

MODIFICATION OF THERMOPLASTIC POLYMERS

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Synopsis: Modification of thermoplastic polymers (polystyrene, vinyl acetate, polyacrylates, polyvinyl chlorides) by introduction of oxygen or oxygen containing gas (air) into monomer polymerization zone and heating of the peroxycorresponding polymer which is being formed to 110-180 °C. The ways of utilization of modified polymers to produce electric insulating, thermo insulating and soundproof materials, construction, corrosion protective, fiberglass plastic and impregnation materials; radiation protective materials, corrosion-proof products and antiseptic, anaesthetic preparations are offered.

INTRODUCTION

Polymeric materials are widely used in different branches of industry and everyday life. Intensive development of industry requires polymeric materials with different physical and chemical properties. Such material can be developed by synthesizing new polymers or by modifying already known polymers [1-3]. Modification of the known polymers is a more economical and perspective method than synthesis of new polymers since it does not require raw materials to develop them. With respect to heating the well-known polymers are divided into thermoplastic and thermo reactive [4,5]. Both types of polymers have their advantages and shortcomings. Thermoplastic polymers are mainly cheaper than thermo reactive. But they have lower heat resistance than thermo reactive polymers. Low cost of polymers and high thermal stability enables to replace now used thermo reactive polymers by modified thermoplastic polymers. This also reduces the cost of the manufactured products and in many cases the quality of the products is improved. Thermoplastic polymers can be transformed to thermo reactive polymers by introduction active centers or groups into the polymer, they destruct at high temperature and form cross-linking of polymeric chains as in thermo reactive polymers [6,7]. Such transformation is carried out by introduction of peroxide compounds into the polymer by copolymerization with peroxide oligomers or monomers. Such modification of polymers is expensive and explosive since the synthesis of the

peroxide groups requires additional material, energy costs and observation of the requirements to the synthesis of explosive materials.

Another shortcoming of this method is increase of modified polymers embrittlement in the process of heating at the expense of polymeric chains hard cross-linking.

DISCUSSIONS

This paper offers a cheaper and less explosive method of modifying polymers, this method enables to develop heat resistant polymers having small embrittlement. The method [8] is realized by introduction of oxygen or oxygen containing gas (air) into polymerization zone. Then oligomer radicals join oxygen molecules and form polymeric chains containing peroxide groups. Polymerization process takes place under the temperature below 90-110 ° C. Higher temperature (above 110 ° C) leads to destruction of peroxide groups and formation of oxioligomer radicals which further take part in the polymerization process. This results in low molecular polymer chains, structural changes in polymer forms and weakening of its physical and chemical properties. Hence, oxygen in monomer polymerization zone is considered to be undesirable.

Depending on the product produced by changing the process of oxygen introduction during monomer polymerization high or low molecular compounds containing different numbers of peroxide groups in their chains can be obtained. Oxygen may be introduced into polymerization zone both, at the initiating of

small oligomer chains (after short period of polymerization) and during the formation of higher molecular oligomers (at later stage of polymerization). The number of peroxide groups in the polymer being modified can be regulated by changing speed and duration of oxygen introduction. When being used, the modified polymer must be heated at the temperature of 100-180 ° C. In the process of thermal treatment it loses viscosity or gains elasticity depending on the condition of the initial modified polymer. This is accompanied by decomposition of peroxide groups and by formation of oxyoligomer radicals which possess high chemical activity. They easily interact or transfer radicals into polymer chains, thus leading to cross-linking of polymeric chains, changes in supermolecular structures of polymer and formation of set layer. In the process of the polymer hardening its embrittlement increases a little as oligomer oxyradicals being formed change supermolecular structure of polymers without causing high tension in them. Polymer modified in such a way can be used to develop new polymeric materials or different products. Field of application of polystyrene, vinyl acetate, polyacrylates, polyvinylchloride, polyvinyl alcohol widens considerably. This method can be used to modify polymers developed in the process of radical polymerization of monomer in mass or in solution.

Polymers modified by this method can be used in different fields, possible ways of their application are given below.

Possible ways of application of modified polymers

Electrical insulating materials

As it is known polystyrene is one of the most spread and cheap polymers with high dielectric properties which enables it to be used as electric insulating material [9]. However, application of polystyrene based electric insulating materials is limited as polystyrene has low heat resistance and poor adhesion. Modifying polystyrene by the offered method it is possible to change its properties considerably by converting it to thermo reactive polymer which has high heat resistance and higher adhesive properties. This enables to develop new cheap and high quality electric insulating materials on the base of modified polystyrene (lacquers, compounds), electrical appliances materials for electrical equipment, which can have high Comparative Tracking Index (CTI) of Electrical Insulating Materials. Utilization of such materials only as electric insulating lacquers to coat electric wires enables to use thinner wiring in electric motors, thus reducing their weight, cost and quality respectively.

