

Phthalates as Endocrine Disrupters

There is some concern about the environmental and physiological affects of some chemicals related to plastics. These chemicals have been shown to have potential affects on the human endocrine system, either by interfering with normal functions or by mocking the human hormone. These chemicals include plasticizers and certain components or monomers, the building blocks, of some plastics including polystyrene and polycarbonate. This document is the official position of NNI, based on current science and input from the industry and the resin manufacturers.

Based on industry research and correspondence with our specific suppliers, Nalge Nunc International (NNI) considers our plastic products to be safe for use with human consumables, if molded from food grade resins and used properly. NNI does not consider any of the food grade resins, or molded products, a significant threat to human health due to endocrine disruptors potentially extracted from these plastics. NNI catalogs for NALGENE® and Nunc™; brand products contain details about the various plastic products, resins and applications.

Background:

An issue of the 1990's has become the hypothesis that there are chemicals in the environment that can have an adverse effect on human health because of the chemicals ability to interact with the human endocrine system. This issue includes chemicals that may be present in plastics. These chemicals are described using several terms; most are interchangeable, including:

- Hormone disrupting chemicals
- Endocrine disrupting chemicals or endocrine disruptors
- Environmental estrogens
- Estrogen mimics
- Endocrine modulators

For the purposes of this document, the term "endocrine disruptors" will be used.

This issue recently generated public attention in Japan when the Kyodo news service, on April 25, 1998, and CNI news service, on April 27, 1998, carried a report that certain compounds in polystyrene bowls could contaminate food and have adverse effects on the human endocrine system. An article issued on July 5, 1998 in the Korea Herald contained claims from a Professor Kim Man-ku of Kangwon University Research Institute that nursing bottles and instant-noodle packaging contained some hormone disrupting chemicals in recent testing. This is clearly a global issue.

The types of chemicals that can be considered as potential endocrine disruptors can be divided into several groups, as follows:

1. Organochlorine pesticides, including DDT, Lindane and atrazine
2. Polychlorinated biphenyls (PCBs) and dioxins
3. Alkylphenols, including industrial detergents such as Triton X-100
4. Plastic related chemicals
 1. Phthalates, widely used as plasticizers
 2. Bisphenol A, the monomer (or building block) of polycarbonate
 3. Styrene dimers and trimers, these are very short chain combinations of two or three styrene monomers
5. Other chemicals, including some heavy metals, phytoestrogens of plant origin, butylated hydroxyanisole (BHA) an antioxidant used in foods.

In order for these chemicals to pose a threat to human health from NNI products, they must be:

- present in the plastic
- available for extraction which means on the surface of the plastic part in contact with a fluid
- soluble in the fluids they come in contact with

Details:

Each group of chemicals will be addressed:

1. Organochlorine pesticides are not present in, or used in contact with, NNI plastic products.
2. Polychlorinated biphenyls (PCBs) and dioxins are not present in NNI plastic products.
3. Alkylphenols, including industrial detergents such as Triton X-100 are not present in, or used in contact with, NNI plastic products.
4. Plastic related chemicals
 1. Phthalates, widely used as plasticizers
Phthalate plasticizers are only used in products molded with Polyvinyl Chloride (PVC) resin/compounds including PVC tubing and bottles. Non-plasticized tubing such as silicone or polyurethane (PUR) can be substituted for PVC tubing, if the phthalate content of the PVC is of concern.
Phthalate plasticizers are not present in any other NNI plastic products.
 2. Bisphenol A, the monomer (or building block) of polycarbonate
There has been a lot of work related to bisphenol A (BPA) and polycarbonate (PC). BPA is indeed a monomer of polycarbonate, and therefore present in the molded plastic product, in very low residual levels typically at the parts per million (ppm) levels. However, in order for the BPA to raise a health concern, it must be on the surface of the PC product and extractable in sufficient quantities. Industry research has demonstrated that the BPA contained in the PC plastic is not extracted in sufficient quantities to raise any significant health threats for humans in normal product use.

The Society of the Plastics Industry, Inc. (SPI), United States Environmental Protection Agency (USEPA) and the Scientific Committee on Food of the European Union, have all agreed on the no-observed-adverse-effect-level (NOAEL) for BPA to be 50 mg/kg body weight/day. The USEPA uses a "reference" dose for BPA of 0.05 mg/kg/day.

In 1995, SPI studies used discs of polycarbonate resin blended with equal portions of food, using PC resins from three major US manufacturers. The discs contained 10 ppm residual BPA. Food simulants including water, 3% acetic acid, 10% ethyl alcohol and coconut oil (Miglyol) were used as extraction fluids, at 212°F (100°C) for 6 hours and 120°F (49°C) for 10 days. There was no detectable BPA, with sensitivity to 5 ppb BPA.

