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Tert-Amyl Methyl Ether (TAME)

The Global Product Strategy (GPS) Safety Summary gives an overview of information on chemical products in the framework of the International Council of Chemicals Association (ICCA) initiative and is focused on the products' basic characteristics related to safe use. All the information for health, safety and environment for this specific product can be found in the extended Safety Data Sheet (e- SDS) provided by Hellenic Petroleum SA to its customers.

GENERAL INFORMATION

TAME is mainly a component in gasoline enhancing octane properties. A minor use is as process solvent for production of various products. TAME is a low molecular weight, highly flammable liquid of moderate volatility. In contradiction to other ethers TAME does not readily form explosive peroxides. The database for the toxic and eco toxic effects of TAME when supplemented by read-across to test data for structurally similar ethers (Methyl Tertiary Butyl Ether/MTBE and Ethyl Tertiary Butyl Ether/ETBE), permits a reliable evaluation of its hazard properties. TAME should not enter surface water and soil. If the recommendations under the section below "Risk Management Measures" are applied, the substance can be handled safely.

CHEMICAL IDENTITY

Name	Tert-Amyl Methyl Ether (TAME)
Trade name	TAME
IUPAC Name	2-methoxy-2-methylbutane
CAS Number	994-05-8
EC Number	213-611-4
Molecular formula	C ₆ H ₁₄ O

USES AND APPLICATIONS

TAME has many properties which make it an excellent gasoline component for cleaner and sustainable fuels. Because of the oxygen in the molecule, when used as part of the gasoline formulation, TAME leads to a reduction in emissions of exhaust pollutants (such as volatile organic compounds and particulates). Reducing these pollutants improves air quality.

PHYSICAL AND CHEMICAL PROPERTIES

TAME is a colorless liquid with a characteristic sweetish odor. The liquid is lighter than water, but relatively soluble in water while vapors are heavier than air. Based on its boiling point and flash point, TAME is classified as highly flammable liquid according to the Globally Harmonized System (GHS) for the classification and labeling of chemicals.

Property	Value
Physical State	Liquid
Color	Colorless
Odour	Sweetish
Density	0.77 g/cm ³ (15°C)
Boiling point	87.3 °C
Flash point	-18°C
Explosive properties	No explosive properties
Self-ignition temperature	430°C
Vapor pressure	91hPa (25°C)
Water solubility	c.a. 10.4 g/l, at 20°C
Viscosity (kinematic)	0,494 mm ² /s at 40°C
Octanol-Water partition coefficient (logKow)	1,55

HEALTH EFFECTS

Human health hazard assessment

The human health toxicological hazards of TAME indicate slight acute toxicity by the oral and low acute toxicity by dermal and inhalation routes of exposure. Transient signs of altered nervous system function are observed with exposure to high levels. This substance may pose an aspiration hazard. Irritation to eyes and skin has not been observed from contact to liquid. There is no evidence of respiratory irritation with exposure or allergic skin or respiratory reactions. The substance is readily absorbed by oral exposure or respiration but absorption through the skin is expected to be low.

Effects noted in repeated-exposure studies in rodents reveal target organ effects specific to rodents that are not relevant to human health or occurred at very high dose levels of low relevance to human exposures. Tests conducted in bacteria, mammalian cells and in animals demonstrate TAME is not mutagenic / genotoxic. In the available repeated dose studies no clear evidence of pre-neoplastic lesions were observed. Based on all available data, lack of alert from molecule structure and results of carcinogenicity testing for the related substances ETBE and MTBE it's therefore concluded that that TAME is not a cancer concern to humans. There were no specific effects observed in studies of reproduction conducted in rats and developmental toxicity conducted in rats. Developmental effects (cleft palate) in mice were only observed at maternal toxic concentrations.

The table below gives an overview of the health effects assessment results for TAME.

