Annex XV Dossier

Cyclododecane

EC Number: **206-033-9**

CAS Number: **294-62-2**

PROPOSAL FOR IDENTIFICATION OF A SUBSTANCE AS A CMR CAT 1 OR 2, PBT, vPvB OR A SUBSTANCE OF AN EQUIVALENT LEVEL OF CONCERN

It is proposed to identify the substance as a PBT according to Article 57 (d).

It is proposed to identify the substance as a vPvB according to Article 57 (e).

Submitted by: France

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Substance Name: Cyclododecane

EC Number: 206-033-9

CAS number: 294-62-2

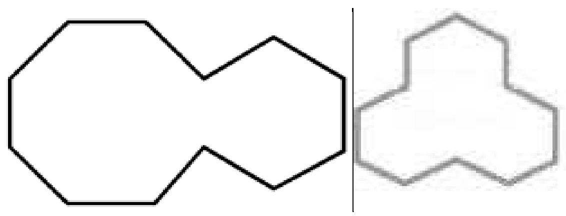
Summary of how the substance meets the CMR (Cat 1 or 2), PBT or vPvB criteria, or is considered to be a substance of an equivalent level of concern

According to the TC NES subgroup on identification of PPT and vPvB substances, cyclododecane is considered to be a PBT and vPvB substance based on the screening criteria. The substance fulfils the vB criterion. The P/vP criterion and the T screening criterion are also met.

JUSTIFICATION

1 IDENTITY OF THE SUBSTANCE AND PHYSICAL AND CHEMICAL PROPERTIES

1.1 Name and other identifier of the substance

Chemical Name:	Cyclododecane
EC Name:	206-033-9
CAS Number:	294-62-2
IUPAC Name:	Not relevant
Molecular Formula:	C12H24
Structural Formula:	
Molecular Weight:	168.33

1.2 Composition of the substance

Typical concentration (% w/w): Unknown

Concentration range (% w/w): unknown

no relevant impurities

1.3 Physico-Chemical properties

Table 1: Summary of physico-chemical properties

REACH ref Annex, §	**Property**	**IUCLID section**	**Value**	**[enter comment/reference or delete column]**
VII, 7.1	Physical state at 20°C and 101.3 kPa	3.1	liquid solid	
VII, 7.2	Melting/freezing point	3.2	61°C	Hüls AG (1979). Study not evaluated
VII, 7.3	Boiling point	3.3	244°C at 1013hPa	Meyer and Hotz (1975). Study not evaluated
VII, 7.5	Vapour pressure	3.6	0.07 hPa at 20°c	Meyer and Hotz (1976). Study not evaluated
VII, 7.7	Water solubility	3.8	< 1 mg/l 10 mg/l 0.11 mg/l	MITI (1992) Sicherheitsdatenblatt Huels AG. Study not evaluated WSKOW v1.41
VII, 7.8	Partition coefficient n-octanol/water (log value)	3.7 partition coefficient	6.19 6.12 (calculated) 6.7 (calculated)	MITI (1992) KOWWIN v1.67 CLOGP3 by Huels AG Marl
XI, 7.16	Dissociation constant	3.21	Not available	

2 MANUFACTURE AND USES

Two main uses of cyclododecane have to be considered:

- as intermediate, for :

  - the production of hexabromo-isomers of cyclododecane ($C_{12}H_{18}Br_6$) (HBCDD) wich are used as flame retardance,

  - the production of chemicals wich are used to make polyamides, polyesters, synthetic lubricating oils, nylon and high purity solvents (Sabljic, 1987 ; Kuney, 1991),

  - the production of 1-ethoxymethoxy-cyclododecane which is used in perfume composition as perfume exalting

  - the production of methoxy-cyclododecane as cleaning and washing agents

- as raw substance as binding media for temporarily sealing, consolidation and conservation of weak or friable materials in the field of excavation and transport of archeological objects and also as a facing adhesive, release agent and consolidant for old paints, papers and textiles… The main utilization (spray) is dispersive.

In the first case, according to the producers or suppliers (Degussa AG, TCI Europe NV, Merck Schuchardt OHG, Chemos GmbH, Dupont UK Ltd., Elf Aquitaine, Huels AG, Oexno Olefinchemie

GmbH…), the intermediate use occurs mainly in closed systems. The use tonnage is expected to be significant but not known at the day.

In the second case, according to the producers or suppliers (Kremer pigmente GmbH, www.kremer-pigmente.com and Hangleiter GmbH), cyclododecane has been widely used in Germany for these kinds of purposes. But analysis of literature shows that it is also used in other european countries, like France. The use volume for theses purposes can be expected to be lower than the first one, but is not known at the day.

