==========Electronic Edition==========

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News and resources for environmental justice.

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THE BEST LANDFILL LINER: HDPE.

The very best landfill liners today are made of a tough plastic film called high density polyethylene (HDPE). HDPE has only been in use in this country for this purpose since the early 1980s, so we have little actual experience to go on. However, landfill designers assure us that HDPE resists attack by nearly all chemicals.

Resistance to chemical attack is important because the theory of landfill design says that the landfill liner must maintain its integrity for the duration of the hazard it is supposed to contain. If the garbage in the landfill will remain toxic for thousands of years, the landfill liner must maintain its integrity for thousands of years; if the liner fails before the hazard has gone away, the failed liner will allow the hazard to escape, and we will have simply passed today's problem onto our children and grandchildren.

There are other plastic liners besides HDPE in use today, and we will discuss their characteristics in future issues of RHWN. But HDPE is the liner of choice, if you can afford it, so let's start there.

When we looked up HDPE in a standard reference source (the KIRK-OTHMER ENCYCLOPEDIA OF CHEMICAL TECHNOLOGY, 3rd edition), we learned that HDPE "is not attacked by most inorganic chemicals and is insoluble in most organic solvents at room temperature. In a study of linear polyethylenes, only 14 of 270 chemicals and materials were rated as capable of causing, upon prolonged exposure at room temperature, softening, embrittlement, or a significant loss of strength." The study cited by KIRK-OTHMER was conducted by the Phillips Petroleum Company in Bartlesville, OK, so we phoned Phillips to learn more.

Phillips has been in the plastic business for 30 years, and they are proud of their HDPE product. They sent us a very informative booklet describing the chemical properties of HDPE. The booklet described the use of HDPE for packaging. Thus the information is very relevent, because that's what a landfill liner is: a huge plastic baggie for packaging wastes; like a plastic bottle or drum, a landfill liner is intended to contain wastes, to

prevent them from escaping. The booklet gave us confidence that Phillips has done its homework, but it did not give us confidence in HDPE as a landfill liner.

According to Phillips, there are many household chemicals that will degrade HDPE, permeating it (passing through it), making it lose its strength, softening it, or making it become brittle and crack. If you've ever held a thick (100 mil, or 1/10 of an inch) piece of HDPE landfill liner in your hand, you know it's about as stiff as a linoleum tile. If chemicals make it even stiffer and it cracks under the massive weight of the garbage heaped above it, that's all she wrote for the safety of the local environment.

In addition to many individual chemicals (mentioned below), Phillips lists two major classes of chemicals that are not compatible with HDPE: aromatic hydrocarbons, and halogenated hydrocarbons. The basic aromatic hydrocarbon is benzene (a major component of gasoline); others are toluene (also called methylbenzene), and the three xylenes (o-, m-and p-xylene). Others include naphthalene (moth balls), and pdichlorobenzene (also moth balls). These aromatic hydrocarbons "permeate excessively and cause package deformation," says Phillips.

Another class of compounds incompatible with HDPE is halogenated hydrocarbons. The most familiar names here are carbon tetrachloride, chloroform, DDT, aldrin, dieldrin, lindane, 2,4-D, 2,4,5-T, trichloroethylene, trichloroethane, perchloroethylene, and so forth. The full list is very long and growing all the time as chemists find new ways to attach chlorine, fluorine, bromine and iodine atoms to carbon and hydrogen.

The Phillips booklet lists many individual household chemicals as incompatible with HDPE.

Appendix I of the Phillips booklet lists the following chemicals under the heading "can cause stress cracks" in HDPE:

Acids: acetic acid (1% to 10% solution); aqua regia.

Foods & food products: cider, lard, margarine, vinegar, vanilla extract.

Household toiletries and pharmaceutical products: detergents (standard); detergents (heavy duty); dry cleaners; hair oil; hair shampoo; hair wave lotions; hand creams; iodine (tincture) ("embrittlement may occur after prolonged exposure"); lighter fluid; nail polish; shaving lotion; shoe polish (liquid); shoe polish (paste); soap; wax (liquid and paste); amyl alcohol 100%; carbon tetrachloride; chlorobenzene ("softening and part deformation will occur"); chloroform ("softening and part deformation will occur"); cyclohexanol; ethyl alcohol (also known as booze); methyl alcohol (a component of shellac); propyl alcohol.

Oils: castor; mineral; peppermint; vegetable; pine.

Industrial chemicals: amyl alcohol 100%; chlorobenzene; chloroform; cyclohexanol; ethyl alcohol; methyl alcohol; propyl alcohol.

So much for stress cracks. What about common chemicals that can permeate through HDPE? Phillips says "permeation is considered a physical migration of a product through the container walls." Chemicals that will permeate a plastic film will often also physically damage it. Appendix I of the Philips booklet lists the following chemicals (giving the permeation in parentheses):

Household toiletries and pharmaceutical products: lighter fluid ("high"); nail polish ("4% loss per year"); shoe polish (liquid) ("high"); turpentine ("8.5% loss per year").

Industrial chemicals: acetone ("3.4% loss per year"); amyl acetate ("4% loss per year"); amyl chloride ("high"); benzene ("high"); carbon tetrachloride ("80% loss per year"); chlorobenzene ("high; softening and part deformation will occur"); chloroform ("high"); ethylene chloride ("high; softening and part deformation will occur"); gasoline ("high"); toluene ("high; softening, swelling, and part deformation will occur"); trichloroethylene ("high; softening, swelling, and part deformation will occur").

Oils: orange ("high"); peppermint ("high"); pine ("high").

So much for chemicals that pass through HDPE, weakening it as they go.

Appendix II of the Phillips booklet lists the following chemicals as "unsatisfactory" or causing "some attack" on HDPE at room temperature: bromine liquid; butyl acetate; chlorine liquid; chlorosulfonic acid 100%; cyclohexanone; ethyl chloride; methyl ethyl ketone; methyl bromide; methylene chloride 100%; nitrobenzene 100%; oleum concentrated; petroleum ether; tetralin; tetrahydrofuran; xylene.

So long as your municipality's garbage contains none of the items listed above (assuming the information from Phillips is complete), HDPE will perhaps do a good job for you. However, if your garbage is free of these items, you're probably from another planet anyway and therefore you won't need to rely on America's best available landfill liners for solving your resource management problems.

Get MARLEX POLYETHYLENE TIB 2 PACKAGING PROPERTIES free from: Mrs. Frances L. Campbell, Plastics Technical Center, Plastics Division, Phillips 66 Company, Bartlesville, OK 74004. Phone (918) 661-6600. Additional technical information available from: Phillips 66 Company, P.O. Box 792, Pasadena, TX 77501; phone 1-800-231-1212.
--Peter Montague, Ph.D.

Descriptor terms: hdpe; high density polyethylene; landfilling; landfill liners; failure mechanisms; leaks; toluene; methylbenzene; carbon tetrachloride; chloroform; ddt; aldrin; dieldrin; halogenated hydrocarbons;