10]. Adhesive resins are configured from two phases of the polymer matrix (binder) and conductive fillers. Adhesives have been requested for a variety of substrates such as metal-metal, metal-wood, and wood-wood. The adhesive and tapes account for up to 9% of market demand. The application of adhesives allocated for automotive industries, aerospace, domestic appliances, biomedical and dental usages, consumer and electronic equipment, constructing buildings and docks, marine and sports stuff, and fabrication of general industrial machines [11-14].

The bakelite resin is classified in the sub-group of phenolic resins [15]. Phenolic polymers were introduced and discovered via chemical reaction (polymerization) of both compounds of phenol and aldehyde in 1907. So, they are one of the oldest resins synthesized in this regard. The process of curing resin structures via covalent crosslinking bonds can generate phenolic resins that pertain to fibrous materials. The application of phenolic resins for both Novolac and Resole classes and their derivations listed as ablation (in aerospace ablative), abrasives (variety of abrasive products, bonded, coated, and non-woven), composites (multi-application in resin processing methods), thermal and electrical insulation, friction (automotive, industrial, oil field and marine friction), dimensional stability; chemical resistance (packaging), and adhesives (wood bonding and fibers). The technology posed in the way of phenolic resins production is relatively cheap. The prominent characteristics of this group of resins are comprised of (1) good fire performance, (2) proper thermal insulation performance, (3) appropriate dimensional stability, and (4) good chemical and corrosion resistance. The vast applications of mentioned resins encompassed related electrical systems, household appliances, wiring equipment, coatings, and wood-based products, etc. [16-18].

Alkyd resins are polyesters altered via introducing fatty acids and other compounds. They are a good attraction towards nanoporous films and some plastic substrates [19, 20]. These resins are employed in coating and paint manufacturing. With a promoted gloss, properties are easily used in variable environmental conditions [21].In recent studies use of agrarian seed oil encouraged modification of the structural properties of alkyd resins. The agrarian seed oil is exploited instead of fatty acid in the structure of alkyd resin [22, 23]. The study of Chiplunkar et al. [24] sought the same purpose by adding Palm fatty acid to produce an eco-friendly alkyd resin. Many studies employed the raw materials to produce the Alkyd resin such as Refined linseed oil, Sunflower oil, Noah, NaCl, Sulfuric acid (95-98 %), Phthalic anhydride, Ethyl alcohol, Dimethylol propionic acid, Melamine, Formaldehyde, Methanol, Para-toluene sulfonic acid, Toluene, Sodium carbonate, Isopropyl alcohol, Cobalt naphthenate, Lead naphthenate, Nitrogen gas, and Glycerol [25, 26].

The research by Hillermeier et al. [27] reported an advanced technology using the high-pressure resin transfer molding process with high efficiency and economic viability. Despite the use of bio-based resins restricted but the scientists believe the new technologies will pave the way to the extensive application of these materials in the near future [28].

The objective followed by the present review sought to collect a discussion of modern and newly developed technologies for producing four different kinds of resins in the framework of screening projects in the EIA plan in Iran. The projects investigated to demystify the EIA plan by the Iranian evaluator team. In the following step, an inventory of the availability of projects has been listed in tables. Figure 1 presents the steps of the EIA plan to assess industrial projects in Iran.

