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(54) Title: WATER SOLUBLE POLYETHYLENE OXIDE FILMS

(57) Abstract

The invention relates to blends of a polyethylene oxide (PEO) resin and a latex emulsion. The blends are formed by mixing or coating a PEO powder resin with a latex emulsion and melt blending the powder. The blends have improved processibility and toughness which are beneficial in the manufacture of PEO–based films and fibers. The films composed of the PEO/latex blend have improved toughness, breathability, and tear resistance and are useful for the manufacture of disposable, flushable medical and personal care products, such as diapers, tampons, feminine napkins, and bladder control pads.

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WATER SOLUBLE POLYETHYLENE OXIDE FILMS

FIELD OF THE INVENTION

The present invention relates generally to polymeric films, processes for their manufacture, and their use in flushable medical and personal care products. More specifically, the invention relates to the modification and processing of polyethylene oxide (PEO) resins to make films for the production of such flushable products which have the advantages of improved toughness, softness, and tear resistance.

BACKGROUND OF THE INVENTION

Disposable personal care products, such as panti-liners, diapers, and tampons, are a great convenience, as are disposable medical care products, such as drapes, gowns, head coverings, and face masks. These products provide the benefit and convenience of one time, sanitary use. However, disposal of many of these products is a concern due to limited landfill space. Incineration of such products is not desirable because of increasing concerns about air quality and because of the costs and difficulty associated with separating these products from other disposed articles that cannot be incinerated. Consequently, there is a need for disposable products which may be quickly and conveniently disposed of without dumping or incineration.

It has been proposed to dispose of such products in municipal and private sewage systems. Ideally, the products would be degradable in conventional sewage systems. Products suited for disposal in sewage systems which can be flushed down conventional toilets and are dispersed or disintegrated in water are termed "flushable." Disposal in this manner is simple, convenient, and sanitary.

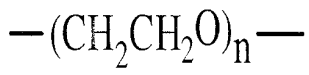
Personal care and medical care products must have sufficient strength to maintain integrity under the environmental conditions in which they will be used. They must also be able to withstand the elevated

temperature and humidity conditions encountered during use and storage and still lose integrity upon contact with water in the toilet. Therefore, a water-disintegrable material which is capable of thermal processing into a thin film having mechanical integrity is desirable.

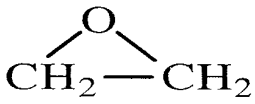
Currently, thin films are typically made from water-insoluble polymers or polymer blends. Frequently used polymers include amorphous polymers, epoxy resins, and semicrystalline polymers. Examples of amorphous polymers are polystyrene (PS), styrene-acrylonitrile copolymers, polycarbonate, and poly(vinyl chloride) (PVC). Examples of semicrystalline polymers are polyethylene (PE), polyamide (PA), polybutadiene (PB), and polypropylene (PP). The most commonly used polymers are polypropylene, and polyethylene.

The thin films composed of these polymers are formed by extrusion casting or melt blowing processes. Conventional film extrusion involves mixing commercially available pellets of the desired polymers at increased temperatures, followed by extruding the mixture in a single screw extruder through a slit die to form a film. The film is then cooled by passing it through a series of chilled rolls. Films made in this manner from such water-insoluble polymers are unsuitable for use in "flushable" personal care and medical care products because they do not possess the desired characteristics, e.g., they will not degrade in conventional sewage systems and consequently form blockage in the sewer lines.

Polyethylene oxide (hereinafter PEO) is a hydrophilic, water-soluble polymer,



that is produced from the ring opening polymerization of ethylene oxide,



It is available in widely varying molecular weights in the form of a powder from a number of sources, for example, Union Carbide Corp. (Danbury, CT) PEO is currently used as a flocculant to enhance the deposition of colloidal particles onto wood pulp fiber in the paper-making process. It is also used as an additive to modify such properties as the aggregation state, sedimentation behavior, and rheology of polymers employed as paints and

adhesives. PEO is also used to modify and stabilize polymer lattices, for example, by grafting PEO chains to a polystyrene lattice.

Due to its unique interaction with water and body fluids, the present inventors are considering it as a component material for flushable and personal care products. However, currently available PEO resins are not practical for the formation of thin films by melt extrusion or for personal care product applications for a number of reasons.

For example, while low molecular weight PEO resins have desirable melt viscosity and melt pressure properties for extrusion processing, they have low melt strength and low melt elasticity which limit their ability to be drawn into films having a thickness of less than about 2 mil. Films produced from low molecular weight PEO also have low tensile strength, low ductility, and are too brittle for commercial use.

High molecular weight PEO resins, on the other hand, should produce films having improved mechanical properties compared to those produced from low molecular weight PEO. High molecular weight PEO, however, has poor processibility and poor melt drawability due to its high melt viscosity. Melt pressure and melt temperature must be significantly elevated during melt extrusion of high molecular weight PEO, resulting in PEO degradation and severe melt fracture. Therefore, only very thick films of about 7 mil or greater in thickness can be made from high molecular weight PEO. Films this thick are not practical for flushable applications.

Attempts to melt extrude PEO often result in severe degradation of the PEO. Even when a film can be formed, the PEO undergoes morphological changes such as crystallization and aging, when it is cooled from the melt and exposed to the ambient environment. These changes affect the mechanical properties of the film, resulting in a film that is weak and brittle, having very low elongation-at-break and tear resistance, and, thus, not suitable for the production of personal care products. What is needed in the art, therefore, is a means to overcome the difficulties in melt processing of PEO resins and to improve the resultant ductility and toughness of the thin films formed therefrom.

It is known in the art to modify water-insoluble polymer resins, such as polystyrene and polypropylene, by incorporating soft rubber particles into the polymeric structure to improve the toughness of the polymer, to reduce its modulus, and to improve the softness and flexibility of the resulting material. The modifier can be a rubber-like elastomer, a core-shell modifier, or another polymer, such as styrene

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