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Production of Melamine Formaldehyde Based Composites and Investigation of Usage Areas

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Abstract – Melamine formaldehyde-based composites have been preferred in many sectors. Various reinforcing materials are used to improve the physical and chemical properties of these composites. To lighten melamine formaldehyde-based composites, low-density organic and inorganic industrial wastes are reinforced. Inorganic factory wastes are used to increase the hardness of the composites. Besides, mineral fillers are preferred to improve the thermophysical properties of composites. In industrial applications, many modification processes have been carried out to develop both the physical and chemical properties of such composites. For composites, importance is given to optimum mechanical strength, non-flammability, surface morphology, pore structure, and distribution. Depending on the intended use of composites, the desired properties may differ in each sector. For example, there are prominent standards in every sector such as home appliances, furniture, automotive, construction, electronics, and decoration. In these standards, it is desirable to have optimum properties such as mechanical strength, hardness, density, thermal conductivity, non-flammability, and thermal stability. Therefore, these standards can be achieved by applying appropriate reinforcements and modification processes to improve the properties of melamine formaldehyde-based composites.

Keywords – Melamine Formaldehyde, Composites, Thermophysical Properties, Industrial Application

I. INTRODUCTION

There are many studies on melamine formaldehyde resins in the literature. To improve the properties of these resins, styrene is used and microencapsulation can be done [1]. Melamine formaldehyde microcapsules are preferred for self-healing materials. Microcapsules containing a self-healing substance can be used with functional materials to maintain their mechanical strength after a crack has formed. Such microcapsules should have optimum mechanical strength [2]. Melamine formaldehyde resin can also be used as a shell material with microencapsulated ammonium polyphosphate and can be prepared for the polymerization process [3].

Natural flax fiber reinforced melamine formaldehyde resins are used and composites with enhanced mechanical properties can be produced. It is known that melamine formaldehyde resins form a strong composite structure with cellulosic reinforcements. The mechanical properties of the obtained composites, low density, and economical provide many advantages [4].

It has been determined that hard and transparent nylon fibers improve the mechanical properties of composites in melamine formaldehyde resin [5]. Besides, it has been observed that silver nanoparticles have an antibacterial effect in melamine formaldehyde [6]. Melamine formaldehyde resins, which are used as outer coating material, are also used in the form of microencapsulation for phase change material [7].

In the literature, it has been determined that melamine urea-formaldehyde resin gives successful results in interfacial polymerization and acts as a buffer against external effects [8]. Also, novalac and amino-based additives are used to ensure the rapid curing of such resins. Thus, both the curing time is reduced and the adhesion strength is increased. In addition, the curing time of phenolic resins is reduced by sodium carbonate supplementation [9]. By adding alginate to melamine formaldehyde resins, both the mechanical and flame retardant properties of the obtained composites are improved [10].

Nanoparticles such as graphene oxide are used for dye adsorption in melamine formaldehyde resin and to produce Fe_3O_4 magnetic composite [11]. Also, natural fibers attract the attention of researchers and are preferred. Natural fibers as reinforcing materials provide a great advantage to composites because they are environmentally friendly, biodegradable, abundant, easily accessible, non-toxic, non-corrosive, renewable, inexpensive, and low-density [12].

Polyvinyl alcohol and melamine formaldehyde resin can be used together in food packaging [13]. Polyvinyl alcohol and melamine formaldehyde resin can be used together in food packaging. It is also preferred to produce these double hollow microspheres. Fibers are also used in the textile industry to increase the functionality of melamine formaldehyde resin [14-16].

In this research, composites based on electro-conductive melamine formaldehyde resins were developed. The conductivity of the melamine formaldehyde composite is increased by using it in a mixture of polyaniline and nickel [17]. In another study, an organic sol-gel process was developed by incorporating fluorescent dyes into melamine formaldehyde resin microspheres. Various organic fluorescent dyes are successfully combined with this process and monodisperse fluorescent melamine formaldehyde microspheres have been prepared [18].

In a research conducted with melamine formaldehyde resin, flame retardant composite foam production is carried out. The thermal stability of the composite obtained by using melamine formaldehyde, foamed polyurethane, and ammonium polyphosphate is improved [19].

Other studies on melamine formaldehyde in the literature are given below.

The mechanical, thermal, and water absorption properties of poly(lactic acid) composites containing sisal fiber treated with melamine formaldehyde have been investigated [20]. Microencapsulation of ammonium polyphosphate with polyvinyl alcohol-melamine-formaldehyde resin and flame retardancy in polypropylene are investigated [21].

