BISPHENOL A
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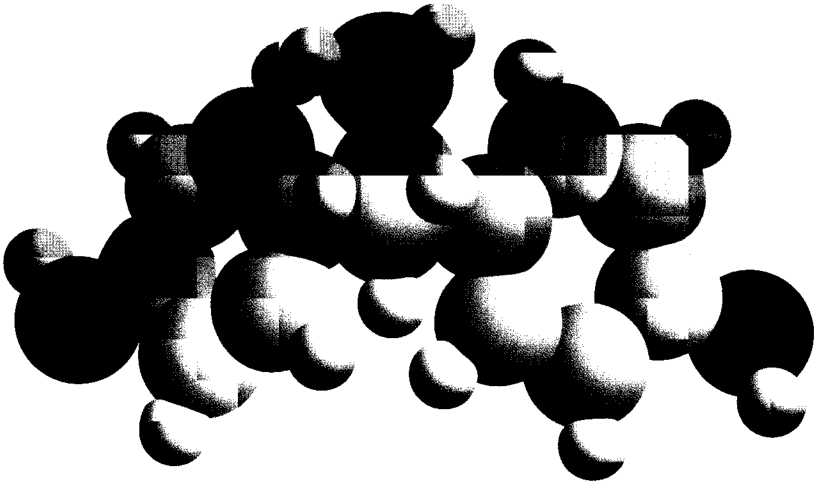

A Safety and Handling Guide

The Society of the
Plastics Industry, Inc.

APME
Association of Plastics
Manufacturers in Europe

Introduction

Bisphenol A (BPA) is generally not considered to be a particularly hazardous material because:

- it is solid at room temperature so exposures to vapors at room temperatures are minimal due to its low vapor pressure;
- a short single exposure is not likely to cause significant skin irritation;
- single dose oral toxicity is considered to be low to moderate.

However, health and safety hazards have been associated with bisphenol A. This Safety and Handling Guide will discuss these health hazards, as well as suggest approaches for preventing them. Additionally, this guide provides some information on regulations, environmental fate and effects, and product uses.

This guide, produced by a committee of the Society of the Plastics Industry, Inc. (SPI) in the United States (U.S.) and the Association of Plastics Manufacturers in Europe (APME), is intended to provide guidance for safety and handling of bisphenol A. The Committee suggests that these guidelines be followed by those involved in the distribution, handling, use, and disposal of bisphenol A. This guide is intended to provide safety and handling information in a "user-friendly" outline format, however, the Material Safety Data Sheet (MSDS) or Safety Data Sheet (SDS) of the supplier should be consulted as the primary safety and handling document. Following these guidelines does not guarantee compliance with any regulation. Companies involved in the distribution, handling, use, and disposal of bisphenol A should consult with their own legal and technical advisors regarding compliance with any applicable and possible future regulations.

Producing Member Companies

The Society of the Plastics Industry, Inc.
Washington, DC, U.S.

Bisphenol A Task Group

Aristech Chemical Corporation
Bayer Corporation
The Dow Chemical Company
G. E. Plastics
Shell Chemical Company

Association of Plastics Manufacturers in Europe
Brussels, Belgium

Bisphenol A Working Group

Bayer AG, Germany
Dow Europe SA, Switzerland
G. E. Plastics bv, The Netherlands
Shell Chemicals Europe Ltd., UK

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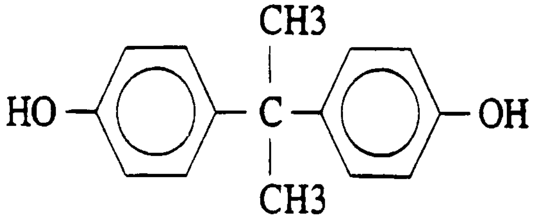


Bisphenol A (not intended to be isomer specific)
Chemical Abstract Service (CAS) Number 80-05-7

