The Durability of Polypropylene Nonwoven Geotextiles for Waste Containment (Landfill) Applications

INTRODUCTION

By virtue of its chemical composition, molecular structure, and thermodynamic properties, polypropylene is one of the most resistant organic raw materials known today. This is one of the reasons that over 80 percent of all geosynthetics are made from the polypropylene (Schneider 1989).

Polypropylene is a very durable polymer commonly used in aggressive environments including automotive battery casings, fuel containers and the like. Because of its excellent resistance to harmful chemical environments, the use of polypropylene to manufacture nonwoven geotextiles for waste containment systems is a beneficial use of this versatile polyolefin. Presently, nonwoven polypropylene geotextiles are used in more than 80% of all waste containment applications.

METHODS OF DEGRADATION

Chemical degradation of geotextiles is a result of environmental and polymer compositional factors. Regarding environmental factors, one can expect the greatest amount of degradation to occur, in general; (1) at relatively high temperatures (i.e. >100C), (2) in soils which are chemically active; (3) and when the geosynthetic is under stress. Key chemical degradation mechanisms that can be found in some soil and waste environments include oxidation, hydrolysis, and environmental stress cracking.

An oxidation reaction can either be initiated by ultraviolet radiation or thermal energy, but must have sufficient oxygen present. Since the geosynthetic will be buried in most applications, thermally activated oxidation is of most interest. Polypropylene oxidation is the reaction of free radicals within polymer with oxygen, resulting in breakdown and/or degradation of the molecular chains and embrittlement of the polymer.

TOXICOLOGY

Polypropylene is biologically inert and used for packaging food intended for human consumption. To ensure that the processing performed does not alter these characteristics, skin and mucous laboratory tests have shown that polypropylene does not cause irritating affects. Furthermore, polypropylene is considered to be without significant oral toxicity.

MOISTURE

Polypropylene is a paraffinic hydrocarbon and does not adsorb water like the polyamides polyester (PET) or nylon. The moisture gain of polypropylene fibers is insignificant and water has no affect on tensile strength and other mechanical properties. Therefore, water alone does not cause any noticeable degradation in polypropylene fibers. Fibers subjected to boiling water or steam for long periods show no loss of strength (Cook, 1984).

ULTRAVIOLET RESISTANCE (Sunlight)

Polypropylene is attacked by atmospheric oxygen and the reaction is stimulated by sunlight. Polypropylene fibers will deteriorate on exposure to light, but may be effectively protected by stabilizers (Cook, 1984). Without site-specific environmental conditions, we recommend a maximum exposure period of 1 day between laydown and cover of geotextile.

TEMPERATURE STABILITY

High Temperatures

The mechanical properties of the fibers deteriorate as temperature increases. The softening point of polypropylene fibers is approximately 150°C , and the fibers "melt" at 165 °C

Low Temperature

The low temperature flexibility of polypropylene is excellent for most applications. Polypropylene geotextiles retain normal flexibility from –40C to 150C. Below –40°C, polypropylene can become inflexible and not suitable for all applications.

BIOLOGICAL RESISTANCE

Insects

Polypropylene cannot be digested by insect and related pests, such as white ants, dermestid beetles, silverfish, and moth larvae. Polypropylene fiber is not liable to attack unless it becomes a barrier beyond which the insect much pass to reach an objective. In this case, the insect may cut through the fiber without ingesting it. Furthermore, polypropylene does not attract nor is it a food source for insects or rodents. As stated earlier, much like humans, it is believed that rodents would not be adversely affected by ingesting small quantities of polypropylene.

Micro-Organisms

Polypropylene fibers will not support the growth of mildew or fungi. Some micro-organisms, however, may even grow on the very small amount of contaminants which may develop on the surface of fibers or yarns in use. Such growth has no effect on the strength of any materials made from polypropylene fiber. Similarly, polypropylene is an inert resin which does not support or attract fungal growths and does not deteriorate due to fungal presence (Cox, 1994).

CHEMICAL RESISTANCE

Polypropylene is inert to a wide range of chemicals. Its resistance and susceptibilities are similar to those of polyethylene, but its higher crystallinity tends to make it more resistant that polyethylene to those chemicals which degrade polyolefin fibers. Extensive information on the chemical resistance of polypropylene shows that it is very resistant to acids and alkalies at room temperatures (Ahmed, 1994).

However, polypropylene is vulnerable to the following substances: highly oxidizing substances (peroxide), concentrated nitric acid (>40%), concentrated sulphuric acid, chlorosulphonate acid, pure halogen, certain chlorinated hydrocarbons (halogenated hydrocarbons), and certain aromatic hydrocarbons (Schneider, 1989).

Lifetime Prediction When properly stabilized and buried, nonwoven polypropylene geotextiles have been expected to last for up to 100 years.

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