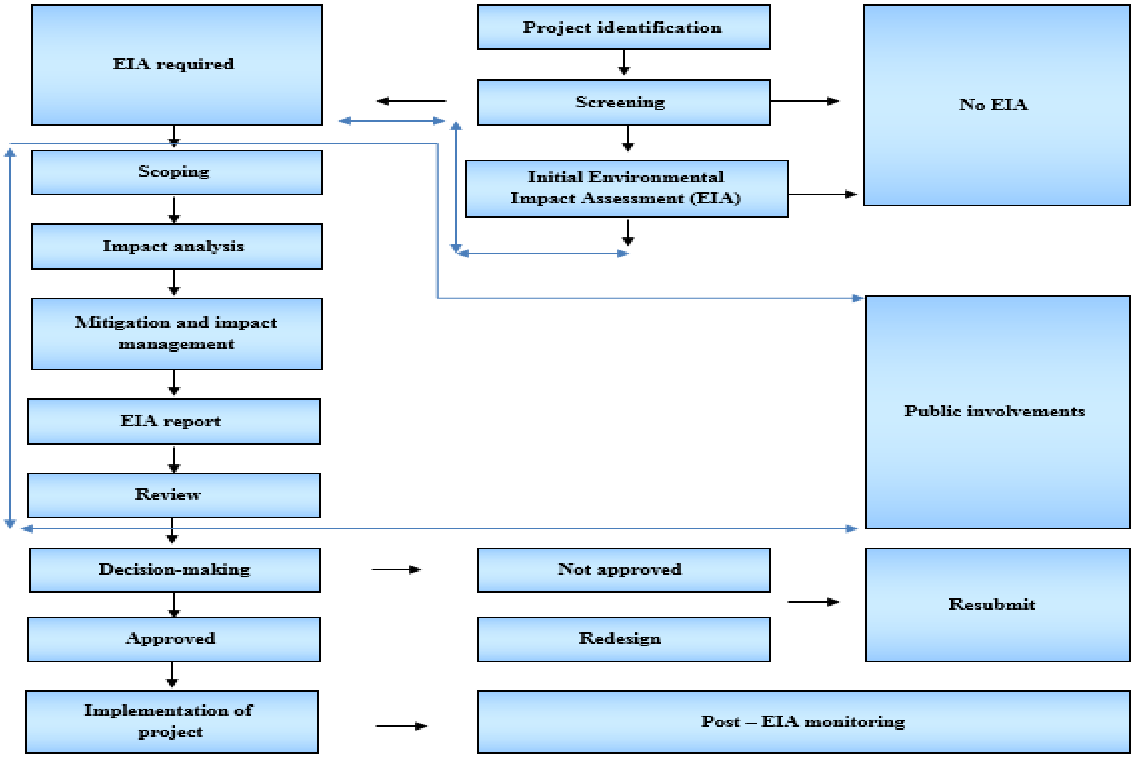

Figure 1. Flow diagram of current review and steps of project identification in EIA plan [29]

The natural resin is a liquid with high viscosity produced from plants, their bark, flowers, and other sections of plants. The main proportions in a natural resin content devoted to terpenes, strong, pleasant-smelling compounds built upon isoprene subunits, and sometimes resinic acids. A variety of products can be generated from the evaporation and volatilization of fresh resins and their additives [30, 31]. The discussion of this group of resins is out of objective declared.

II. Bisphenol A (BPA)

BisphenolA (BPA) is a toxic compound, and there are prohibiting regulations against its application in daily requests, but it is used widely in too many human demands over the world. It is a prominent chemical precursor in the generation of many chemicals such as vinyl ester resins, unsaturated polyester resins, and cyanate esters. BPA is allocated to comprise 85% of the base or initial feedstock of the epoxy resin generation and procures an important role in mechanical characteristics and sturdy properties for output materials released [32].

III. Iranian resin industries

Kamaron Resin has been used in processing the various gaskets as supplementary materials along with materials and anti-oxidation agents. An industry with a nominal capacity of 200 tons demands a quantity of around 2310 kg of Kamaron resin. The industry of rubber insulators with a nominal capacity of 25 tons needs 160 kg of resin in the processing cycle. The 36 tons and 30 tons of Polyurethane resin and single composite resin are requested to produce the polyurethane synthetic leather in industries with a nominal capacity of around 12000 m^2. Unsaturated polyester resin of 84240 kg is applied for the manufacturing of rubber buttons in an industry with a nominal capacity of 100 tons. The use of petroleum resin, ion exchange resin, komaron resin, komaron resin, Polyester-isophthalic resin and gelcoat-isophthalic resin, unsaturated polyester, komaron resin, polyester resin (35-85%), modified phenolic resin, modifier resin have been employed for manufacturing the 77 tons in an tape industry with nominal capacity of 3370000 No, 150 kg in manufacturing of disinfectants with a nominal capacity of 900000 liters, 102 kg in manufacturing of rubber glass head with a nominal capacity of 3240000 No, 160 kg in manufacturing the rubber pieces with a nominal capacity of 25 tons, 10.5 tons in manufacturing the fiberglass boats with a nominal capacity of 5000 No, 70 tons in manufacturing the fiberglass pieces with a nominal capacity of 100 tons, 4620 kg in manufacturing the automotive rubber pieces, 490 tons in manufacturing the sanitation stuff with a nominal capacity of 4500 tons, 15150 kg in generation of printing ink industry with a nominal capacity of 500 tons, 5 tons for producing the festering materials and insulation of gas pipes with a nominal capacity of 100 tons respectively.