3 CLASSIFICATION AND LABELLING

3.1 Classification in Annex I of Directive 67/548/EEC

Not classified

3.2 Self classification(s)

No self classification.

4 ENVIRONMENTAL FATE PROPERTIES

Cyclododecane may be released to the environment in wastewater streams, fugitive emissions generated at sites of its industrial production and sites of its use (Hall Howard, 1997). If released to soil, it is not expected to leach based upon an estimated Koc of 65000. If released to water, it may volatilize and partition to sediment.

4.1 Degradation

4.1.1 Stability

If released to the atmosphere, cyclododecane will abiotically be degraded. The rate constant for the vapour-phase reaction of cyclododecane with photochemically produced hydroxyl radicals has been estimated to be $1{,}67.10^{-11}$ cm^3/molecule-sec at 25°C, wich corresponds to an atmospheric half-life of about 23hr and a atmospheric concentration of 5.10^5 hydroxyl radicals par cm^3 (Atkinson, 1987). Reaction half-life with OH-radicals in the atmosphere was estimated at 22.7 hours by AopWin v1.91 ($5*10^5$ OH cm^{-3}; 24 h day^{-1}). No estimate for reaction with ozone was provided by the model. Alkanes are generally resistant to aqueous environmental hydrolysis (Lyman et al, 1990) ; therefore, cyclododecane is not expected to hydrolyze in the environment.

4.1.2 Biodegradation

According to MITI (1992), **0-12% of the substance was degraded after 14 days** in a ready biodegradability test with a test substance concentration of 100 mg l^{-1} and a sludge concentration of 30 mg l^{-1}.
Following tests with non-adapted micro-organisms are cited in the available IUCLIDs (European Commission, 2000; Degussa AG, 2002).
A closed bottle test according to the OECD 301 D guideline (Huels-Untersuchung, unveröffentlicht) resulted in **3% degradation in 28 days**.
In a BODIS test according to ISO 10708 (in preparation) degradation of **18% after 28 days** was observed (Huels-Untersuchung, unveröffentlicht). In addition, **no degradation was detected in 28 days** in a modified Sturm test (C.5. of 84/448/EEC; Hüls AG 1997). These results were not evaluated by the Rapporteur as the reports were not available.
Azolay et al. (1983) observed that two of five bacterial strains isolated from Mediterranean sediment from a polluted site grew well using cyclododecane as the sole carbon source. In a test employing a mixed bacterial sediment population from the same polluted site **30% of cyclododecane in a hydrocabon mixture was degraded after 8 day**s of incubation at 30ºC. Degradation in sediment from unpolluted site was used as reference. In addition, Schumacher and Fakoussa (1999) concluded that *Rhodococcus ruber* CD4 was oxidising cyclododecane as the sole carbon source at 28ºC. Cyclododecane was shown to be oxidized to cyclododecanol and cyclododecanone, followed by ring fission. The resulting lactone gives rise to an omega-hydroxyalkanoic acid, which is further degraded by common beta-oxidation.

4.1.3 Summary and discussion of persistence

Very slow or no biodegradation at all was observed in the tests, even if a significant degradation has been shown by an adapted inocula with mixed microbial population and by specific strains. Cyclododecane is considered not readily biodegradable. It is not expected to hydrolyse abiotically in the environment.
Based on these informations, this substance can be considered as very persistent in the environment. Insufficient data are available to predict the rates of importance of degradation processes and further testing are needed.

4.2 Environmental distribution

4.2.1 Adsorption/desorption

Based on an estimated Koc value of 6500, cyclododecane may partition form the water column to sediment and suspended material (Sabljic, 1987). According to an estimated Koc value of 6500 (Sabljic, 1987), cyclododecane is expected to be relatively immobile in soil.

Insufficient data are available.

4.2.2 Volatilisation

Based on vapour pressure of 0.07 hPa at 20°C, cyclododecane is considered to be a volatile substance and expected to exist almost entirely in vapour-phase in the ambient atmosphere (Eisenreich et al., 1981). Henry's law coefficient is calculated at > 100 Pa m^3 mol-1 (using vapour pressure mentioned above and all water solubility values given in Table 1) which indicates that the substance is highly and quickly volatile from water.
From water, volatilization half-lives of 3.8 and 45hr can be estimated for a model river (1m deep) and model pond (2m deep) respectively, when the effects of adsorption are not present (Lyman et al, 1990). In presence of adsorption (Koc of 6500), the volatilization half-life from the pond decrease to 43 days (EPA, 1987).

4.2.3 Distribution modelling

Cyclododecane is not subject to long-range atmospheric transport due to its short half-life in air. But adsorption to sediment in water may be important transport processes for cyclododecane.

