

# Solvent Alternatives



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## CTC PHASE-OUT – WHY?

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**THE PROBLEM:** Carbon tetrachloride (CTC), a common cleaning solvent, poses a health risk and endangers life on Earth. Occupational exposure affects the central nervous system (CNS) causing dizziness, headache and vomiting. Moreover it is rated as a possible human cancer hazard.

Once evaporated, CTC rises up to the atmosphere where it destroys the ozone layer. This allows more ultraviolet (UV) rays to pass through the ozone shield that protects our Earth. UV rays contribute to eye cataract and skin cancer, besides endangering plants and aquatic life.

Thus the impacts of CTC are felt at the local workplace as well as on our planet as a whole.

**THE SOLUTION:** To protect our health and environment we have to stop using CTC and other substances that destroy the ozone layer.

**THE RESOLUTION:** India has signed the Montreal Protocol and, along with more than 185 countries across the globe, has resolved to remove CTC from the market. Starting with a sharp reduction in January 2005, CTC supplies will further decline until the phase-out is completed by December 2009.



## HOW GTZ ASSISTS YOU

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**EVALUATION:** In consultation with affected industries, GTZ evaluates the requirements of processes in which CTC is currently used. High emphasis is placed on dialogue with users to ensure that technical and economical dimensions of the processes involved are well understood.

**SUBSTITUTE IDENTIFICATION:** The process of identifying suitable CTC substitutes is in full swing. For most industry segments one or more alternative products have already been found. In many cases GTZ can draw on the experience of industries that already use alternatives successfully.

**SUBSTITUTE TESTING:** To throw light on critical parameters such as performance, cost and possible risks for health and safety, GTZ conducts tests on substitute candidates in the laboratory and in the industry. The aim is to provide reliable information that enables informed decisions.

**SHARING:** Ultimately, information on substitute products and processes is made available to industries, free of charge. Besides publications, GTZ holds technical seminars for the concerned industries and engages in capacity building wherever required.

## THIS BOOKLET IN A NUTSHELL

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**THIS BOOKLET** presents a selection of 19 solvents available on the Indian market. Its purpose is not to endorse or recommend these products but to increase awareness of alternative solvents that do not destroy the ozone layer.

**THERE IS NO IDEAL SOLVENT.** Physical properties, price, health and safety risks vary from one solvent to another. Each one has its own limitations. While all solvents are toxic, the degree varies from one substance to another. Besides, they may be carcinogenic and/or fire hazards. Therefore an understanding of strengths and weaknesses is essential for taking informed decisions.

**MANY ALTERNATIVES EXIST.** Evidently, a single solvent cannot address the requirements of all industries using CTC. Given the variety of materials on which CTC is used, the best alternative for one industry may not be suitable for another. For any application there may exist a host of alternative options. From among these the best are to be found in a careful process of selection and trial. This booklet aims to guide you in this challenging task.

**FIND EXPLANATIONS** for important terms used in this booklet in the chapter EDITORIAL NOTES on page 43.

## POINTS TO CONSIDER

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**FLAMMABILITY** is common to ordinary hydrocarbon solvents such as petroleum derivatives, alcohols, esters, ketones and terpenes. To ensure a maximum level of safety, one should select solvents with as high a flash point temperature as possible. Safe usage requires a well ventilated work space away from open fire or other sources of ignition.

Several members of the group of chlorinated solvents are non-flammable. However, this advantage comes at a cost: chlorinated solvents pose a human cancer risk (see **CANCER RISK** below).

**TOXICITY** is common to all solvents. What varies however is the degree of the impact. In cases where solvents are used continuously, their long term effects need to be considered carefully. Although these effects may not be immediately felt, the damage caused over time may be irreversible.

**CANCER RISK** exists from Benzene and all chlorinated solvents such as Trichloroethylene (TCE) and Perchloroethylene (PCE). Their safe use requires effective prevention of inhalation of vapours. Contrary, open indoor cleaning processes without adequate vapour suction equipment – as common in the industry – are prone to put workers' health at risk.

# Solvent Profiles



# ACETONE

*Common names:* 2-Propanone; Ketone Propane; Dimethyl Formaldehyde; Dimethylketal; Dimethyl Ketone; Beta-Ketopropane; Methyl Ketone; Pyroacetic Acid; Pyroacetic Ether.

|                   |                         |
|-------------------|-------------------------|
| Type:             | Ketone                  |
| CAS number:       | [67-64-1]               |
| Price band:       | 50 - 75 Rs/litre + VAT  |
| Flammability:     | <b>Highly flammable</b> |
| Flash point:      | - 20 °C                 |
| Boiling point:    | 56 °C                   |
| Specific gravity: | 0.79 g/cm <sup>3</sup>  |
| Vapour pressure:  | 180 mm Hg               |
| Dipole moment:    | 2.9 Debye               |
| Solvency power:   | (not available)         |

## Known applications

- **Cleaning agent** for fabric, for rubber cots and metal rollers in spinning mills, for films and lamination machine rollers in offset printing, for finishing of diamonds, for electrical contacts, for degreasing wool and de-gumming silk.
- **Cleaning solvent** in the electronics industry.
- **Solvent** for adhesives, contact cements, printing inks, gums, waxes, resins, fats, greases, oils and dyestuffs, and for manufacture of cosmetics.