Physical Properties *

White to light tan solid flake, powder, prill, or granular
Solid at ambient conditions
Mild phenolic odor
Slightly hygroscopic
Other names:
  4,4'-Isopropylidenediphenol
  Diphenylolpropane
  4,4'-(1-methylethylidene) bisphenol
Molecular Weight: 228 g/mol
Boiling Point, @ 4mm Hg: 428 °F/220 °C
Melting Point: 309 - 314 °F/154-157 °C **
Flash Point, COC ***: 405 °F/207 °C
Flash Point, CC****: 441 °C/227 °C
Minimum Ignition Temperature: 990°F/532°C
Lower Explosion Limit: 0.019 g/l
Minimum Ignition Energy: 1.8 millijoules
Volume 0_2 above which deflagration can take place: 9.3% *****
Severity of Explosion Constant: 297 bar-m/sec
Peak Pressure: 105 psig/7.24x10^5 Pa
Specific Gravity, 25/25°C: 1.195
Bulk Density: 37 - 45 lb/ft^3/0.59 - 0.64 kg/dm^3
Volumetric Resistivity: 5.1 x 10^{15} ohms/cm
Heat of fusion: 32.28 cal/g **
Specific Heat @ 25°C: 0.35 cal/g°C
Specific Heat @ 75°C: 0.39 cal/g°C
Specific Heat @ 125°C: 0.52 cal/g°C
Specific Heat @ 175°C: 0.51cal/g°C
Approx. solubility, g/100g solvent @ 25°C

Acetone	85
Caustic Soda Solution (NaOH), 1.5 normal	17
Epichlorohydrin	38
Ethanol	150
n-Heptane	< 0.01
Methanol	210
Methylene Chloride	0.2
Water	< 0.1

* These are typical properties
** May vary with crystalline form
*** Cleveland Open Cup
**** Closed Cup
***** NFPA 69, Standard on Explosion Prevention Systems, 1992 edition, Table C-2 Limiting Oxidant Concentrations to Prevent Deflagrations of Suspensions of Combustible Dusts Using Nitrogen or Carbon Dioxide as Diluents, p.69-24.

Fire, Explosion, Reactivity and Thermal Hazards

Fire and Explosion Hazards

Mechanical handling of bisphenol A can cause formation of dust which when suspended in air it can be flammable and pose a fire and explosion hazard if not properly handled. Any suspended dust that occurs can be ignited by static electricity or other ignition sources. Static discharge generated by flowing bisphenol A can also readily ignite suspended particulates.

Ways to Reduce the Potential of an Explosion

- Minimize the accumulation of dust.
- Properly ground hopper cars, conveyance and storage facilities.
- Conveyance and bulk storage facilities should be blanketed with an inert gas such as nitrogen. This gas must contain less than 9.3% by volume oxygen.

If a Fire Should Occur

- Fires involving bisphenol A can be extinguished by water, water fog, or carbon dioxide (hand held carbon dioxide or dry chemical extinguishers may be used for small fires).
- After a fire has been extinguished, the remaining bisphenol A should be soaked thoroughly with water to cool and prevent re-ignition.

Thermal Hazards

- Minimize maintaining bisphenol A at elevated temperatures.
- All heated vessels, transfer lines, instrument loops, tracing lines, sampling points, etc. should be thoroughly insulated to prevent burns from incidental contact.

Reactivity Hazards

- Avoid contact with oxidizing materials such as peroxides and perchlorates.
- Under normal circumstances bisphenol A is chemically stable. Hazardous polymerization will not occur.
- At elevated temperatures, molten bisphenol A will slowly decompose to phenol and isopropenyl phenol.

Health Hazards and First Aid

Inhalation Health Hazards

- Dust and vapors may cause irritation to the upper respiratory tract.
- Dust may cause sneezing.
- Exposure to vapors are minimal at room temperature due to low vapor pressure of bisphenol A.
- Vapor levels sufficient to cause irritation may be generated when bisphenol A is in the molten state.