Cyclododecane has been detected in all five of the great American lakes (Erie, Ontario, Huron, Superior and Michigan) aquatic ecosystems (Greta lakes water quality board, 1983) but concentrations, sampling dates and sample types were not reported by the authors.

4.3 Bioaccumulation

4.3.1 Aquatic bioaccumulation

4.3.1.1 Bioaccumulation estimation

BCFWIN v2.15 predicts BCF of 10,330 based on logK_{ow} of 6.12.

An estimated BCF of 74.000 indicates that bioconcentration in aquatic organisms may be important (Lyman et al, 1990).

4.3.1.2 Measured bioaccumulation data

Bioaccumulation of cyclododecane was studied in 1982 with common carp (Cyprinus carpio) (MITI, 1992). Nominal test concentrations of 3 and 30 µg l^{-1} were used. Tests were performed in a flow through system with 100 l glass tanks and with a flow rate of 1,155 l day^{-1}. Two dispersants (HCO-20 and HCO-40) were used in a concentration of 600 µg l^{-1} for each dispersant at the 30 µg l^{-1}test substance level and in a concentration of 60 µg l^{-1} at the 3µg $^{l-1}$ test substance level. Mean fish weight was 32.5 g and mean length 11 cm. Analysis of cyclododecane in water and fish were performed after 1,2,4,6,8 and 10 weeks. Two fish were sacrificed at each sampling occasion. Steady state appears to have been reached after 6 weeks based on measured concentrations in fish and water. A mean test concentration of 13 µg l^{-1} and a mean test concentration of 1µg l^{-1} were measured corresponding to 30 µg l^{-1} and 3µg l^{-1} nominal levels, respectively. Individual BCFs were calculated based on measured concentrations. The mean BCF of individual BCFs of the 6-10 week-samples was approximately 13,700 (wet weight basis) at both test concentrations. This value is considered to represent the steady state BCF.

Despite of several weaknesses (use of dispersants, significant difference in nominal and measured concentrations and large variation of the results), this study is considered to give sufficient evidence on a very high bioaccumulation.

4.3.2 Terrestrial bioaccumulation

No data available

4.3.3 Summary and discussion of bioaccumulation

For fish a BCF of 13,700 has been measured. The available QSAR-prediction is in line with the experimental result. **It is concluded that cyclododecane has a very high bioaccumulation potential**.

4.4 Secondary poisoning

No data available.

5 HUMAN HEALTH HAZARD ASSESSMENT

Not relevant for the PBT assessment

6 HUMAN HEALTH HAZARD ASSESSMENT OF PHYSICO-CHEMICAL PROPERTIES

Not relevant for this type of dossier.

7 ENVIRONMENTAL HAZARD ASSESSMENT

7.1 Aquatic compartment (including sediment)

7.1.1 Toxicity test results

It should be noted that due to the high volatility of cyclododecane from aqueous solution, monitoring of test concentrations is crucial for the plausibility of the data.

7.1.1.1 Fish

Short-term toxicity to fish

Hüls AG (1997) tested effects of cyclododecane on *Cyprinus carpio* in a semi static test according to the C.1. test guideline of Directive 84/449/EEC. The test solution was changed daily and test concentration was measured after and before the change of water (measured concentrations not reported in the IUCLID, Degussa AG, 2002). Test concentration was 1 mg l^{-1} which was the highest soluble concentration achieved. Temperature was 19.6-22.1ºC, dissolved oxygen stayed at 93-100% of saturation and pH was 8.0-8.6 during the test. One batch of ten fishes was used for the test and one fish was found dead at the day 4. LC_{50} (96 hours) > 1 mg l^{-1} resulted. It is noted that the rapporteur did not evaluate the study as the report was not available.

MITI (1992) found LC_{50} (48 hours) of 21.8 mg l^{-1} for *Oryzias latipes* in a test according to the Japanese standard JISK-0102-1986-71. Test conditions are provided for the whole set of substances tested as follows. Test system was static or semi-static (not specified); temperature 25 ± 2ºC and 10 fish per concentration were used. Test concentrations were not obviously monitored and therefore the result is considered as not valid.

In a static 48-hour test according to DIN 38412 Teil 15 no effects were observed in *Leucidus idus* up to the water solubility limit (Huels-Untersuchung, unveröffentlicht). No monitoring of test concentrations occurred according to the IUCLID (European Commission, 2000) and the test is therefore considered as not valid.

Ecosar v0.99h predicts using the neutral organics QSAR without corrections LC50 (96 hours) of 0.017 mg l^{-1} for fish. The result is in contradiction with the test data above.