- **Component** in preparation of surface coatings, thinners, acrylic and nitrocellulose lacquers and paints.

## Health concerns

Acetone is not known to be carcinogenic.

**Short-term exposure** at low concentrations results into sensory irritation and mild depression of the central nervous system (CNS), although some may develop a certain tolerance to the effects.

Higher exposure levels can cause headache, dizziness, a feeling of drunkenness, drowsiness, lack of coordination, confusion, nausea, vomiting, and throat and eye irritation.

Extremely high exposure can cause unconsciousness, collapse, coma and even death.

Acetone is toxic for the liver and effects may be enhanced if used in combination with other solvents.

**Long-term exposure** may reduce the fat content of the skin (see *Skin*).

**Skin:** Acetone is a skin irritant and can reduce the fat content of the skin on prolonged or repeated exposure, causing a dry cracking skin (dermatitis).



## BENZENE

*Common names:* Benzol; Carbon Oil; Coal Naphtha; Cyclohexatriene; Phenyl Hydride. Not to be confused with *Benzine*.

|                   |                         |
|-------------------|-------------------------|
| Type:             | Aromatic hydrocarbon    |
| CAS number:       | [71-43-2]               |
| Price band:       | 60 - 68 Rs/litre + VAT  |
| Flammability:     | <b>Highly flammable</b> |
| Flash point:      | - 11 °C                 |
| Boiling point:    | 80 °C                   |
| Specific gravity: | 0.88 g/cm <sup>3</sup>  |
| Vapour pressure:  | 75 mm Hg                |
| Dipole moment:    | 0 Debye                 |
| Solvency power:   | 107 KB                  |

### Known applications

- **Solvent** in printing and lithography.
- **Diluent** in lacquers and paint removers.

### Health concerns

 Usage strongly discouraged. Benzene is a confirmed human cancer hazard and harms the developing foetus. Pregnant and nursing women should avoid exposure. In developed countries commercial use as a solvent has been radically eliminated because of its toxicity.

**Short-term exposure** causes headache, tiredness and irritation in nose, throat and eyes. A period of feeling excited or giddy may precede the onset of other symptoms.

Higher concentrations cause depression of the central nervous system (CNS) marked by drowsiness, dizziness, headache, nausea, loss of coordination, confusion and unconsciousness.

Exposure to extremely high concentrations may result in death.

**Long-term exposure** causes severe damage to bone marrow resulting in aplastic anaemia, an acquired and perhaps lethal disorder where the bone marrow fails to produce sufficient blood and clotting cells. Symptoms include an increased incidence of headaches, fatigue, difficulty in sleeping and memory loss.

Benzene also causes reproductive and developmental damage resulting in reduced weight of the foetus, foetal chromosome damage, birth defects and leukaemia.

**Skin:** Benzene is a skin irritant and can cause a dry cracking skin (dermatitis).

## CHLOROFORM

*Common names:* Trichloromethane; Trichloroform; Formyl Trichloride; Methane Trichloride; Methenyl Trichloride; Methyl Trichloride; Freon 20.

|                   |   |
|-------------------|---|
| Type:             | Chlorinated hydrocarbon                       |
| CAS number:       | [67-66-3]                                     |
| Price band:       | 67 - 89 Rs/litre + VAT<br>45 - 60 Rs/kg + VAT |
| Flammability:     | None  |
| Flash point:      | None  |
| Boiling point:    | 62 °C   |
| Specific gravity: | 1.48 g/cm <sup>3</sup>                        |
| Vapour pressure:  | 160 mm Hg                                     |
| Dipole moment:    | 1.2 Debye                                     |
| Solvency power:   | 67 KB   |

### Known applications

- **Cleaning solvent** for films in offset printing.
- **Used** for bonding pieces of acrylic glass.
- **Laboratory chemical** for dilution, extraction and liquid chromatography.
- **Extracting agent** for nitrogenous chemicals from plants such as poppies and datura.
- Earlier used as an **anaesthetic** in surgeries (in the late 19<sup>th</sup> and early 20<sup>th</sup> Centuries). Has now

been discontinued from use and replaced by less harmful and more effective anaesthetics.

### Health concerns

Chloroform is **possibly carcinogenic**. It may cause reproductive damage and result in malformation of the baby or foetal death. Pregnant and nursing women should avoid exposure.