First Aid:

- In the event of breathing problems, remove individual to fresh air; provide oxygen and if necessary, give artificial respiration; then seek medical attention.

Ingestion Health Hazards

- Amounts that may be ingested accidentally in the workplace are considered to have low toxicity.

First Aid:

- Seek medical attention.
- Do not induce vomiting unless directed to do so by medical personnel.

Eye Health Hazards

- Bisphenol A dust may cause moderate irritation and corneal injury.

First Aid:

- Flush eyes with flowing water immediately and continuously for 15 minutes; consult a physician.

Skin Health Hazards

- A short single acute exposure is not likely to cause significant skin irritation.
- Prolonged or repeated exposure may cause skin irritation, especially under conditions of sweating.
- Skin contact may cause mild allergic skin reaction in susceptible individuals exposed to sunlight (photosensitization).

First Aid:

- Flush bisphenol A off skin in flowing water. Follow by washing with soap and water.

Other Health Effects - Animal Studies

- Liver, kidney, and bladder effects were observed in animals which were fed high doses of bisphenol A over a prolonged period of time, however, these effects were reversible when exposure was discontinued.
- A 2-year cancer bioassay and mutagenicity studies demonstrated that bisphenol A is neither a carcinogen nor a mutagen.
- Bisphenol A is not a selective reproductive toxin; there is no evidence for reproductive toxicity in humans.
- High doses of bisphenol A given orally and by injection have produced slight effects on certain reproductive end points, such as enlargement of the uterus in laboratory animals. However, the significance of this information to humans is unknown and a subject of continuing research.
- Research with laboratory animals has shown that bisphenol A is readily excreted and metabolized.

Environmental Fate and Effects

Numerous studies have been completed to determine the fate and effects of bisphenol A in the environment. Following is a summary of the results of these studies.

Fate

- Bisphenol A undergoes rapid biodegradation in laboratory tests which employ microorganisms previously exposed (acclimated) to bisphenol A.
- Bisphenol A is "inherently biodegradable," according to data from the Organization for Economic Cooperation and Development's standard biodegradation test.
- Bisphenol A is rapidly biodegraded in wastewater treatment systems, with 92-98% removal reported in a test simulating an activated sludge plant.
- Surface water degradation half-life is 2.5 to 4.0 days.
- Numerous water samples of rivers and estuaries in Japan and Western Europe have been analyzed for their bisphenol A content. In the majority of samples, no bisphenol A was detected. Only a few samples showed a very low content (0.01 - 1.9 ppb).

Effects

- Aquatic toxicity tests performed on a variety of freshwater and saltwater algae, invertebrates and fish, suggest that bisphenol A is only moderately toxic to aquatic organisms.
- Bioconcentration and metabolism studies have shown that bisphenol A has no significant bioaccumulation potential.

Work Place Health and Safety Controls

The following section briefly describes U.S. and European Exposure Guidelines. Also, work place health and safety controls, including Personal Protective Equipment (PPE), Engineering Controls, and Handling, are described.

Exposure Guidelines

United States

- Presently in the United States, the Occupational Safety and Health Administration (OSHA) has not established a permissible exposure limit (PEL) for bisphenol A. The American Conference of Governmental Industrial Hygienists (ACGIH) has not established a threshold limit value for bisphenol A either. OSHA has an exposure limit for Particulates Not Otherwise Regulated (PNOR) of 15 mg/m^3 for total dust and 5 mg/m^3 for the respirable fraction. The ACGIH has an exposure guideline for Particulates Not Otherwise Classified (PNOC) of 10 mg/m^3 for total dust and 3 mg/m^3 for the respirable fraction. Additionally, some manufacturers have established their own exposure guidelines.

Europe

- The German MAK[1] Commission has recently set a new standard for bisphenol A (airborne dust). MAK = 5mg/m^3. Additionally, bisphenol A has been given a favorable pregnancy rating at this level (no adverse effects to unborn life). For more detailed information, refer to the MAK-Booklet. (This booklet is titled: Maximale Arbeitsplatzkonzentrationen und Biologische Arbeitsstofftoleranzwerte.)
- The Netherlands has set the MAC[2] for bisphenol A at 5mg/m^3.