A. The epoxy resin industries

The produced epoxy resin in the unit is one of the copolymer types of EpiChloroHydrin(ECH) bisphenol A, which is mainly used in the formation of surface coatings, electrical applications, adhesives, tank lining, etc. In terms of physical condition, various types of epoxy resins (according to the customer's request and, for example, solid, liquid, and soluble types) can be produced. Both ECH and bisphenolA are introduced into the reactor to produce epoxy resin. While melting and handling the temperature in a constant range, the first stage of the reaction begins. In this stage, which is also calorific, the epoxy radical is bonded to the hydroxyl radical by separating from the ECH, and chlorohydrin ether is formed. In the second stage of the reaction, in the presence of sodium hydroxide, the chlorohydrin ether mediates the production of the epoxy radical. Characteristics of this stage of the reaction are a considerable speed and being endothermic of the reaction. From the reaction of bisphenol A and ECH, Bisphenol A mono glycerol ether is formed, which gradually leads to the formation of a high molecular weight polymer. To produce low molecular weight epoxy resin, excess ECH is added to stop the polymerization process. To complete the polymerization process, the resulting polymer is separated from the polymer by a storage tank in which the polymer is evaporated under a vacuum chamber of 5 mm Hg. The polymer whose ECH has been removed resumes reacting with unreacted by-products and raw materials. To remove the reaction by-products and complete the reaction of unreacted materials, the next step is accomplished via purification reactions, in which sodium hydroxide is added to repeat the reaction, which removes a large number of chlorine compounds. Methyl isobutyl ketone is used to remove sodium chloride and by-products of reaction due to differences in density as well as pH adjustment. The pH-adjusted polymer product will be completed under a vacuum of two to three millimeters of mercury to remove and recover methyl-isobutyl ketone and finally produce an epoxy product. It will be stored after packaging to be shipped to the consumer market. Figure 2 and Table 1 present the layout units and the annual requirements of industries of epoxy resin, respectively.

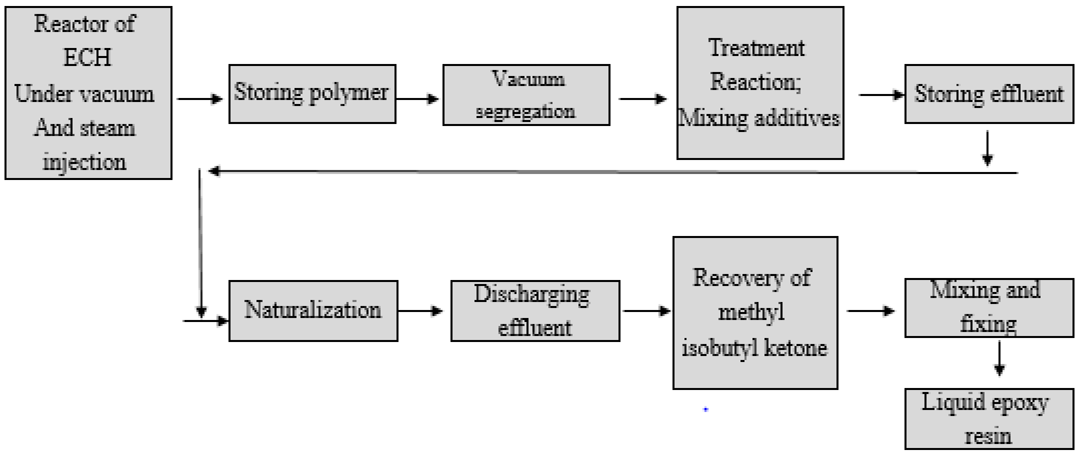

Figure 2. The layout units of epoxy resin manufacturing industries [37-39]

Table 1. The annual requirements of industries of epoxy resin[37-39]

The materials and equipment	Total annual rates
Equipment and devices	
Storage tank	6 No
Evaporator, 4 tons	1 No
Condensation separator, 4 tons	1 No
Condenser, 10 tons	1 No
The reactor, 10 tons	1 No
Purification tank, 5 tons	1 No
Filter, 2 kg/cm^2	1 No
Transmission pump	4 No
Vacuum pump, stainless steel, 2 m^3/h	1 No
Primary and secondary pumps, 2 m^3/h	2 No
Fitted lab and repair workshop	1 and 1 No
Required materials	
Bisphenol A	3710t
ECH	4000t
Noah, 45%	3070t
Methyl Isobutyl Ketone	100t
Pure N_2	165t
Products	
Epoxy resin	5475t
Employees	
Staff	28 persons
Energy consumption	
Required water	7 m^3/day
Power	243 kW/day
Required fuel (Stoves)	102 Giga Joule/day
Required land and landscaping	
Required land	5300 m^2
Construction of infrastructure (Buildings)	1525 m^2

