TC NES SUBGROUP ON IDENTIFICATION OF PBT AND VPVB SUBSTANCES

RESULTS OF THE EVALUATION OF THE PBT/VPVB PROPERTIES OF:

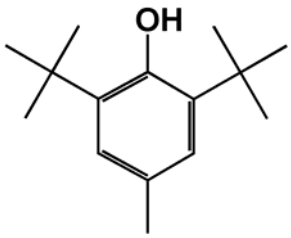
Substance name: 2,6-di-tert-butyl-m-cresol

EC number: 204-881-4

CAS number: 128-37-0

Molecular formula: C15H24O

Structural formula:



Summary of the evaluation:

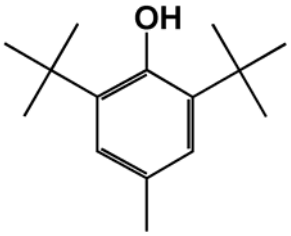
2,6-di-tert-butyl-m-cresol is not considered to be a PBT substance. This conclusion concerns only the parent compound.

The substance does not meet the B criterion. It may meet the P/vP criteria based on the available data. Although the substance has been observed to degrade and some degradation products have been identified, no estimate is available on the rate of degradation. The substance may also meet the T criterion (as boarderline case) based on the available ecotoxicity data.

JUSTIFICATION

1 IDENTIFICATION OF THE SUBSTANCE AND PHYSICAL AND CHEMICAL PROPERTIES

Name: 2,6-di-tert-butyl-m-cresol
EC Number: 204-881-4
CAS Number: 128-37-0
IUPAC Name:
Molecular Formula: C15H24O
Structural Formula:



Molecular Weight: 220.35
Synonyms: BHT; Di-tert.-butyl-p-cresol; di-tert.-butyl-4-hydroxytoluene; Di-tert.-butyl-p-methylphenol; 4-hydroxy-3,5-di-tert-butyltoluene; 3,5-di-tert-butyl-4-hydroxytoluene; 2,6-bis(1,1-dimethylethyl)-4-methylphenol; butylated hydroxytoluene (for a complete list, see European Commission, 2000)

1.1 Purity/impurities/additives

No data available.

1.2 Physico-chemical properties

Table 1 Summary of physico-chemical properties. For details and references, see European Commission (2000)

REACH ref Annex, §	Property	Value	Comments
V, 5.1	Physical state at 20 C and 101.3 Kpa	solid, liquid	European Commission, 2000
V, 5.2	Melting / freezing point	70ºC	Bayer AG
V, 5.3	Boiling point	265ºC (at 1013 hPa)	Bayer AG
V, 5.5	Vapour pressure	0.013 hPa (at 20ºC)	Bayer AG
V, 5.7	Water solubility	0.6 mg l^{-1} (at 25ºC)	
V, 5.8	Partition coefficient n-octanol/water (log value)	4.17 (at 21ºC) 5.03 5.1 (at 20ºC) 5.6 (calculated) 6.2 (calculated)	Freese et al., 1979 KOWWIN v1.67 Shell (unpublished), 1981 CLOGP v3.63 (Bayer AG, 1992) USEPA (1983)
VII, 5.19	Dissociation constant	8-11	For hydroxylated aryl compounds (Rochester, 1971) (data not evaluated)

2 MANUFACTURE AND USES

Eleven companies have notified the substance. Production volume of four Western European producers covers according to OECD (2003) 25,000 tpa. The substance is according to industry used as antioxidant in a wide range of applications including human and animal food, cosmetics, pharmaceuticals and polymers. BHT is present also in consumer products.

3 CLASSIFICATION AND LABELLING

The substance is not classified in the Annex I of Directive 67/548/EEC.

4 ENVIRONMENTAL FATE PROPERTIES

4.1 Degradation (P)

4.1.1 Abiotic degradation

Mikami et al. (1979a) tested photolytic stability of ^{14}C-labelled BHT in water. After 8 days of exposure to sunlight, 25% of BHT had remained undegraded, transformation products BHT-OOH, BHT-OH, BHT-C_2OH, BHT-CHO and BHT-COOH were present in an amount of approximately 25% and unidentified polar compounds made 48% of applied radioactivity. In the dark control 59.8% of BHT remained undegraded, the oxidation products as above made approximately 40% and unidentified polar compounds approximately 23% of applied radioactivity. It can be concluded from the study that BHT is transformed to several oxidation products in water under sunlight and in the dark with a moderate to rapid rate, whereas sunlight accelerates the degradation. The rate of mineralization cannot be estimated from this study.