Personal Protective Equipment

- Wear chemical goggles to protect the eyes, if there is likelihood of contact.
- Use gloves resistant to bisphenol A, e.g., PVC gauntlets, to protect the hands and lower arms when handling the substance.
- When respiratory protection is required because of dust levels, use a "NIOSH"[3] approved air- purifying particulate respirator or other general purpose dust respirator (Nominal Protection Factor, NPF, 20 – generally accepted European practice).

Engineering Controls

- General and/or local exhaust ventilation should be provided to maintain airborne levels below exposure guidelines.
- Inerting systems with interlocks.
- Grounding systems with interlocks.

Handling

- Minimize exposure to product dust resulting from open transfer operations, mechanical handling and fabrication.
- Good housekeeping and controlling of dust is necessary to minimize dust ignition hazard.

Footnotes:

1 Maximale Arbeitsplatz Konzentration or Maximal Workplace Concentration

2 Maximaal Aanvaarde Concentratie or Maximal Accepted Concentration

3 U.S. National Institute for Occupational Safety and Health

Packaging and Unloading Considerations

Following are controls for sacks, bulk sacks, hopper trucks and cars, and conveyers that may help increase plant safety.

Sacks

- 50 lb or 25 kg sacks are commonly used for bisphenol A packaging.
- Pallets should be shrink wrapped and stacked no more than two high to avoid unstable situations.
- Fork trucks should be rated Underwriters Laboratory (UL) safe for lifting pallets or stringers containing sacks.
- Sacks should be stored indoors in a clean, well ventilated area.
- Warehouse area should be kept clean and well ventilated.
- Lifting bags should be from beneath, with support at both ends to prevent sacks from tearing.
- Before a sack is lifted, it should be inspected for snags and punctures.
- Sacks with tears should be repaired immediately if their contents have not been contaminated; otherwise, their contents should be properly disposed.
- Where sacks are not already palletized, pallets or stringers should be placed on the floors and the sacks stacked on them.
- Sacks should be shipped on disposable pallets holding a maximum of 40 sacks (2000 lb or 1000kg).

Bulk Sacks

- 1000 - 2500 lb or 500 - 1000 kg bulk sacks are commonly used for bisphenol A packaging.
- Bulk sacks are shipped on disposable pallets holding either one or two disposable sacks. Arrangements for bulk sack reuse are also possible.
- Lifting straps are attached to the bulk sack to allow the sack to be lifted by a tow motor or hoist.
- Bulk sack discharge spout is located on the bottom of the sack and sacks are available with remote opening mechanisms.
- Bulk sacks are typically made of ultraviolet (UV) resistant woven polypropylene or similar material.
- Bulk sacks can be coated for moisture protection. In cases where a separate liner is added for additional moisture protection, care must be taken to account for the separate liner upon opening the sack.
- Bulk sacks should be recycled, returned or properly disposed of after use.
- Warehouse area should be kept clean and well ventilated.

- Fork trucks should be rated UL safe for lifting pallets or stringers containing sacks.
- Static discharge from handling bulk sacks can be reduced by use of static eliminating shoes.
- Equipment and bulk sacks should be properly grounded during emptying.
- Bulk sacks should be conductive and capable of being grounded.

Hopper Trucks and Hopper Cars

- Both hopper trucks and hopper cars are sealed containers that are loaded through roof hatches and gravity or pneumatically unloaded through bottom outlet nozzles.
- Gravity unloading can be facilitated with the use of a mechanical vibrator.
- Electrical grounding should be used during all unloading and material transport operations.
- Containers should be inerted using inert gas containing less than 9.3% by volume oxygen.