B. Alkyd resin

The raw materials enter the reactor after accurate weighing according to the required ratio of the formulation. Solid raw materials are transferred to the reactor by the worker, and liquid raw materials are transferred to the reactor by a special pump after heating. Liquid raw materials in storage tanks also enter the reactor through piping and with the help of a pump. Then the reactor door is closed, and the reactor stirrer is turned on. After the materials are completely mixed, the heat treatment is done with the help of the heating system. The reaction temperature is 230 °C, and the reaction time is 10 to 15 hours. The reactor is heated by permanent oil flowing through the second wall of the reactor. During the reaction, the product under preparation is regularly sampled, and the viscosity, pH, and specific gravity tests are performed. Increasing the viscosity indicates the progress of the polymerization process, and increasing the acidity indicates the degree of esterification of the reaction product. The temperature inside the reactor is handled by an automatic system. Vapors from heating the material inside the reactor enter the horizontal and vertical condenser systems from the top of the reactor and condense. The resulting products enter the separator, and after separating the two phases, the solvent phase re-enters the reactor, and the heavier water phase leaves the system. After reaching the desired viscosity, the tank temperature is quickly reduced to 185 °C, and the produced resin is transferred from the end of the reactor to the dilution tank to be adjusted and dissolved in the solvent. The resulting resin is filtered after cooling and dilution. Then, it is filled in 220-liter barrels by filler and is transferred to storage. Figure 3 and Table 2 display the layout units and the annual requirements of industries of Alkyd, resin respectively.

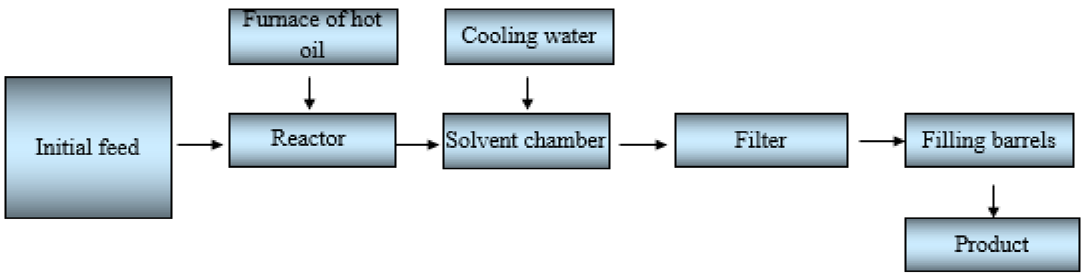

Figure 3. The layout units of Alkyd resin manufacturing industries[37-39]

Table 2. The annual requirements of industries of Alkyd resin [37-39]

The materials and equipment	Total annual rates
Equipment and devices	
The reactor, 1000 L, stainless steel, 25 Hp	1 No
Shell and tube condenser, 40 m^2	1 No
Filter, 80 L, stainless steel, 1 m^2	1 No
Blender, 1500 L, 15 kW	1 No
Hot oil furnace	1 No
PE tank, 5000 L	10 No
Centrifuge pump, 4 kW	1 No
Barrel filling machine, the capacity of 15 barrels of 200 L/h, 3 kW	1 No
Required materials	
Fat acid	94.5t
$C_8H_4O_3$	626.8t
Pentaerythritol	217.5t
Mono ethylene glycol	14.5t
Xylan	197t
Solvent AW-401-AW-409	708.7t
Glycerin, purity of 99%	181.3t
Products	
Resin	2500t
Employees	
Staff	27 persons
Energy consumption	
Required water	15 m^3/day
Power	163 kW/day
Required fuel (Stoves)	3 Giga Joule/day
Required land and landscaping	
Required land	2300 m^2
Construction of infrastructure (Buildings)	650 m^2

According to recent studies, the generation of alkyd resin comprised of both steps of alcoholysis and poly esterification. The solvent of xylene participates in the dewatering process and impedes the ingress of air. The alkyd resin production with the presence of triglyceride oil, glycerol, lithium hydroxide, and catalyst starts at a temperature of 230-240℃ in a batch ambient. The catalyst accelerates the conversion of oil to monoglyceride. Phthalic anhydride is introduced in the next step along with a rise in temperature up to 210-250℃ to synthesis the alkyd resin. The production of acrylate-alkyd resin is performed by a combination of different molar ratios of tung oil, phthalic anhydride, and isobornyl acrylate (IBOA) and via an alcoholysis, polyesterification, and Diels-Alder reaction. Polycondensation reaction of fatty acids, dibasic acids, or acid anhydrides and polyols with hydroxyl functionality greater than two results in alkyd resin synthesis. The advantages and drawbacks posed in alkyd resin application refer to appropriate biodegradability, durability, good adhesion, ease of exploitation and bad water resistance, low hardness, and fair thermal stability, respectively [33-36].