Chang and Maurey (1984) found that the main reaction product of BHT with water and oxygen was stilbenequinone (dimer of BHT) and its precursors but in addition a large variety of other degradation products were observed.

Indirect photochemical degradation in the atmosphere is considered to be fast based on the estimated half-life of 3.04 hours for the reaction with OH-radicals using AOP v1.91 (24 h day^{-1}; 5*10^5 OH$^-$ cm^{-3}).

4.1.2 Biotic degradation

According to MITI (1992), 4.5% of BHT was degraded in 28 days in a modified MITI test (OECD 301C) using predominantly domestic sludge. On the basis of the study, BHT is not readily biodegradable. It is noted, that the result reflects also a low biodegradability of any abiotic degradation products, if those were formed during the test.

The stability of BHT in light clay, sandy clay loam and sandy loam was followed by Mikami et al. (1979b) over 24 days. Disappearance and mineralisation of BHT after 24 days of incubation was 77-92% and 21-29%, respectively, in non sterilized conditions. In sterilised conditions 27-41% disappearance was observed but mineralisation was < 2%. The amount of volatilised substances was monitored and the results showed that a significantly larger amount was volatile in the sterilised batches compared to non-sterilised vials. Major degradation products identified were BHT-OOH and BHT-OH. It can be concluded from the study that BHT is altered to non-volatile compounds mainly by biological processes and that these processes enhance the rate of primary degradation and mineralisation in a soil-air system.

BIOWIN v4.02 supports the available test data predicting that the substance is not readily biodegradable. Biowin 1,2,5 and 6 –models < 0.5, Biowin 3(ultimate survey model) = 2.26, Biowin4 (primary survey model)= 3.19.

4.1.3 Other information [1]

Data not reviewed for this report.

4.1.4 Summary and discussion of persistence

BHT is not readily biodegradable. It does, however, oxidise in water in a moderate to rapid rate forming various reaction products. The main abiotic degradation products observed are BHT-OOH, BHT-OH and stilbenequinone. The aquatic studies available do not provide information on the rate and type of further degradation. Further information on the transformation and/or mineralisation rates of relevant degradation products and their identities is needed in order to be able to assess their PBT-properties. Degradation rate in sediment should be investigated separately, as it may deviate considerably from the degradation in water due to different oxygen conditions. Degradation in soil can be concluded to occur, but the rate of degradation in environmentally relevant conditions cannot be derived from the available study.

4.2 Environmental distribution

Data not reviewed for this report.

4.2.1 Adsorption

4.2.2 Volatilisation

4.2.3 Long-range environmental transport

4.3 Bioaccumulation (B)

4.3.1 Screening data[2]

The available log Kow data range from 4.2 to 6.2 (see **Table 1**) indicating high bioaccumulation potential. The measured logKow of 5.1 results in a calculated BCF of ca. 600 using BCFWIN v2.15 and a BCF of approximately 4,300 using the equation of Veith et al. (1979). It is noted, that BCFWIN identifies the substance as tert-butyl ortho-phenol type calculating a correction factor for this species, whereas the TGD-model only accounts for the logKow.

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[1] For example, half life from field studies or monitoring data

[2] For example, log K_{ow} values, predicted BCFs

4.3.2 Measured bioaccumulation data[3]

MITI (1992) carried out a flow through bioconcentration test with *Cyprinus carpio* according to the OECD 305 C. Test concentrations of 5 and 50 µg l^{-1} were employed. According to the additional information from METI (2004), a dispersant (HCO-40) was used in concentrations of 100 and 1,000 µg l^{-1} for the test concentrations of 5 and 50 µg l^{-1}, respectively, although the test concentrations were below the water solubility limit. The average fish weight was 29.2 g and average length 10.6 cm. The total exposure period was 8 weeks and BHT was measured in fish and water after 2, 4, 6 and 8 weeks. Three fish were sacrificed at each sampling time. The BCF range presented below gives the mean, the lowest and the highest of the individual BCF-values measured.

