Chapter 1

Introductory Chapter: Introduction to "Polyester – Production, Characterization and Innovative Applications"

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Additional information is available at the end of the chapter

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1. Introduction

Polyesters are one of the most important and most used polycondensation polymers and are derived from dicarboxylic acids (sometimes other acid types) and diols. Polyester is a polymer class containing ester functional group on polymeric main chain. Polyester term is usually used for polyethylene terephthalate (PET), despite the numerous polyester forms are present [1, 2].

Recent researches have indicated that using of polyester polymer processed into various forms, e.g., fibers, filament, fabric, composites, resins, dendrimers, films, sheets, and membranes in different fields, such as textile, automotive, medical, electronic, and construction applications, attracts worldwide interest. Polyester is also extensively used as packaging materials, such as bottle/containers. The polymerization of polyester could be carried out as polycondensation, ring-opening polymerization, and polyaddition processes. Furthermore, polyester could be recycled by physical (mechanical) or chemical (hydrolysis, methanolysis, and glycolysis reactions) methods [1, 2].

Recycled polyester could be used for packaging, construction parts, pipes, tanks, geotextiles, nonwoven, carpets, etc. It is expected to run out of crude oil reserves at World in 2043. Thus, recycling of petroleum-based polymers is crucial. In addition, effectively recycling of polyester will give rise to lessen carbon dioxide emission and thus global warming [1, 2].

Polyester can be classified into two groups: thermoplastic polyesters and thermoset (unsaturated polyester, polyester resin) polyesters. Thermoplastic polymers could be categorized as linear aromatic polyesters (fiber- and film-forming polyesters), elastomers (block copolyesters), liquid crystal polyester, engineering plastics, aliphatic polyesters, and poly(hydroxyl alkanoates) [1, 2].

2. Thermoset polyesters (unsaturated polyester)

Unsaturated polyester resins (UPRs) are used in civil/structural engineering applications, ships materials, composites, construction, piping, storage tanks, protective coatings, and automotive paints, which required high strength, ductility properties, and fire resistance [3–5]. The composite materials composed of unsaturated polyester are produced by some methods, such as lay-up method, pultrusion, filament winding, vacuum bagging and autoclave curing, and liquid molding [6]. Unsaturated polyester resins have advantages due to their chemical resistance, electrical properties, rapid curing, and relatively low prices for using the application areas. However, UPRs are extremely flammable and produce toxic smoke during combustion. Some filler and additives such as alumina trihydrate (ATH), magnesium hydroxide, nickel hydroxide, molybdenum disulphide, nanoclay, antimony oxide, gypsum particles, graphene, and carbon nanotube in the resins and some modifications of the resins with halogens such as bromine or phenolic resin could be used to improve fire resistance of the composites. Furthermore, their stiffness and strength properties were limited in comparison with other thermosetting resins. Fiber-reinforced unsaturated polyesters (UPs) and filler containing UPs were widely investigated to surpass these deficiencies [3–5]. Applications of unsaturated polyester resins were illustrated in **Figure 1**.

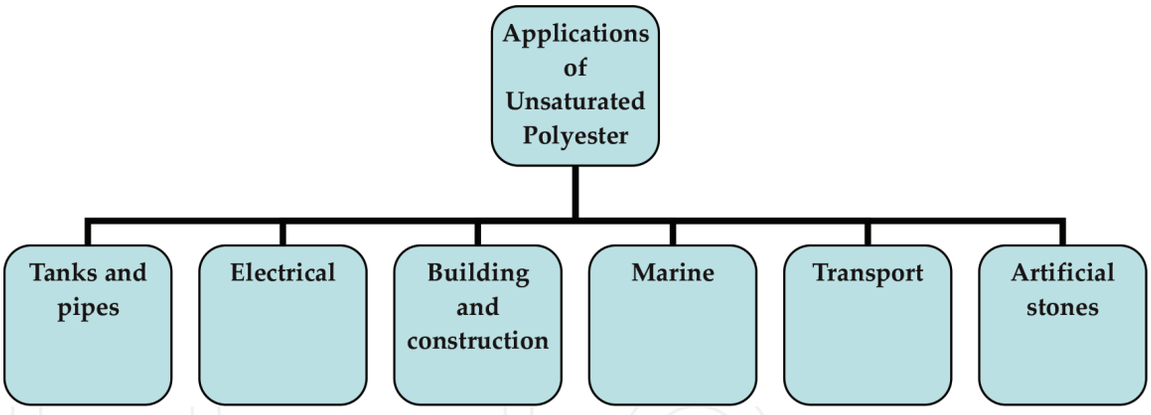

Figure 1. Applications of unsaturated polyester resins [7].

3. Thermoplastic polyesters

Polyester is the most produced thermoplastic polymer and has many application fields such as especially textile fibers and bottles. Polyester used in textiles is generally polyethylene terephthalate (PET), whose well-known properties are chemical inertness, lightness, good processability, high-melting point, high tenacity, and low cost [8, 9]. Furthermore, recycling of polyester bottles for sustainable textiles recently draws attention in the world and provides diverting waste as bottles from landfills, reducing environmental pollution and reducing carbon footprint and save energy compared to produce virgin polyester [10]. The bottle could

be recycled by mechanical and chemical processes. Chemical process is based on the depolymerization of polyester to oligomers or monomers by chemical reaction, while mechanical process is carried out with melting and re-extruding to make fiber [11, 12].

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