C. Bakelite resin

The applied equipment and devices in this process can be requested to prepare both Russell and Novalk resins. Only by changing the ratio of raw materials and requested catalysts and operating conditions, both types of resins can be produced in either liquid or solid form. The production process of each option is as follows. Production of Novlak resin: First, phenol is melted in its special tank, and then a certain value is poured into the reactor. A formalin solution containing 37% formaldehyde in water is weighed in its own tank and then is discharged into the reactor. The ratio of raw materials depends on the desired properties of the resin, but generally, 0.75 to 0.85 mol of formaldehyde per mole of phenol is calculated to produce novolk resin. To ensure the correct ratio of phenol and formaldehyde discharged into the reactor, its refractive index is compared with the standard sample in the lab. After ensuring the correct charge of the material, the temperature of the material is heated by water steam to 60 - 65 °C, and then an acid catalyst of 0.1 to 0.3% by weight of phenol is gradually added to the reactor. Since the reaction is exothermic at this stage, it is cut into the outer wall of the reactor, and by measuring both pH and temperature inside the reactor, the amount of added catalyst is controlled. So, the reactor temperature does not exceed the temperature of80 to 100 °C. Therefore, the rapid progression of the exothermic reaction does not cause danger. The reaction is completed at this stage after 4 to 6 hours. At this stage, a sample is sent to the laboratory to measure the amount of free phenol remaining in the reactor. If 95% of the initial phenol was used, it is considered a complete reaction. To heat, the reactor is used water steam at 140-170 °C, and vacuum pressure starts at 25 to 27 inches of water. In this case, the water and free phenol in the reactor are evaporated. Then, they are cooled to become liquid inside the condenser. The cooled liquid is removed from the operating environment and is collected in a special tank. At this stage, the quantity of free phenol in the product is measured again by the laboratory because its quantity has a direct effect on the properties of the resin and its softening point. The product is naturalized via Noah or NH_3 solution and then is sent to a Sequinmachine or is poured into special trays to be crushed and dried after drying or cooling. It is dissolved in an alcohol-soluble reactor to emerge as a syrup. Then, they are mixed with filler mineral powders or paper powders and are packaged as syrup in 200 kg metal barrels.

Production of Russell resin: In this method, first phenol and formaldehyde 37% are weighed and measured in a special quantity in their tanks, and phenol is melted in the tank by the water steam coil. The ratio of raw materials according to the desired properties can be between 1- 2 moles of formaldehyde per mole of phenol to produce Russell resin. If the goal is to produce solid Russell resin, the ammonia solution (25%) is added to the reactor as a catalyst. But if the target is to produce a liquid type, caustic soda is used in the 3% by weight of phenol consumed, which is usually prepared and added as a solution of 10 to 15%. The reactor paddle stirrer is responsible for stirring the materials inside the reactor and cleaning the surface inside the reactor so that the Russell resin does not overheat in the inner wall and does not cause it to harden and stick to the surface. The reaction takes place at a temperature of 100 °C for 1 to 3 hours inside the reactor. Since it is exothermic, there is no need to use steam to heat the reactor. It only needs to be heated at the beginning of the reaction up to 60-70 °C by hot steam. Then, the water-steam flow is cut off to prevent exceeding the reaction temperature up to 100 °C. Temperature handling is carried out by vacuum pump and creating a relative vacuum of about 30 mm Hg by distillation and reflux. It results to distill and dehydration. The surplus water is separated from the resin. Due to the higher concentration of the product, the liquid water vapor is collected in the condenser in a special container. If the resin is a liquid product, distillation is done for a shorter time, and when its solid percentage comes into view(60-70%) is emptied into the filter and then is sent to a storage tank to be packed in barrelsof200 kg. If the production of solid resin is the goal, the distillation operation is performed until complete dewatering, and the molten resin is cooled to near the melting point of about 50 °C. Then, it is sent into the Sequinmachine, which after cooling and crushing inside, plastic bags are packed. In all the above cases, after a laboratory check-up to complete the reaction and create the desired product, the produced resin is washed with a dilute sulfuric acid solution, and its pH is neutralized. After this step, it leaves the reactor. Resin is made up of a double-walled reactor equipped with a stirrer and a cooling condenser at vacuum pressure, and the maximum reaction temperature is 100℃. Bakelite or phenol-formaldehyde resin is produced from the reaction between phenol and formaldehyde and has two types of Novolak resin and

Russell resin. If the molar ratio of formaldehyde to phenol is less than one and an acid catalyst is used, Novolak resin is synthesized, which this process is fulfilled in two stages of curing or networking. If the molar ratio of formaldehyde to phenol is more than one and a base catalyst is exploited, Russell resin is processed, which is converted into a polymer network in one step. By mixing the resin with cellulose filler powder, bakelite powder is procured, which in most cases Novlak resin is requested to synthesis bake lite powder.Figures4, 5, and Table 3 represent the chemical structure of Bakelite, layout units, and the annual requirements of industries of Bakelite resin, respectively.

