RESISTANCE TO ENVIRONMENTAL STRESS CRACKING

As emphasized in the preceding section, polyethylene resins are highly resistant to most chemicals and solvents in the absence of stresses. However, many polyethylenes may crack when exposed to the same chemical "environment" under polyaxial stress; that is, while being stretched or bent in several directions at once.

NOTE: The LADTECH, Inc. adjustment ring is never exposed to polyaxial stress (bent or stretched) in application. Only static and impacting compressive loads are transferred to the adjustment ring, and this is when the rings are in a contained configuration.

Thus, under unfavorable conditions, various oils or even common household cleaning agents may cause a polyethylene bag, pipe, or bowl to split after a short period of time. Bottles or bags designed to contain detergents, solvents or acids must therefore have a high resistance to "environmental stress cracking."

Failure caused by environmental stress cracking may be attributed to "stored" stresses acquired in the molding or extruding operation. These dormant stresses may release themselves by cracking under the combined influences of both the adverse environment and polyaxial stretching, which may occur in use.

Polyethylene of narrow molecular weight distribution, characteristic of certain types, has slightly less tendency to crack under environmental stress. Polyethylene of melt indexes lower than 1.5 g/10 min. has a high resistance to environmental stress cracking, and polyethylene types of melt index less than 1.0 g/10 min. show excellent stress crack resistance.

NOTE: Remember that the LADTECH, Inc. adjustment rings are manufactured from discarded food, detergent and chemical bottles. This material typically has a melt index of less than 1.0 g/10 min. and was initially chosen because of its high resistance to chemicals and stress cracking.

Such resins are particularly suitable for electrical applications such as cable coating and for packaging applications — bottles and films — where contact under stress with potentially aggressive chemical may occur.

IMPERMEABILITY TO LIQUIDS AND GASES, GREASES AND OILS

Polyethylene is highly resistant to penetration by most substances, whether liquid or gaseous, chemically neutral or reactive. This is a property of prime importance for all kinds of packaging. Because of such a high degree of impermeability, many chemicals can be stored and shipped in polyethylene containers without leak hazards. Easily spoiling foods such as vegetables or meats can be shelved and sold in polyethylene bags without danger of water from the outside getting inside the bags or irreplaceable moisture being lost to the atmosphere. Exchange of gases through the film can also be kept to a minimum. Polyethylene is an ideal material for making pipe to conduct potable water. Polyethylene is also an ideal insulator for submarine cable.

For reasons explained earlier, the more crystalline the polyethylene, the less it is permeable to liquids and gases. Thus, a resin of higher density, and to a much lesser degree, of lower melt index, is more impervious to liquids and gases. Resistance to grease and oil absorption, quite important in many end products, is effectively the same property as impermeability to liquids.

IN SUMMARY

The LADTECH, Inc. adjustment rings are injection molded from high-density polyethylene plastic. This material is referred to as "fractional melt" having a melt index lower than 1.0 g/10 min. This material is predominately reclaimed plastic from bottles initially used to store and transport food, household cleaners, industrial solvents and harsh chemicals. The rings, in application, are not subject to polyaxial stresses.

By virtue of the inherent properties and performance of the manufacturing material, the following statements can be made. "The LADTECH, Inc. adjustment ring is resistant to stress cracking from exposure to chemicals and gases, has a high level of impermeability and is highly resistant to the absorption of grease and oil. When used in the application intended and installed per factory recommendations, the LADTECH, Inc. adjustment ring will provide a long service life with no deterioration from the environment found in most infrastructures."

ENVIRONMENTAL STRESS CRACKING ANALYSIS

Test performed by Chemir/Polytech Laboratories, Inc.
Group Leader, Materials Science Section, G. Fred Willard, Ph.D.

We have completed the analysis of your sample "Test Bars" (Chemir/Polytech #990878) determining stress cracking in accordance with ASTM D 1693 - 97a Standard Test Method for Environmental Stress-Cracking of Ethylene Plastics. The results are summarized below:

ANALYSIS RESULTS

Environmental Stress-Cracking ASTM D 1693 - 97a

No stress cracks were noticed after forty-eight (48) hours of exposure to the reagent lgepal CA-120 and a mild solution of sulfuric acid with a pH of 5 at 50°C. The test was allowed to continue for a total of one hundred sixty eight (168) hours. There were no stress cracks noticed on any of the twenty specimens up to 168 hours.

ANALYSIS DISCUSSION

Environmental Stress-Cracking ASTM D 1693 - 97a

All testing and sample preparation was carried out in accordance with ASTM D 1693 - 97a. This test method covers the determination of the susceptibility of ethylene plastics to environmental stress-cracking when subjected to the conditions herein specified. Under certain conditions of stress and in the presence of environments such as soaps, wetting agents, oils, or detergents, ethylene plastics may exhibit mechanical failure by cracking. Bent specimens of the plastic, each having a controlled imperfection on one surface, are exposed to the action of a surface-active agent. The proportion of the total number of specimens that crack in a given time is observed. Environmental stress-cracking is a property that is highly dependent upon the nature and the level of the stresses applied and on the thermal history of the specimen.

Under the conditions of the test method, high local multiaxial stresses are developed through the introduction of a controlled imperfection. Environmental stress-cracking has been found to occur most readily under such conditions. The specimens were cut in accordance to specifications in section 8.2 and placed inside the specimen holder. The holder was then placed inside two test tubes, one containing lgepal CA 210 and the other containing a mild sulfuric acid solution with a pH of 5. The test tubes were then placed into a control chamber at 50°C for 48 hours. Since no stress-cracking was observed, the test continued for a total of 168 hours. No stress cracks were observed. Ten specimens were tested for each reagent. The results are summarized in the table below.

ASTM D 1693 - 97a Environmental Stress-Cracking

Identification of Material Tested Post consumer recycled high-density polyethylene plastic with less than 1% injection grade polyethylene and polypropylene supplied by LADTECH Inc.

Manner of Preparation of Injection molded test bars.

Test Specimens Reagent and Strength	lgepal CA 210 - 100% Mild sulfuric acid solution < 1%. With pH of 5.
Condition of Test	50.0 ± 0.5 °C.
Duration of Test (Hours)	168 Hours.
Percentage of Specimens that Failed	0
Date of Test	April 28, 1999.

For more information about testing procedures and existing test results, contact LADTECH, Inc. at testing@ladtech.com