Effect Assessment	Result
Acute toxicity Oral/Inhalation/dermal Irritation/corrosion Skin/eye/respiratory tract Sensitization	Harmful if swallowed. Low acute toxicity by dermal and inhalation routes. May cause drowsiness or dizziness. Non-irritating to the eye and skin
Toxicity after repeated exposure Oral/dermal/inhalation Genotoxicity/mutagenicity Carcinogenicity Toxic for reproduction	Not considered to be sensitising Effects on adrenals, liver and kidney at exposures of ≥ 250 ppm (inhalation) or >125 mg/kg bodyweight (oral) Not mutagenic / genotoxic Not considered to be a human cancer concern No adverse effects on fertility and not selectively toxic to the fetus

ENVIRONMENTAL EFFECTS

Environmental hazard assessment

The log Kow value of TAME is low suggesting a low potential for bioaccumulation. The half-life in the atmosphere is about 3.07 days due to reaction with hydroxyl radicals in the atmosphere. So reaction with atmospheric hydroxyl radicals is a relevant removal pathway from the environment. In addition, TAME is inherently biodegradable under certain conditions in aquatic aerobic environments but likely to be readily biodegradable when sewage sludge has become adapted to the substance. Overall TAME is a low ecotoxicity hazard based on the results of acute and chronic studies conducted on various trophic levels of aquatic species, including freshwater and marine organisms, for TAME and structurally similar ethers (MTBE,ETBE). Therefore TAME is not a PBT substance (Persistent, Bioaccumulative, Toxic).The table below gives an overview of the environmental assessment results for TAME.

Effect Assessment	Result
Aquatic Toxicity	Low toxicity to water organisms
Fate and behavior	Result
Biodegradation	Inherently biodegradable under certain conditions in aerobic environment
Bioaccumulation potential PBT/vPvB conclusion	Not bio-accumulative Neither considered to be PBT nor vPvB

EXPOSURE

Human health

Worker: Exposure can occur in a TAME manufacturing or formulation facility, during storage, transport and delivery of TAME and gasoline, and in the use of fuels containing TAME. Improved technology has led to a continuous reduction of these exposures. The use as a process solvent takes place in closed systems with limited exposure only. Each facility should have a thorough training program for employees and appropriate work processes and safety equipment in place to limit unnecessary

exposure. Workers should follow the recommended safety measures in the Extended Safety Data Sheet.

Consumer: Exposure to consumers can occur resulting from the use of fuels containing TAME. However, consumers are not expected to come into contact with harmful levels of TAME, as the substance is only used at low concentrations in fuels.

For both worker and consumer, the concentrations to be expected -based on model calculations-are below the No Effect Levels derived from toxicity data if the Risk Management Measures noted below are observed.

Environment

Exposure to the environment may take place during manufacturing, transport, formulation and storage and during professional and consumer use operations. In the case of manufacturing, emissions to the environment are primarily to water with smaller fractions to air and soil. In the case of storage, approximately equal fractions are emitted to air and water with no release to soil. In the case transport, formulation, and customer use, emissions to the environment are primarily to air with lower fractions in water and soil. Indirect exposure via air, food, or water will not pose a risk to humans. Based on model calculations, if the Risk Management Measures noted below are observed, the concentrations expected to the aquatic and terrestrial environment are below the Predicted No Effect Levels in fresh water and soil, respectively.

RISK MANAGEMENT MEASURES

For the detailed Risk Management Measures (RMMs) please consult the extended Safety Data Sheet of this product

Industry use, production and formulation

TAME should only be handled by knowledgeable and trained personnel. Make sure that there is adequate ventilation at workplace. Do not eat, drink or smoke where TAME is handled or stored. Adequate closed storage facilities are needed. All formulation activity is assumed to involve a predominantly enclosed process. In the case of transfer or maintenance operations, clear transfer lines prior to decoupling and flush/drain to a closed system for recycle prior to opening equipment. In cases where engineering controls cannot maintain airborne substance concentrations below exposure limits or in cases with a risk of accidental exposure, additional risk management measures are necessary, such as the use of a complete overall protecting against chemicals and respirator use.

Consumer use

TAME containing fuels are for adult use only. When fueling a car or other vehicle, the safety and handling instructions at the fueling station should be understood and followed. Adult use only. Time for fuelling the car: 15 minutes, maximum three times per week, 150 times per year with an amount of 60lt and maximum 15%w/w TAME in the gasoline.