Corrosion protective materials

Modified polymers can also be used as corrosion protective materials by coating equipment, machines, reservoirs, copper plating, copper monuments and other surfaces. Modified polymers can be applied to different surfaces in the form of lacquers, low molecular polymers or heated viscous solutions of polymers. The first two types of polymers are applied on the surface by usual

methods (by a sprayer, etc.), the surface is dried and heated by a portable heater (electric or gas) to the temperature of 110-180 ° C to form glassy solid surface. Heated viscous solutions of modified polymers are applied by means of stationary or portable screw electric appliances. Thus, protective coatings can be applied on different surfaces on the base of polyvinyl acetate, polystyrene, polymethylmethacrylate, polyvinylchloride and other polymers.

Radiation protection materials

Modified polymers can be used to produce different radiation protection means: clothes, containers, storages, devices casing. These materials can be produced by applying modified polymer on metal foil (aluminium or copper) when making clothes or by applying on thin metal sheets (aluminium or other materials) when manufacturing other protection means (containers, storages and etc.).

Manufacturing of corrosion resistant products

Modified polymers can also be used to manufacture different products, in particular, to manufacture parts for equipment and machines, building materials. Such products can be obtained by pouring heated modified polymer into different moulds. To obtain products with specific properties these polymers can be mixed with different fillers beforehand. In particular, to obtain current conducting products mixed with graphite or metal powders; to obtain harder products polymers can be mixed with granite fine powder, asbestos, titanium

dioxide or with other fillers. Besides, to obtain new polymer materials possessing specific properties polymer mixtures comprising different modified polymers can be used when manufacturing different products: polymethylmethacrylate – polystyrene, polymethylmethacrylate – polyvinyl acetate, polystyrene – polyvinyl acetate.

Manufacturing of glass fibre plastics and impregnating materials

Modified polymers can also be used to obtain glass fibre plastics or other impregnating materials out of cheap polymers (polyvinyl acetate, polystyrene and acryl polymers). Then, the quality of the products improves and their cost reduces as expensive polymer materials (polyether, epoxy and other) are substituted by cheap modified polymers. The quality of the products is improved owing to chemical bond of impregnating material and oxide radical which is formed during modified polymer heating during decomposition of peroxide containing polymer chains.

At present glass plastics and impregnating materials on the basis of these thermoplastic polymers are not practically manufactured since such polymers do not possess the required qualities. Only polymers modified by means of the offered method can be used to obtain glass fibre plastics and impregnating materials as they are transformed to thermo reactive polymers. Such products can be manufactured by two methods: to apply heated modified polymer on

impregnating material or to heat impregnating material together with modified polymer to the required temperature.

Manufacturing of structural materials

Polystyrene is a structural material for the products which are not subjected to large mechanic loads as it possesses small mechanical strength (brittleness) and it shows a tendency to ageing. Modified polystyrene can be used to manufacture more durable structural materials by heating modified polymer to 110 – 180 ° C and by filling appropriate moulds of structural products with it. To introduce melted polymer a screw heater can be used or simple filling. In certain time depending on modified polymer polystyrene will be polymerized and hard cross-links will be formed. Different fillers (powdery, net, fabric, reinforced) may be used during structural materials manufacturing, the fillers combine well with the polymer by means of the formed oligomer oxyradicals and thus they increase the products mechanical strength.

Manufacturing of thermal insulating and sound – insulating materials

To manufacture such materials modified polystyrene or other thermoplastic material (polyvinyl acetate, etc.) can be used. Modified polymer is mixed with low boiling substance (isopentane or its fraction), is poured into a hollow autoclave and heated to 180 ° C. Then the pressure is released and the foaming polymer fills completely the hollow autoclave of the set shape. In certain time, depending on the modified polymer, the autoclave must be opened

and porous polymer is taken out. Thermal and sound insulating materials will have higher mechanical strength than polystyrene manufactured in usual method, as foaming material will have cross cross-links between polymer chains formed by oligomer oxide materials.

Manufacturing of antiseptic and anaesthetic preparations and materials

Polymers on the basis of esters of acrylic acids (polybutylmethacrylate) and polyvinylacetate can be used as raw material to manufacture such preparations and materials. To obtain the above said materials and preparations modified polymer is gradually heated to 110 – 180 ° C, powdery antiseptic, analsthetic remedies are added or iodine vapours are passed through polymer. Antiseptic and anaesthetic substance or each taken separately is introduced into polymer. During the modified polymer heating oligomer oxyradicals interact with added substances and form oligomer chains containing antiseptic and anaesthetic substances. These modified polymers can be used as base for manufacturing different antiseptic and anaesthetic preparations in the form of ointments, aerosols or to manufacture special antiseptic and anaesthetic materials: plasters, packs, bandages. When the above preparations or materials contact with injured surface (wound) antiseptic and anaesthetic substances can penetrate into a wound, disinfect it and soothe pain. Then, the injured place is covered with polymer pellicle which prevents foreign substances and microbes

from getting into the wound. Besides, the anaesthetic preparations produced by means of this method do not allow local anaesthetics remedies to penetrate into blood, most of them have narcotic properties, thus preventing their influence on human organism.

CONCLUSIONS

Modification of thermoplastic polymers by introduction of oxygen or oxygen containing gas (air) into monomer polymerization zone and heating of the peroxycarrying polymer which is being formed enables to extend utilization of the most spread polymers and to obtain different polymer products, which has some advantages in comparison with existing products.

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