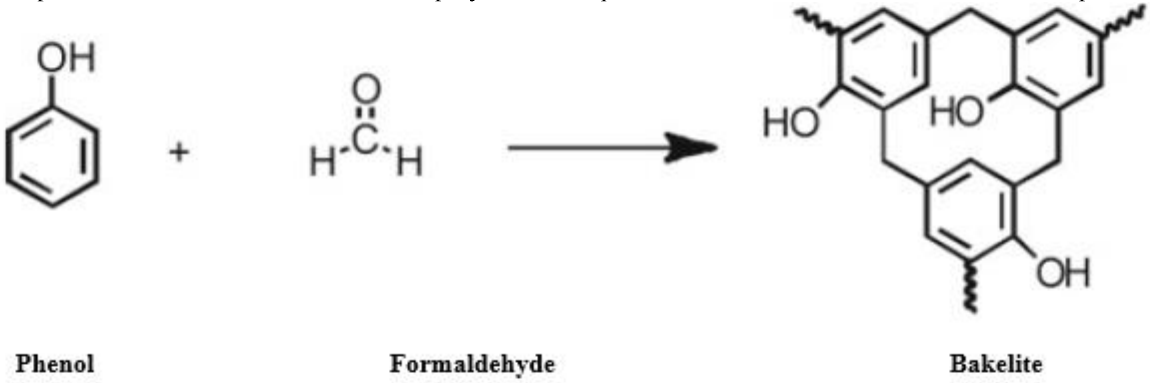

Figure 4. Chemical structure of Bakelite [40]

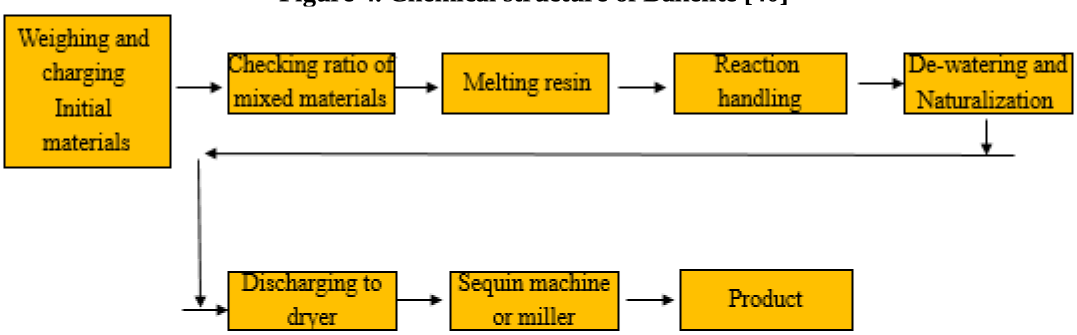

Figure 5. The layout units of Bakelite resin generation [37-39]

Table 3. The annual requirements of industries of Bakelite resin [37-39]

The materials and equipment	Total annual rates
Equipment and devices	
Stainless steel reactor, 8000 L	1 No
Mixer, 20 kW, 60 rpm	1 No
Reflex column, steel, h and d= 1.5 m and 20 cm	1 No
Condenser, steel, A= 4 m^2	1 No
Tank equipped to the thermal coil, 4000 L	1 No
Formalin tank, steel, 4000 L	1 No
The tank holding acidic catalyst, 2000 L	1 No
Distillation tank, 4500 L	1 No
Two stages, vacuum pump, 500 m^3/h, 18.5 kW	1 No
Spiral product pump, 5 m^3/h	2 No
Filter press, 1 m^2	2 No
Sequin machine as roller, 200 kg/h	2 No
Hammer mill, 650 kg/h	2 No
Centrifuge pump, 15 m^3/h	3 No
Boiler, 1 ton/h	1 No
Resin treatment machine, 3 m^3/h	1 No
Required materials	
Formaldehyde 37%	1600t
Phenol	1600t

NH_3, 25%	200t
H_2SO_4, 98%	40t
Nylon bags, 50 kg	40000 No
Products	
Bakelite resin; Black or brown as a powder or liquid used for molding and casting.	2000t
Employees	
Staff	24 persons
Energy consumption	
Required water	11 m^3/day
Power	200 kW/day
Required fuel (Stoves)	35 Giga Joule/day
Required land and landscaping	
Required land	4500 m^2
Construction of infrastructure (Buildings)	1295 m^2

