RESISTANCE OF THERMOPLASTIC PIPING MATERIALS TO MICRO- AND MACRO- BIOLOGICAL ATTACK

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Plastics Pipe Institute
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Foreword

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The purpose of this technical report is to provide information available to PPI on resistance of thermoplastic piping materials to micro- and macro- biological attack. This report has been prepared by PPI as a service to the industry. The information in this report is offered in good faith and believed to be accurate at the time of its preparation, but it is offered "as is" without any express or implied warranty, including WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE. Any reference to or testing of a particular proprietary product should not be construed as an endorsement by PPI, which does not endorse the proprietary products or processes of any manufacturer.

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RESISTANCE OF THERMOPLASTIC PIPING MATERIALS TO MICRO- AND MACRO- BIOLOGICAL ATTACK

1.0 INTRODUCTION

The micro- and macro-biological degradation of organic materials has been of great concern the world over. Fungus was found to be a severe problem during World War II, particularly in tropical and subtropical climates where fabrics deteriorated rapidly and electrical equipment malfunctioned. Similarly, malfunction of marine communication cables due to attack of living organisms on outer cable materials has been a continuing problem. Rodents have caused damage to underground power and communication cable. Termites have been responsible for damage to structural organic materials in most climates and soils.

This report provides available information regarding the resistance of thermoplastic piping materials to micro- and macro- degradation. Summary information follows on resistance of thermoplastic pipe to fungi, bacteria, termites, and rodents. A considerable number of papers directly and indirectly related to plastic pipe have been screened. References that have pertinent data are presented in a list at the end of this report and are grouped according to their relative significance.

2.0 POSSIBLE DEGRADATION FACTORS

2.1. Fungi

The term fungi refers to a family of heterotrophic spore producing organisms including yeasts, molds, mildews, mushrooms, etc. They derive their energy from many different kinds of organic materials and some inorganic materials, generally through a mass of microtubules called hyphae. Some organic materials, such as carbohydrates, are a particularly good nutrient for fungi. Many fungi thrive in a warm, humid environment and play an important role in the decay of most organic materials by secreting chemicals that can break down large, naturally occurring organic molecules into smaller pieces. They are most abundant in, but by no means limited to, tropical areas and are also frequently present in moist soil everywhere in the world.

As a result of extensive loss of military equipment due to fungi in tropical areas during World War II, considerable studies were made on the relations between plastics compounds and the effects of fungi (1, 2, 3, 4, 5). From the literature surveyed, it is apparent that the growth of fungi on plastics is not due to the nutrient value of the polymer or resin component but rather to lower molecular weight additives such as lubricants, stabilizers, and plasticizers that more closely resemble natural food sources from a chemical perspective. Even in the case of highly plasticized (flexible) vinyl chloride plastics, however, attack by fungi is avoided if proper attention is paid to the selection of plasticizer and other additives (1, 2, 5).

Thermoplastic materials used for the manufacture of pipe contain little non-polymeric material and the polymers themselves have a high degree of resistance to attack by fungi because of the lack of nutrients in their formulations and their compositions not being susceptible to most fungal secretions. Despite this lack of nutrient availability, fungi may settle and grow upon pipe surfaces as a substrate, feeding upon other nutrients in the environment. Such growths are commonly observed on brick, concrete, and even glass, which provides no nutrient value and serve merely as a physical support for the life cycle. Such surfaces are generally not attacked or suffer only slight surface etching while the bulk of the material remains unaffected.

2.2. Bacteria

Bacteria inhabit every environment on earth, from dry soil to surface water to deep oceanic vents, to arctic ice, to the surface of the human body. Bacteria can live using a large variety of different means and use many different food sources depending on species. Some bacteria are capable of synthesizing food from sunlight, similar to plants, using water and carbon dioxide. They can perform chemical fixation using dissolved nutrients while attached to a suitable substrate or live through consuming the substrate on which they grow in a process similar to fungi. However, laboratory tests show that the situation between plastics and bacteria is the same as that with plastics and fungi, i.e., no nutrients are present in the plastic pipe compositions, and they are generally resistant to attack (1, 2, 3, 6, 7, 8).

2.3. Termites

Termites are found in many areas of the world and are known to cause extensive damage to wood and other building materials. Termites generally consume cellulosic materials for food, especially wood and leaf litter. In tests of the susceptibility of plastic pipe to termites and other insects, it was shown there was little interest in termites attacking pipe samples. This included experiments in which pipes were buried in termite infested soil and periodically dug up and examined. In one test, the area contained decayed pine logs infested with termites.

Pine strips were placed between the polyethylene pipe samples to serve as bait. The soil was covered with logs which contained termites. At the end of eighteen months, the pipe was uncovered. There was no attack by termites, fungi, insects, or any other biological agent, and the pipe was in excellent condition. The pieces of pinewood that were buried with the pipe were infested with termites and heavily decayed by fungi. In another test, PVC pipe samples were exposed to termites for five years without attack on the pipe. Termite attack has been reported on plastic film and wire and cable insulation in Europe, Africa, China, and Australia (9, 10, 12) where the particular species of termites seem especially destructive. In one report (9), it was found that termites chewed on plastic, even though they could not use it as food. It is believed that in some cases "worker" termites burrow through soil and anything else their jaws can handle in search of food.

2.4. Rodents

Rodents include a large variety of small to medium-sized mammals that are characterized by having a pair of continuously growing front teeth. Rodents can be primarily burrowing, live solely on the ground surface, or in trees, e.g., mice, rats, squirrels, gophers, beavers, etc. They use their front teeth for a large variety of activities, including eating, burrowing, and defense. Because their teeth grow continuously, rodents have a strong tendency to gnaw anything they come across and must continuously gnaw on harder materials to wear down their teeth. Rodent gnawing activities can include piping materials when they are in the rodent's habitat.

All materials except the hardest metals, concrete, and stone, are susceptible to damage from being gnawed by rodents. There are instances where plastic pipe has been damaged by rodents. Primarily, this is seen when gophers or similar burrowing rodents gnaw through conduit and cables buried in their territory. Cases are of such a random nature that it appears that rodents are neither attracted to, nor repelled by, thermoplastic pipe but simply gnaw it habitually, or because it gets in the way of their burrows. The period when the pipe is newly installed and the soil is loose around the pipe makes an attractive burrowing area for rodents. Pipe in sizes larger than two inches in diameter do not appear to be affected simply because it is too large for the teeth to dig into the pipe.

For above ground or in building pipe, there are isolated instances of other rodents, like mice or squirrels, gnawing on pipe or cables. Squirrels are a leading cause of power outages because of their damage to overhead power lines not encased in conduit. Proper installation techniques that avoid putting pipe into area frequented by rodents should minimize this issue.

3.0 SUMMARY

The inert nature of the thermoplastic materials used in pipe does not support micro-biological attack from bacteria or fungi. Pipe surfaces may act as a surface for growth potentially leading to discoloration, without detrimentally affecting the pipe itself. Pipe also does not attract insects or rodents to become the subject of macro-biological attack. There are instances of damage by rodents, insects, and even birds that damage pipe and conduit that are present in their habitat. These are considered to be minor, isolated instances, since the pipe did not attract the attack and provided an additional layer of protection in many cases.

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