**Short-term exposure** depresses the central nervous system (CNS). Inhalation causes dizziness, headache, fatigue, stomach upset, irritation of the mucous membranes, eyes and skin and loss of consciousness (as it acts as an anaesthetic).

Inhalation of higher concentrations leads to redness of the eyes, paralysis, cardiac and respiratory failure and death.

Exposure of the eyes to liquid Chloroform can cause burning, pain and possible corneal injury. Skin exposure causes burning, pain and redness (see *Skin*).

**Long-term exposure** can cause liver enlargement, CNS depression and gastrointestinal disorders. Repeated skin contact can cause dermatitis (see *Skin*).

**Skin:** Chloroform causes burning, pain and redness. Prolonged or repeated exposure can cause dermatitis.

## CYCLOHEXANE

*Common names:* Hexamethylene; Hexanaphthene; Hexahydrobenzene; Benzenehexahydride.

|                   |                         |
|-------------------|-------------------------|
| Type:             | Alicyclic hydrocarbon   |
| CAS number:       | [110-82-7]              |
| Price band:       | 70 - 130 Rs/litre + VAT |
| Flammability:     | Highly flammable        |
| Flash point:      | - 20 °C                 |
| Boiling point:    | 81 °C                   |
| Specific gravity: | 0.78 g/cm <sup>3</sup>  |
| Vapour pressure:  | 78 mm Hg                |
| Dipole moment:    | 0 Debye                 |
| Solvency power:   | 58 KB                   |

### Known applications

- **Solvent** for paints, varnishes, lacquers, resins, fats, waxes, oils, bitumen, cellulose ethers, and crude rubber.
- **Used** in the manufacture of adhesives and perfumes, in essential oil extraction, in analytical chemistry for molecular weight determination and in fungicidal formulations.
- **Component** in sealants, laundry starch preparations, special cleaning products and paint and varnish removers.

### Health concerns

Cyclohexane is not known to be carcinogenic.

**Short-term exposure** to the vapours of Cyclohexane causes irritation of the eyes and mucous membranes.

Exposure to higher vapour concentration is likely to cause dizziness, nausea, and other narcotic effects.

Severe exposure can cause, vomiting, lack of coordination and may lead to narcosis and coma.

Contact with Cyclohexane, liquid or vapour, can damage the eyes.

**Long-term exposure** may affect the central nervous system (CNS) and causes eye damage and respiratory problems. Cyclohexane is known to reduce the fat content of the skin (see *Skin*).

**Skin:** Prolonged or repeated exposure to Cyclohexane reduces the fat content of the skin, causing a dry, scaly, fissured dermatitis.

## DICHLOROETHANE

*Common names:* 1,2-Dichloroethane; 1,2-DCE; Ethylene Dichloride; Ethylene Chloride; Dutch Oil; Glycol Dichloride; Freon 150. Not to be confused with 1,1- or 1,2-Dichloroethylene.

|                   |   |
|-------------------|---|
| Type:             | Chlorinated hydrocarbon                       |
| CAS number:       | [107-06-2]                                    |
| Price band:       | 43 - 86 Rs/litre + VAT<br>35 - 70 Rs/kg + VAT |
| Flammability:     | <b>Highly flammable</b>                       |
| Flash point:      | 13 °C   |
| Boiling point:    | 84 °C   |
| Specific gravity: | 1.24 g/cm <sup>3</sup>                        |
| Vapour pressure:  | 64 mm Hg                                      |
| Dipole moment:    | 1.6 Debye                                     |
| Solvency power:   | (not available)                               |

### Known applications

- **Solvent** for rubber, fats, oils, greases, waxes, gums and resins.
- **Cleaning agent** for metal, leather and rubber. Metal degreasing and pickling agent; dry cleaning agent.
- **Component** of cosmetics, carpet and upholstery cleaners, degreaser compounds, rubber and acrylic adhesives, and synthetic resin.

- **Further uses** as wetting and penetrating agent, water softener, pesticide, fumigant, in photography and xerography, and as extracting agent for spices.

### Health concerns

Dichloroethane is possibly carcinogenic.

**Short-term exposure** irritates eyes, nose and throat. Inhalation may cause depression of the central nervous system (CNS) with symptoms such as headache, nausea, drowsiness, drunkenness and fatigue.

Inhalation at high exposure levels may result in fluid accumulation in the lungs (pulmonary oedema), unconsciousness and death due to cardiac and respiratory failure.

**Long-term exposure** may cause damage to the lungs, liver, kidneys and adrenal glands. It may cause weight loss, low blood pressure, jaundice, reduced urine output, dermatitis, anaemia and eye-damage.