D. Urea Formaldehyde (UF) Adhesive

First, a certain amount of formaldehyde solution (37%) is sent into the reaction tank. Then, according to the formulation, the molar ratio of urea to formaldehyde 1: 1-1.5, the required amount of urea is weighed and added to the tank. During this time, the mixture inside the tank is stirred frequently. The pH of the solution is constantly monitored, and its value is kept constant at about 8. Ammonia solution of caustic soda (4%) can be used as this controlling agent. The heating agent of the mixture inside the reactor is the steam flow in the tank. The reactor lid is closed, and the mixture is boiled for half an hour at a temperature of 50-60°C. The vapors are returned by the liquid condenser into the reactor. The reaction between the two main substances of urea and formaldehyde is performed at this temperature, and the reaction product is two types of the mixture of Monomethyl Urea (MU) and Dimethyl Urea (DU). MU is formed at 50 °C and DU at 65 °C. To check the product, separate sampling is used. After stopping the thermal reaction, the pH of the product by formic acid reaches 4. The mixture is then boiled again, and thus the reaction is completed. Using the caustic soda of 4%, the pH goes to 7 again. At a pressure below atmospheric pressure, distillation takes place. Then, some of the water in the mixture is evaporated and added to the percentage of solids in the mixture. Lowering the pressure is accomplished by turning on the vacuum pump and distillation system and closing the returning flow valve into the reactor. In this way, the product is collected in the storage tank. Evaporated water is collected in the condenser. Until this stage, resin processing and polymerization reactions are completed. The next step can be to release the adhesive according to the desired formulation. This is carried out by adding filler, water at the beginning, and a catalyst and hardener at the end of the reactor. The mixture is stirred inside the tank by the stirrer as well as the returning flow of the material. The next step is to unload the product into the storage tank to be directed to the packaging. Figure 6 and Table 4 denote the layout units and the annual requirements of industries of UF adhesive respectively.

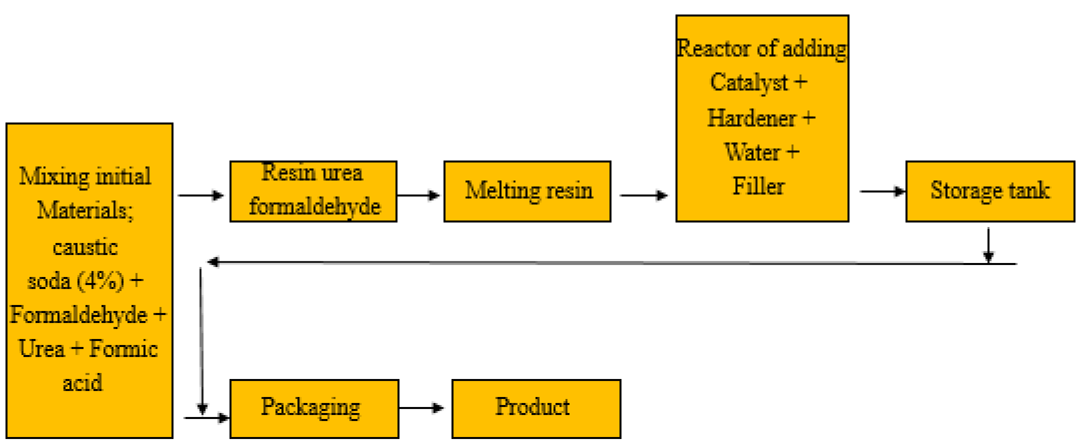

Figure 6. The layout units of UF adhesive [37-39]

Table 4. The annual requirements of industries of UF adhesive [37-39]

The materials and equipment	Total annual rates
Equipment and devices	
Mixing tank, 1.5 m^3, steel 316	1 No
Condenser, the thermal area around 0.6 m^2	1 No
Steel 315 tank of about 2 m^3	1 No
Acid formic tank, 1 m^3, steel 304	1 No
Formalin tank, 5 m^3 equipped to steam coil	1 No
Formalin pot, 400 L, steel 304	1 No
Noah tank, 1 m^3	2 No
Conveyor, L and W= 5 and 0.4 m	1 No
Ring maker machine possessing 2 molds of 5 and 1 kg	5 No
Filling machine 1 kg/3 second	1 No
Transmission pump, 12 m^3 and with the head of 10 m	1 No
Required materials	
Urea	163t
Formaldehyde	391t
Hexamine	8.2t
Cao	58.1t
Aluminum chloride	2.2t
Noah	7.4t
Furfural	4.4t
Calcium Phosphate	10.4t
formic acid	1.5t
Plastic cans	1010000 No
Packaging cartons	84167 No
Products	
UF adhesive: based on UF resin for normal temperature applications (mainly in commercial work and coating) and applications with the help of heat treatment (manufacturing of plywood and chipboard) with the specifications and features of the National Standard of Iran No. 1585 (under the title of adhesive wood)	1000t
Employees	
Staff	21 persons
Energy consumption	
Required water	39 m^3/day
Power	69 kW/day
Required fuel (Stoves)	23 Giga Joule/day
Required land and landscaping	
Required land	6100 m^2
Construction of infrastructure (Buildings)	1749 m^2