<u>Long-term toxicity to fish</u>

No data available

7.1.1.2 Aquatic invertebrates

<u>Short-term toxicity to aquatic invertebrates</u>

A static study of Passino and Smith (1987) using *Daphnia pulex* resulted EC_{50} (48 hours) of 21 mg l^{-1}. Authors used ASTM procedures for the test. Five test concentrations were employed and solubility problems were encountered at higher test concentrations. Authors did not follow actual concentrations by monitoring. Hence, this test is considered not valid.

Hüls AG (1988) reported EC_{50} (24 hours) ≥ 2.6 mg l^{-1} for *Daphnia magna* from a DIN 38412 Teil 11 test. This study was not evaluated by the reporter as the report was not available.

Ecosar v0.99h predicts LC_{50} (48 hours) of 0.024 mg l^{-1} for Daphnia. This result is in contradiction with the test data above.

<u>Long-term toxicity to aquatic invertebrates</u>

No data available

7.1.1.3 Algae and aquatic plants

No effects were observed up to the highest test concentration (2.1 mg l^{-1}) in a test according to Directive 87/302/EEC, part C, p. 89 "Algal inhibition test" using *Scenedesmus subspicatus* (test duration 48 hours, static). Monitoring of test concentration was limited to the stock solution only (as cited in IUCLID of Degussa, 2002). Due to the volatility of cyclododecane its concentration in test vessels should have been monitored and the study is thus considered as not valid. It is noted that the Rapporteur could not fully evaluate the study as the report was not available.

Ecosar v0.99h predicts LC_{50} (72 hours) of 0.019 mg l^{-1} for algae. This result is in contradiction with the test data above.

7.1.1.4 Sediment organisms

No data available

7.1.1.5 Other aquatic organisms

No data available

7.1.2 Calculation of Predicted No Effect Concentration (PNEC)

7.1.2.1 PNEC water

No data available

7.1.2.2 PNEC sediment

No data available

7.2 Terrestrial compartment

No data available

7.3 Atmospheric compartment

No data available

8 PBT, VPVB AND EQUIVALENT LEVEL OF CONCERN ASSESSMENT

8.1 Comparison with criteria from annex XIII

Persistence: based on the biodegradability screening tests available, cyclododecane is considered to be not readily biodegradable. The substance has been observed to be degraded by adapted marine sediment micro-organisms and by specific microbial strains but no environmentally relevant degradation rates have been determined. Cyclododecane is not expected to hydrolyse abiotically in the environment. The substance is therefore considered to meet the P/vP screening criterion.

Further testing would be needed to quantify the rate of biodegradation in the environment, but based on the very slow or negligible biodegradation in the tests conducted with non-adapted organisms; it is considered that further information would be unlikely to give evidence on fast degradation. The substance is mainly used as intermediate, and it is therefore considered that no further testing is required at the present.

Bioaccumulation: the available study provides a BCF of 13,700 for fish. Cyclododecane is considered fulfilling the vB criterion.

Toxicity: QSARs predict acute $L(E)C_{50}$ values which are clearly below 0.1 mg l^{-1}. Of the data provided in the IUCLIDs, one fish test seems reliable providing $LC_{50} > 1$ mg l^{-1}. This study could not be evaluated by the reporter as the report was not available. Other ecotoxicity results have been reported, but due to lacking information on actual test concentrations, they are considered unreliable. In the absence of reliable toxicity data, cyclododecane is considered fulfilling the T screening criterion based on the QSAR predictions.

8.2 Conclusion of PBT and vPvB or equivalent level of concern assessment

Cyclododecane is considered to be a PBT and vPvB substance based on the screening criteria. The substance fulfils the vB criterion. The P/vP criterion and the T screening criterion are also met.

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INFORMATION ON USE, EXPOSURE, ALTERNATIVES AND RISKS

1 INFORMATION ON EXPOSURE AND USE

Please refer to Section 2 of the Justification part of this report (list of the main categories of uses).

Concerning occupational exposure, the NIOSH has statistically estimated that 28 workers were concerned in 1989 by the use of cyclododecane in the US and potentially exposed (use as raw substance as described in chapter 1).

But according to the recent rise in interest for the use of this substance for archeological and restoration activities, and especially in Europe due to the importance of its historical heritage, the number of users and the tonnage used are expected to be higher. Moreover, cyclodecane is being used in more and more restoration activities.

No more data are available at the day.

2 INFORMATION ON ALTERNATIVES

2.1 Alternative substances

For the use of cyclododecane as binding media for archeological and restoration activities, camphene, tricyclene and menthol have been identified as alternative substances.

But no more data are available for this purpose and for the others.

2.2 Alternative techniques

No data available

3 RISK-RELATED INFORMATION

The use for excavation and restoration outdoor activities is a dispersive way of cyclododecane in the environment, from archeological sites for example. According to the persistence and bioaccumulation ability of this substance in soil and aquatic ecosystems, a significant risk can be expected.

REFERENCES

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