Conveyors

- Equipment must be properly grounded (piping flanges should be straddled using grounding continuity straps)

Pneumatic Suction Conveyors

- are widely used to transport granular, flaked, and prilled bisphenol A from the unloading area;
- dilute phase systems carry bisphenol A along in a rapidly moving inert gas stream to transport bisphenol A up to several hundred feet. They are not suggested because they utilize high velocities that generate dust which can cause handling problems and increase explosion potential;
- a dense phase system using inert gas velocities less than 2000 fpm or 650 m/min is suggested to reduce dust.

Screw Conveyors

- can be used to transport material up to 100 feet or 30 meters where the conveyor angle is small enough that material on the conveyor will not slide backwards.

Belt Conveyors

- are used to move bisphenol A considerable distances because the power requirements are low;
- belt conveyor construction should include a weather-tight housing and should be padded with inert gas;
- bearing and grease fittings should be external to minimize product contamination.

Drag Flight Chain Conveyor

- have been used to move bisphenol A;

- consist of one or more endless chains equipped with flights and traveling through a trough or set of guides;
- material may be conveyed several hundred feet either horizontally or up an incline, however, these conveyors typically require frequent maintenance.

Bucket Elevators

- can be used to load bisphenol A into the tops of storage bins and are either an endless rubber belt or one or more endless chains to which buckets are attached.

Storage Considerations

Storage Bins and Silos

- Storage bins and silos are usually made of one of the following:
  - concrete
  - aluminum
  - stainless steel
  - epoxy resin-coated carbon steel.
- Most satisfactory bins and silos have a cone shaped bottom with a slope of about 60 degrees or greater to minimize the tendency towards hanging up or plugging of material.
- Unloading may be facilitated with the use of a mechanical vibrator. This vibrator should be turned off when unloading is not in progress to prevent packing, which will hinder later unloading operations.
- Storage bins and silos should be grounded and padded with an inert gas such as nitrogen to reduce the risk of electrical spark, dust explosion, and moisture gain.
- Care should be taken to exclude oxides of nitrogen in storage compartments to minimize color advancement.
- Storage bins should be equipped with properly designed explosion relief devices.

Waste Disposal Considerations

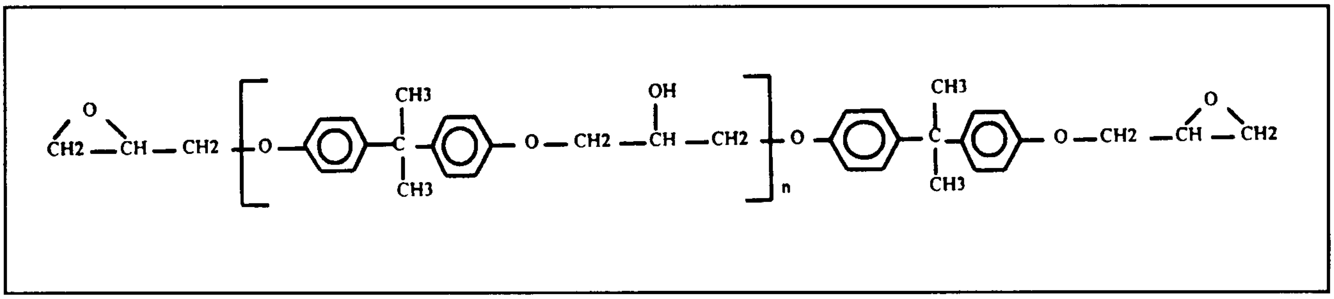
- All discharge disposal methods must be in compliance with all U.S. Federal, State/Provincial, local laws and regulations, and/or EU regulations.
- Waste characterizations and compliance with applicable laws are the sole responsibility of the waste generator.
- For unused and uncontaminated product, the preferred options include, permitted recycling, reclaiming or incineration, and other thermal destruction methods.
- Empty sacks or bulk sacks of bisphenol A, unless thoroughly cleaned, will contain residual bisphenol A and should be recycled, reclaimed, incinerated or otherwise thermally destroyed in accordance with regulations.