Test conc. (µg l^{-1})	BCF (x ± sd) n=3			
	2 w	4 w	6 w	8 w
5	800 ± 290	917 ± 779	520 ± 156	1120 ± 370
50	623 ± 213	710 ± 372	513 ± 302	1276 ± 1145

In addition, a test concentration of 500 µg l^{-1} within the same study was reported by METI (2004) with a BCF range of 220-2,800. No detailed information is available for this test. Due to the similar BCF range with other test concentrations, it is assumed that the mean BCF is also similar. Only two single fish –BCFs of probably 36 in total have been observed above 2,000. Despite the non-optimal sampling regime, the use of dispersants and the large variation of the single BCFs, the study is considered reliable enough for the estimation of the bioaccumulation potential.

Inuit et al. (1979) found in their static study on distribution of ^{14}C –labelled BHT in an aquarium system only a very small amount of initial radioactivity in fish. This study cannot be, however, applied for the assessment of bioaccumulation potential due to several deficiencies (BHT concentration in water not constant, dispersant used).

4.3.3 Other supporting information[4]

Data not reviewed for this report.

4.3.4 Summary and discussion of bioaccumulation

BCF for fish has been measured in the range of 220-2,800 (min-max of single fish BCFs) in a flow through test of MITI (1992). The mean BCFs of the sampling occasions were between 520 and 1,276. Based on this study, BHT is considered to have moderate to high bioaccumulation potential.

5 HUMAN HEALTH HAZARD ASSESSMENT

The estrogenic activity of 73 phenolic substances including BHT was investigated by Miller et al. (2001) in an *in vitro* recombinant yeast assay where the binding of the test substance to the human

[3] For example, fish bioconcentration factor

[4] For example, measured concentrations in biota

estrogen receptor was measured. The estrogenic potency of 2,6-di-tert-butylphenol relative to 17β-estradiol was estimated to 1/8,000,000.

Other test data was not reviewed for this report

6 ENVIRONMENTAL HAZARD ASSESSMENT

6.1 Aquatic compartment (including sediment)

6.1.1 Toxicity test results

6.1.1.1 Fish

Acute toxicity

No adverse effects were observed in a 96-hour limit test with *Brachydanio rerio* using water saturated concentration. The test was conducted under semi-static exposure with renewal of solution every 24 hours. Exposure concentration measured after 24 hours was 0.57 mg l^{-1} (Bayer AG, 1994).

Long-term toxicity

No experimental data are available. Based on the equation of Verhaar et al. (1995; cited in TGD), 30 d NOECs of 0.028 mg l^{-1}, 0.01 mg l^{-1} and 0.0029 mg l^{-1} result using logKow of 5.1, logKow of 5.6 and logKow of 6.2, respectively. ECOSAR v0.99g provides a 30-day NOEC of 0.063 mg l^{-1} (logKow of 5.1 used).

6.1.1.2 Aquatic invertebrates

Acute toxicity

Bayer AG (1994) observed no effects in a 48-hour limit test with *Daphnia magna* according to the C.2 of Annex V to 67/548/EEC (equivalent to OECD 202, part 1). The test concentration was measured at 0.17 mg l^{-1}. Hence, 48-hour $EC_0 \geq 0.17$ mg l^{-1}.

Long-term toxicity

A 21-day reproduction study of Bayer AG (1994) with *Daphnia magna* gave a NOEC of 0.07 mg l^{-1} for reproduction (measured concentration). The test was conducted according to OECD 202 (part 2) under semistatic conditions with nominal test concentrations of 0.1, 0.316 and 1.0 mg l^{-1}.

Based on the equation of Verhaar at al. (1995; cited in TGD), 21 d NOECs of 0.014 mg l^{-1}, 0.004 mg l^{-1} and 0.00096 mg l^{-1} result using logKow of 5.1, logKow of 5.6 and logKow of 6.2, respectively. ECOSAR v0.99g provides a 21-day NOEC of 0.048 mg l^{-1} for daphnids (logKow 5.1 used).