Environment

Prevent any leak or spill. Develop a comprehensive spill plan. Prevent entry into waterways or sewers. Comply with national legislation for the disposal.

PERSONAL PROTECTIVE EQUIPMENT AND EMERGENCY MEASURES

		<ul style="list-style-type: none"> ➤ For short term exposure: respirator with organic vapor cartridge ➤ For long term exposure : full face respirator with a chin style or a front or back mounted organic vapor canister
		<ul style="list-style-type: none"> ➤ Protective gloves ➤ Flame retardant protective overall
		<ul style="list-style-type: none"> ➤ Safety glasses skintight
First aid measures		<ul style="list-style-type: none"> ➤ Implement emergency response procedures. Wash affected skin and eyes with plenty of water. Contaminated clothing should dry before washed.
Firefighting measures		<ul style="list-style-type: none"> ➤ Small fire: carbon dioxide, dry chemicals, water spray, alcohol resistant foam ➤ Large fire: water spray, water fog or alcohol resistant foam ➤ Unsuitable extinguishing media : water
Accidental release measures		<ul style="list-style-type: none"> ➤ For containment: Absorb or cover with dry earth or sand, transfer to containers ➤ For clean up: Use antistatic equipment. Water spray may reduce vapor but may not prevent ignition in closed spaces

CLASSIFICATION AND LABELLING

EU-GHS Criteria (European Regulation, CLP No1272/2008)	Tert-Amyl Methyl Ether (TAME)
Pictograms	
Signal word	Danger
Hazard class and category code	Flam.Liq.2;H225,Acute Tox.4;H302,STOT Single Exp.3;H336
Hazard statement code	H225 Highly flammable liquid and vapor H302 Harmful if swallowed H336 May cause drowsiness or dizziness (Affected Organs: Central Nervous System Route of exposure: Inhalation)
Precautionary statements	<i>Prevention</i> P210 Keep away from heat/sparks/open flames/hot surfaces-No smoking P243 Take precautionary measures against static discharge P261 Avoid breathing vapors/gas/mist/spray P271 Use only indoors or in a well-ventilated area <i>Response</i> P301+ P312 IF SWALLOWED: Call a POISON CENTER or doctor/physician if you feel unwell P304+P340 IF INHALED: Remove to fresh air and keep at rest in a position comfortable for breathing <i>Storage</i> P403+P235 Store in a well-ventilated place. Keep cool.

BASIC TRANSPORT INFORMATION

UN Number :3271

STATE AGENCY REVIEW

- European Regulation EU-GHS No. 1272/2008, Index-No. 603-213-02
- European Regulation No793/93 (risk assessment)
- The substance has been registered under REACH Regulation No 1907/2008
- International Chemical Safety Cards (ICSC)

CONCLUSIONS

- TAME has many properties which make it a good gasoline component for cleaner burning fuels.
- TAME is a highly flammable liquid, has slight acute toxicity by oral route and low acute toxicity by dermal and inhalation route to human health. Does not cause irritation to eye and skin. Vapors may cause drowsiness and dizziness It has low toxicity to water organisms.
- By applying the appropriate Risk Management Measures, the TAME concentrations to be expected at workplaces and to the general public/consumer are below recommended exposure limits.

CONTACT INFORMATION

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- For more information on the GPS Safety Summaries follow the link :
<http://www.icca-chem.org/en/Home/ICCA-initiatives/global-product-strategy/>

ABBREVIATIONS

ICCA :International Council of Chemical Associations

GPS: Global Product Strategy

GHS: Globally Harmonized System

CLP: Classification, Labelling, Packaging

REACH: Registration, Evaluation, Authorisation of Chemicals

PBT/vPvB: Persistent, Bio accumulative and Toxic/very Persistent and very Bio

UN: United Nations

DISCLAIMER

All information and recommendations provided in this GPS Safety Summary, only concern the specific product as described above, and may not apply for the same material if used in combination with any other material or in any process. They are provided in good faith as recommendations only, and are based on data which Hellenic Petroleum SA has available on the above date. They do not supersede or replace required documents by National or European Legislation. However, Hellenic Petroleum SA cannot guarantee their accuracy and validity and accepts no responsibility for any damage or loss that might arise in connection with the use of this material.