Product Use

Bisphenol A is used in such a way that only a certain group of workers, with a knowledge of the processes, come into contact with the chemical. They are able to protect themselves and the environment against exposure through the use of personal or technical protective measures. Thus, exposure to these chemicals should be limited. The chemicals may also be discharged into the environment as point sources. Quantities discharged should be limited due to protective measures such as wastewater or exhaust air purification.

Following are examples of typical uses of bisphenol A. These materials can be hazardous. Only trained knowledgeable workers should use these products. Specific Material Safety Data Sheets or Safety Data Sheets should be read and thoroughly understood before working with them.

Epoxy Resins



n = number of repeating units

Typical Structure

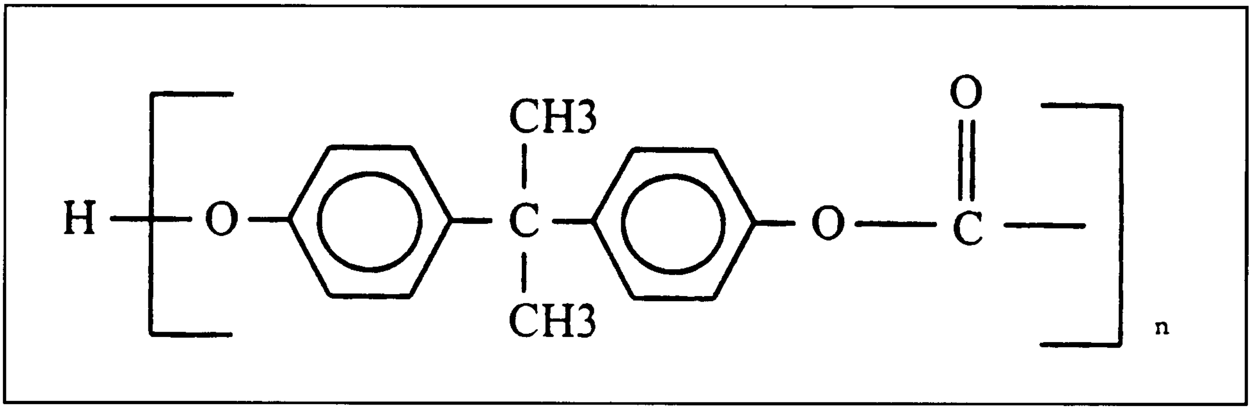
Properties

- A polyhydric phenol like bisphenol A and a chlorohydrin like epichlorohydrin are commonly reacted together to produce an epoxy resin like the typical one shown above. Many epoxy resin derivatives can be prepared by reacting a basic epoxy resin with active hydrogen containing materials such as furans, aldehydes, polyamides and polyamines. Thermoset materials can be made by cross linking epoxy resins with, for example, a polyamine or a polycarboxylic acid through what is referred to as the curing process. Also this can be done by esterifying epoxy resins with short or long chain unsaturated acids.
- Specific parts of the bisphenol A-based epoxy resin structure contribute unique characteristics to the resin and its performance features. The functional sites allow it to be cured with a variety of hardeners at ambient and elevated temperatures. The isopropylidene group between the aromatic rings and the three carbon chains along the oligomeric backbone give the resin increased toughness. The aromatic rings derived from bisphenol A give structural rigidity and high temperature performance properties to the resin. The hydroxyl groups increase the resin's adhesion to and wettability of substances and fillers. Increasing the n value of the resin also increases toughness, adhesion, flexibility and wettability.

Uses

- Some examples of epoxy resin uses include industrial protective coatings, can and coil coatings, powder coatings, electrical laminants, composites, and adhesives.

Polycarbonate



n = number of repeating units

Typical Structure

Properties

- Polycarbonate is a synthetic thermoplastic resin usually made from bisphenol A and phosgene. It has a unique combination of properties including being transparent and heat resistant, and having high impact strength. It is also dimensionally stable, as well as resistant to mineral acids.