IV. Bio-based epoxy resins

A transition of fossil fuel consumption to bio-based chemicals like the variety of biomass materials in the production of resins introduced a new generation of resins products. The use of lignin, glycerol, and similar feedstock's along with the presence of water, and organic solvents, resulted in the formation of bio-based resins [41]. The utilization of renewable resource materials has been encouraged to produce bio-based thermosetting resins like natural oils, cardanol, wood/lignin, itaconic acid, tannins, sugars, lactic acid, and so on. By the way, it will introduce the main role of bio-based polymers in the green chemistry industry [42-46]. The phenol and formaldehyde have superseded with stable substrates like lignin, tannin, cardanol, hydroxymethylfurfural, and glyoxal to synthesis bio-based phenol-formaldehyde resins [47].

V. 3D printing technologies, plasma, and nanotechnologies

The recently developed technologies called 3D printing (additive manufacturing) are applied for various materials forms and states of polymers. The main advantage of these techniques refers to the promotion of cohesion properties of powder layers to make up strong binders via deposition operation. The powder bed fusion is a prominent achievement of these techniques. These techniques also follow melting the solid-state shapes and synthesis of materials via extrusion in the case of pellets and wires, etc. The liquid states of materials seek other kinds of processes via local deposition and curing. It is called Vat photopolymerization that configured from both scanning curing (via laser) and a mask projection curing system (digital light processing). The main drawbacks posed in this procedure refer to raise the viscosity of the product and occurring the sedimentation phenomena that majorly restrict the application of filled photo-curable resins in both operations [48-55].

The application of both plasma technology and nanotechnology is not limited to the production of mechanically, electrically, and thermally stable materials such as employed additives and fillers in resin generation technologies [8]. Using plasma reactors is a motivated lever in the resin generation operation via chemical vapor deposition and simple methods of mechanical and electrical depositions. The plasma reactors also participate in producing a variety of nano-materials and nano-composites, which can be employed in nano-resin products and composites. The procedure assigned to pre-curing and post-curing resin products is similar to polymers (thermosets). However, we know that the common methods for producing polymer matrix composites comprised of hand lay-up, bag molding process, filament winding, pultrusion, bulk molding, sheet molding, resin transfer molding, injection molding. The post-curing processes are supportive processes to generate efficient products [56]. The use of modern and recently introduced technologies has been encouraged in a variety of studies to generate the adhesives such as vacuum-filtration and solution-casting, layer by layer assembly (or sequential deposition = chemical vapor deposition), or the melt-based methods such as polymer-infiltration and hot-pressing can also be used. The new studies emphasized creating novel products by inducing some alterations on filler systems joined to resins and adhesives [57, 58].

VI. Conclusion

The screening of industrial projects in the EIA plan is an integral part of getting permission for constructing industrial projects. By the way, a list of availability of projects is procured. The procured list is passed out to reach a financial assessment of projects for the selected technology in the resin production operation. The tabulated data participate with efficiency assessment of industrial projects in a benchmarking assessment, and it will move the project towards realizing the recommendations for improving weakness points. Financial modeling also is another promotion in EIA for industrial projects using tabulated data. The concept presented by the current review determines the main criteria and alternatives selection in the decision-making theory of the EIA plan. Therefore, it is the easiest way to underpin the framework of the decision matrix and assign the expert idea to sort out the priority of criteria and alternatives in the selection of the best option. There are many drawbacks and advantages for the mentioned technologies to select the best option, but uncertainty can behold back in the decision-making step of the EIA plan. The new technologies also bring a variety of privileges in the new generation of resin products, but further discussion and study are needed to figure it out. 3D printing is the science of additive manufacturing that brought novelty incoherent materials production operation via deposition of powder layers in a strong binder. By introducing a new generation of additives can be made up of new types of resins and other materials.

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Competing interests

The author declares that there are no competing interests.

Conflict of interest

There is no conflict of interest.

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Ethical considerations

Ethical issues have been completely observed by the author.

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