Resistance of Thermoplastic Piping Materials to Micro- and Macro- Biological Attack

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Foreword

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The purpose of this technical report is to provide important information available to PPI on resistance of thermoplastic piping materials to micro- and macro-biological attack.

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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 have been of great concern the world over. Fungus was found to be a severe problem during World 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.

The following is an attempt to list the available information regarding resistance of thermoplastic piping materials to micro- and macro- degradation.

A considerable number of papers directly and indirectly related to plastic pipe have been screened. Those references which seemed to have pertinent data are presented in an attached list which are grouped according to their relative significance.

In addition, a brief summary (below) is given on resistance of pipe to fungi, bacteria, termites, and rodents.

2.0 POSSIBLE DEGRADATION FACTORS

2.1 Fungi

The term fungi is used to refer to a family of heterotrophic plant life made up of molds, mildews, mushrooms, etc, They are completely lacking in chlorophyll, so are unable to derive energy from sunlight. Rather, they derive their energy from utilizable organic materials, such as carbohydrates which are a particularly good nutrient for fungi.

Fungi thrive in a warm humid atmosphere and are most abundant in, but by no means limited to, tropical areas. Temperatures of 25-30C and relative humidities of 85% to 100% are most favorable, although certain fungi have been found to exist at much lower temperatures. At relative humidities below the range of 65-70%, fungi will show very little active growth but can survive extended periods of exposure at low humidity.

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. 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 (if any) nonpolymeric material and have a high degree of resistance to attack by fungi because of the lack of nutrients in their compositions. Despite the minimal nutritive value in most plastic pipe materials, fungi may grow upon pipe surfaces, feeding upon such nutrients as fly-ash which may settle on the surface. Such growths are commonly observed on concrete and even glass which, like plastics, may serve merely as a physical support for the life cycle. Such surfaces are generally not attacked or suffer only slight surface etching.

2.2 Bacteria

Bacteria in general require a wetter environment than fungi for active growth. Some forms of bacteria require the presence of oxygen (aerobic) to sustain life while others are anaerobic, i.e., grow only where there is no oxygen. Others exist whether oxygen is present or not. Since bacteria of many forms are encountered in nearly all areas where water is present, it is to be expected that when pipe is installed in wet areas, it will come in contact with one or more forms of bacteria. 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 resistant to attack (1, 2, 3, 6, 7, 8).

2.3 Termites

Termites are found world-wide and are known to cause extensive damage to wood. In tests of the resistance of plastic pipe to termites and other insects, pipe samples have been 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.

There has been termite attack reported on plastic film and wire and cable insulation in Europe, Africa and Australia (9, 10) where the particular species of termites seem especially destructive. In general, plastics used in these applications are softer and often highly plasticized, in contrast to those plastics used in pipe. Furthermore, the larger size of pipe vs. electrical insulation seems to make the pipe more resistant to attack. 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

All materials except the hardest metals, concrete, etc., are susceptible to being gnawed by rodents. There have been instances where plastic pipe has been damaged by rodents (primarily gophers). Most of the incidents have involved the wire and cable industry but still this is considered a minor problem. Cases with pipe are of such a random nature that it appears that rodents are neither attracted to, nor repelled by, thermoplastic pipe but simply gnaw it when it gets in their way or when the rodents are looking for water. 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 inch in diameter do not appear to be affected simply because it is too large for the teeth to dig into the service.

3.0 SUMMARY

Because of the inert nature of the thermoplastic used in pipe, there is no known micro-biological attack that can occur. In the case of insects and rodents, the few known incidents are isolated cases and are not significant in the overall use of thermoplastic pipe.

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