6.1.1.3 Algae and aquatic plants

A limit test with saturated BHT concentration in water was conducted according to C.3 of Annex V to 67/548/EEC (equivalent to OECD 201) using *Scenedesmus subspicatus*. After 72 hours of incubation 8% inhibition of growth rate was observed. The test concentration was measured to be 0.4 mg l^{-1} and hence E_rC_8 of 0.4 mg l^{-1} can be derived from the study.

6.1.2 Sediment organisms

No data available.

6.1.3 Other aquatic organisms

In a test with activated sludge according to Directive 88/302/EEC, Part C (respiration inhibition test) a 3-hour EC_0 of 1,000 mg/l was determined (Bayer AG 2000).

A 24-hour EC_{50} of 1.7 mg/l *Tetrahymena pyriformis* (protozoa) was found in a cell multiplication inhibition test (Yoshioka et al., 1985).

6.2 Terrestrial compartment

Data not reviewed for this report

6.3 Atmospheric compartment

Data not reviewed for this report.

7 PBT AND vPvB

7.1 PBT, vPvB assessment

Persistence: BHT may meet the P/vP criteria based on available data. BHT is not readily biodegradable but it oxidises in water to several transformation products. However, the environmentally relevant rate of degradation is not known. Degradation rate in sediment may deviate considerably from the degradation rate in water due to a different oxygen regime. The substance has been observed to degrade in soil but the rate of degradation cannot be judged on the basis of the data. Further testing on degradation would be needed especially for soil and sediment to determine environmentally relevant rates of degradation. However, such testing is not required for the PBT-assessment due to the overall conclusion (see below).

Bioaccumulation: the substance does not meet the B criterion. Bioconcentration factors up to 1,276 (min-max: 220-2,800) have been measured in a flow through test with fish. This conclusion applies for the parent compound, only.

Toxicity: Only one chronic ecotoxicity study is available (*Daphnia magna*, NOEC 0.07 mg l^{-1}). The QSAR predictions indicate NOECs on both sides of the trigger of 0.01 mg l^{-1} depending on the logKow-value used. Hence, BHT may fulfil the T criterion as a boarderline case, but more data would be needed to complete the assessment. Further testing is, however, not required due to the overall conclusion (see below). BHT was found to be a very weak binder to the human estrogen receptor in an *in vitro* assay and thus is not considered to fulfil the T -criterion with regards to endocrine disrupting effects.

Summary: 2,6-di-tert-butyl-p-cresol (BHT) does not meet the B criterion. It may meet the P/vP criteria based on the data available. Although BHT has been observed to degrade, no estimate of the rate of degradation is available. The observed degradation products were not assessed for their persistency or bioaccumulation potential. The substance may also meet the T criterion (at the borderline) based on the available ecotoxicity data.

It is concluded that BHT is not considered as a PBT substance. This conclusion concerns only the parent compound.

INFORMATION ON USE AND EXPOSURE

Not relevant as the substance is not identified as a PBT.

OTHER INFORMATION

The information and references used in this report were taken from the following sources unless separately stated:

European Commission (2000) IUCLID Dataset, 2,6-di-tert-butyl-p-cresol, CAS 128-37-0, 18.2.2000.

OECD (2002) SIDS Initial Assessment Report for SIAM 14, Paris, France, 26-28 March, 2002. 2,6-di-tert-butyl-p-cresol (BHT), CAS 128-37-0. UNEP Publications.

Other references:

METI (2004) Additional information on the MITI (1992) –test provided to ECB in August 2004.

Miller D, Wheals B, Beresdorf N and Sumpter J (2001) Estrogenic activity of phenolic additives determined by an in vitro yeast bioassay. Environmental Health Perspectives vol.109, no. 2, 133-138.Rochester, C.H., 1971. In: The Chemistry of the Hydroxyl Group, part 1. Wiley, NY, p. 374 (as cited in Smith, M.B. and March, J., 2001. March's Advanced Organic Chemistry, 5th edition. John Wiley & Sons, Inc., p. 330).

Veith GD, Defoe DL and Bergstedt BV (1979) Measuring and estimating the bioconcentration factor of chemicals in fish. J. Fish. Board Can., 36, 1040-1048. As cited in: European Commission, 2003. Technical Guidance Document on Risk Assessment, Part III. European Commission, Joint Research Centre, EUR 20418 EN/3.