Uses

- Polycarbonate is an excellent material for most, if not all, molding methods including injection molding, thermoforming, and extrusion. Some examples of its use include structural parts, impact resistant glazing, street-light globes, household appliance parts, automotive applications, and bottles.

Other Products

- **Bisphenol A/Formaldehyde Resins**, prepared from bisphenol A and formaldehyde, can be incorporated into automotive primers and surface finishes, binders for abrasives, table and office furniture finishes, undercoats, and wrinkle finishes. Printing inks may also be prepared from this resin that dry rapidly, display high resistance to alkalis and have minimum penetration into paper.

- Tetrabromobisphenol A (TBBPA), prepared from bromine and bisphenol A, is used as a fire retardant in resins.

- Bisphenol A is used as an antioxidant in the formulation of hydraulic brake fluids.

- Bisphenol A and substituted bisphenol A products also are effective as rubber antioxidants.

- Bisphenol A is used as both an antioxidant and color stabilizer for soaps.

- Bisphenol A's fungicidal properties are important in textiles and asphalt-treated cable covering.

- Bisphenol A is a good stabilizer for polyvinyl chloride (PVC) because it inhibits peroxide formation and color development in both the plasticizer and the PVC.

- Bisphenol A increases the dyeability of certain materials such as polyesters and polyolefins.

Regulatory Information

United States/Canada

- Bisphenol A is subject to the reporting requirements of Section 313 of Title III of the U.S. Superfund Amendments and Reauthorization Act (SARA) of 1986 and 40 CFR Part 372.
- This product has been reviewed according to the U.S. EPA "Hazard Categories" promulgated under Sections 311 and 312, Title III of the SARA of 1986 and is considered, under applicable definitions, to meet the following categories: (1) An immediate health hazard and (2) A delayed health hazard.
- Bisphenol A is listed on the U.S. Toxic Substances Control Act (TSCA) inventory of chemical substances.
- Under the U.S. OSHA Hazard Communication Standard, bisphenol A is a "hazardous chemical" as defined in CFR 1910.1200.
- Bisphenol A is considered a controlled product under the Canadian Controlled Products Regulations. Please consult the Safety Data Sheet for the relevant classification and safety information.
- Bisphenol A is included in the Domestic Substance List of the Canadian Environmental Protection Act.

Europe

European Union

- Classification and Supply Label[4]

Chemical Name

- 4,4' - Isopropylidenediphenol (Bisphenol A)
- EU label, EINECS Nr. 201-245-8, EEC Classification Nr. 604-030-00-0

Hazard Symbol

- X_i - Irritant

Risk Phrases

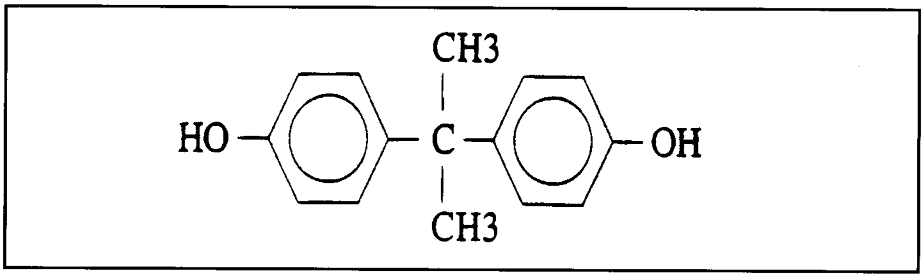
- Irritating to eyes, respiratory system and skin (R36/R37/R38).
- May cause sensitization by skin contact (R43).

Safety Phrases

- Avoid contact with skin and eyes (S24/S25).
- Wear suitable gloves (S37).

Footnotes:

[4] Commission Directive 93/21/EEC, adapting to technical progress for the 18th time Council Directive 67/548/EEC, O J Eur., L110, 20, 1993, O J Eur., L110A, 1, 1993



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For Emergencies:

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CHEMTREC For Emergency Response 1-800-424-9300	Bayer AG +49-214-30 3030
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