Production and characterization of flame retardant nanocapsules with melamine formaldehyde shells for thermal energy storage have been carried out [22]. Production and properties of natural fiber reinforced melamine formaldehyde matrix composites have been investigated [23].

The production and characterization of poly(melamine formaldehyde)/silicon carbide hybrid microencapsulated phase change materials with improved thermal conductivity and light-heat performance are investigated [24].

The effective removal of Congo red dye from aqueous solution and microbial activities have been investigated with polyvinyl alcohol/melamine formaldehyde composite adsorbent films [25]. The effects of melamine formaldehyde resin on hybrid thermosets from polyisocyanate/water glass/emulsifier systems are discussed [26].

The preparation and properties of poly(vinyl alcohol) hydrogel-melamine formaldehyde foam composite have been determined [27]. The curing kinetics of melamine formaldehyde resin/clay/cellulose nanocomposites have been evaluated [28].

High performance capacitors based on polypyrrole/melamine formaldehyde resin derivative carbon material are produced [29]. The behavior of freeze-dried and thermally cured melamine formaldehyde resins at different molar ratios has been investigated [30].

The structure and properties of melamine formaldehyde-containing cellulose nanocomposite films are discussed [31]. Self-crosslinked melamine formaldehyde and pectin-aerogel composites with excellent water resistance and flame retardancy are obtained [32].

Nanosilica-based melamine formaldehyde/nano zeolite composites obtain from rice husk are prepared and their adsorption capacity has been determined [33]. The electrical and mechanical properties of shungite reinforced melamine formaldehyde-based laminates have been investigated [34].

Epoxy component poly(melamine formaldehyde) microcapsules are synthesized and their properties have been characterized [35]. The production of wood polymer nanocomposite impregnated with melamine formaldehyde acrylamide and gum polymer has been carried out [36].

Melamine formaldehyde resin micro and nanocapsules filled with n-dodecane are prepared and characterized. Capsules containing phase change materials have been extensively studied for heat transfer, heat storage, and temperature control applications [37]. Microencapsulated dodecanol in melamine formaldehyde is used as a phase change material by polymerization for thermal energy storage [38].

High performance hydrophobic and porous melamine formaldehyde-based composites have been developed for electromagnetic shielding [39]. The use of ammonium polyphosphate in melamine formaldehyde resin improves the flame retardancy of microencapsulation [40]. A surfactant with high activity is developed as a result of the combination of porous carbon-supported melamine formaldehyde resin and Fe/N/C catalyst [41].

Prepolymers are dissolved in melamine formaldehyde resin to produce flame retardant fibers [42]. In a study on the kinetic behavior of melamine formaldehyde resins, the effects of curing temperature and catalyst amount have been investigated [43].

Composite material is produced from melamine formaldehyde and polyvinyl alcohol and characterization processes are carried out [44]. Successful results are obtained by calcining the coral-like carbon structures, zeolite, and melamine formaldehyde complex at 750 °C [45]. In another study, the effects of production variables on the surface quality and distribution of melamine formaldehyde resin in paper laminates are studied [46].

The mechanical properties and pore structure of the composite produced from melamine formaldehyde resin coated glass microfiber membrane have been determined [47]. Melamine is used together with formaldehyde resin/filler/fiber trio in composite production and characterization processes have been carried out [48]. The physicochemical and mechanical properties of melamine formaldehyde resin microencapsulated phase change material modified with paraffin and methanol have been improved [49]. Also, polyvinyl chloride and melamine formaldehyde resin are used together in the production of composites in drug adsorption [50].

II. RESULTS AND DISCUSSIONS

Composites made of melamine and formaldehyde are preferred in many industries. The physical and chemical properties of these composites are enhanced by the employment of a variety of reinforcing elements. Low-density organic and inorganic industrial wastes are repurposed as reinforcement in melamine formaldehyde-based composites to make them lighter. The composites' hardness is increased by adding inorganic manufacturing wastes. Mineral fillers are additionally favored to enhance the thermophysical characteristics of composites. Numerous modification processes have been used in industrial applications to enhance the physical and chemical properties of such composites. Maximum mechanical strength, non-flammability, surface shape, pore structure, and distribution are considered important properties of composites. The desirable qualities for composites may vary depending on the sector they are used in. For instance, there are important standards in every industry, including the home.

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