In 1997, Biles et al, used cut portions of PC baby bottles with food simulants including water, alcohols and Miglyol. Under "exaggerated" conditions, with temperature up to 149°F (65°C) for 10 days, the PC actually showed some hydrolytic degradation; and still showed BPA extractions equivalent to only 0.006 mg/kg/day, about ten times less than the conservative reference dose of the USEPA. Under "typical": use conditions, BPA extraction was equivalent to only 2 ppb. Note that the cut portions of PC do represent increased surface areas for extraction, and therefore a worst case situation.

The Ministry of Agriculture, Food and Fisheries in the United Kingdom (MAFF, 1997) found no detectable BPA extracted from rinse water (1.2 ppb detection limit) and fruit juice (30 ppb detection limit) from baby bottles after 20 - 50 cleaning cycles.

Two Japanese studies were mentioned on the www.bisphenol-A.org website on the Internet. Yokohama University found an average of 3.9 ppb BPA extracted from baby bottles filled with hot water [203°F (95°C)] and held overnight with warm water [79°F (26°C)]. The Polycarbonate Resin Technology Committee, representing the major PC producers in Japan, found no detectable BPA extracted by food simulants, including water, alcohol, acetic acid and the solvent heptane, at temperatures up to 203°F (95°C), detection limit 50 ppb.

The PC used by NNI meets the requirements of the following food grade regulations (among others):

US Food and Drug Administration - 21 Code of Federal Regulations Part 177.1580

Japanese Self-restrictive Requirements on Food-Contact Articles (JHOSPA)

Section 2-24 Polycarbonate (March, 1996)

European Union Directive 90/128/EEC of 23.02.1990 as amended

3. Styrene dimers and trimers, these are very short chain combinations of two or three styrene monomers

Styrene dimers and trimers are present in plastic products molded with polystyrene (PS). Similar to residual levels of monomer, these dimers and trimers are present in very low levels, typically at the parts per million (ppm) levels.

The Japan Ministry of Health and Welfare's National Institute for Health Science recently stated that there is no reason to regulate the use of PS products because of concerns over endocrine disruptors.

The Japan Styrene Industry Association commissioned research on the safety of PS containers. The research was conducted by the TNO Industrial Research Laboratory, an independent organization for applied scientific research in the Netherlands. The study simulated actual use conditions (consumption of 900 ml of noodles per day, in noodle containers), as well as conditions five times higher than actual use. Using in vivo tests in laboratory rats, the results demonstrated no endocrine disruptor or mimic activity.

Recent studies in the United States tested exaggerated conditions of yogurt consumption, and low dose exposure conditions. In both cases, there was no evidence of any estrogen-like chemicals. European researchers reached similar conclusions, using conditions simulating the consumption of up to 10 kg of food or beverage per day, packaged in PS. In the European study, 23 types of PS were evaluated with no apparent endocrine disruptor activity. Both the US and European tests included in vivo uterotrophic assays, and the US test included an in vitro analysis with MCF-7 cancer cell assay.

5. Other chemicals, including some heavy metals, phytoestrogens of plant origin, butylated hydroxyanisole (BHA) an antioxidant used in foods.
 1. Heavy metals, cadmium (Cd), lead (Pb) and mercury (Hg) can have some endocrine disruptor activity. These heavy metals are not present in NNI plastic products.
 2. Phytoestrogens are of plant origins and are not present in NNI plastic products.
 3. BHA is not used in any NNI plastic products.

References:

Biles, J.A., et al, 1997, Journal of Agriculture and Food chemistry, vol. 45, pages 3541-3544.

Howe, S.R., and L. Borodinsky, 1998, "Potential Exposure to Bisphenol A from Food-Contact Use of Polycarbonate Resins", Food Additives and Contaminants, vol. 15, No 3, 370-375.

MAFF, 1997, "Investigations into the potential Degradation of Polycarbonate Baby Bottles During Sterilization with Consequent Release of Bisphenol A", Central Science Laboratory Report FD 97/08, MAFF R & D and Surveillance Report 253, Ministry of Agriculture Food and Fisheries, Library, Noble-House, London.

Related websites on the Internet:

<http://www.bisphenol-A.org>

<http://www.epa.gov/endocrine> - Endocrine Disruptors Research Initiative

<http://www.styrene.org>

Correspondence with resin suppliers including:

Chevron Chemical company

Dow Chemical Company

DuPont

GE Plastics

Huntsman Corporation

Rexene

Epilogue:

Work on this issue continues, in the United States and all over the world. In general, the technical experts in the plastics industry are concerned about the type of coverage this issue receives in the consumer press. NNI will attempt to stay current with this issue, and update any pertinent technical information we receive.