**Skin:** Dichloroethane is a skin irritant that reduces the fat content of the skin.

## ETHYL ACETATE

*Common names:* Acetic Ester; Acetic Ether; Acetic Acid, Ethyl Ester; Ethyl Acetic Ester; Acetoxyethane; Ethyl Ethanoate; Ester of Ethanol and Acetic Acid; Ethanoic Acid Ethyl Ester; Vinegar Naphtha.

|                   |                         |
|-------------------|-------------------------|
| Type:             | Ester                   |
| CAS number:       | [141-78-6]              |
| Price band:       | 50 - 65 Rs/litre* + VAT |
| Flammability:     | Highly flammable        |
| Flash point:      | - 4 °C                  |
| Boiling point:    | 77 °C                   |
| Specific gravity: | 0.90 g/cm <sup>3</sup>  |
| Vapour pressure:  | 76 mm Hg                |
| Dipole moment:    | 1.8 Debye               |
| Solvency power:   | (not available)         |

### Known applications

- **Solvent** for flexography and gravure printing; in varnishes, lacquers, paints, glues and nail-polish removers. Solvent for textile cleaning and metal vapour degreasing.
- **Used** for decaffeination of tea and coffee; naturally present in fruits and wine at low concentrations. Used in artificial fruit essences.

- **Further uses** as dilution and extraction agent; perfume odourant; insect fumigant, and, in entomology, insect poison. Used in the manufacture of artificial leather, photographic film and plates, artificial silks.

### Health concerns

Ethyl Acetate is not known to be carcinogenic. Though it is mildly toxic by ingestion, it is poisonous by inhalation. Moderately biodegradable.

**Short-term exposure** irritates respiratory tract causing burning, breathlessness, cough, headache, nausea and vomiting. It affects the central nervous system (CNS).

Exposure to high concentrations may cause damage to the lungs, liver or kidneys.

Contact with eyes can cause irritation, redness and pain.

**Long-term exposure** can cause damage to the liver and kidneys. It can also cause anaemia with an increase in white blood cells count (leucocytosis). Long term skin contact removes the fat content of the skin (see *Skin*).

**Skin:** Ethyl Acetate can cause defatting, dryness, cracking and dermatitis with symptoms such as itching, redness and pain.

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\* Based on 2 quotations only

# HEXANE

*Common names:* n-Hexane; Petroleum Ether; Petroleum Naphtha; Petroleum Benzene.

|                   |                         |
|-------------------|-------------------------|
| Type:             | Hydrocarbon alkane      |
| CAS number:       | [110-54-3]              |
| Price band:       | 45 - 50 Rs/litre + VAT  |
| Flammability:     | <b>Highly flammable</b> |
| Flash point:      | - 23 °C                 |
| Boiling point:    | 63 - 70 °C              |
| Specific gravity: | 0.69 g/cm <sup>3</sup>  |
| Vapour pressure:  | 124 mm Hg               |
| Dipole moment:    | 0 Debye                 |
| Solvency power:   | 29 KB                   |

## Known applications

- **Cleaning agent** for fabric, circuitry flushing in RAC, furniture, shoemaking and printing industries, particularly rotogravure printing.
- **Solvent** for special glues used in the shoe and leather industries; for varnishes and inks.
- **Component** in paint thinners, type-over correction fluids and degreasing agents.
- **Used** in binding books, working leather, shaping tablets and manufacture of tyres.

## Health concerns

Hexane is not known to be carcinogenic. Individuals with pre-existent neurological diseases must avoid exposure.

**Short-term exposure** may cause dizziness, confusion, nausea, headache and irritation of the eyes, nose and throat.

High exposure levels may effect functioning of brain and central nervous system (CNS), causing mild symptoms of drowsiness (narcosis) and neurological disturbances which usually continue for a few months after termination of exposure.

**Long-term exposure** may cause disturbances in sensations, muscle weakness and pain in the legs. In some cases it may lead to nerve disorders and/or paralysis of arms and legs. Symptoms include decreased muscle strength, numbness, and a tingling sensation in the arms and legs. Neurological disturbances could progressively worsen and become irreversible.

Changes in vision and tendency to colour discrimination may also occur.

**Skin:** Hexane is a strong skin irritant. Dermal contact results in immediate irritation characterized by redness of the skin (erythema) and increase in blood flow (hyperemia).

## ISOPROPYL ALCOHOL (IPA)

*Common names:* Isopropanol; 2-Propanol; Dimethylcarbinol; sec-Propyl Alcohol.

|                   |                        |
|-------------------|------------------------|
| Type:             | Secondary alcohol      |
| CAS number:       | [67-63-0]              |
| Price band:       | 65 - 85 Rs/litre + VAT |
| Flammability:     | Highly flammable       |
| Flash point:      | 12 °C                  |
| Boiling point:    | 82 °C                  |
| Specific gravity: | 0.79 g/cm <sup>3</sup> |
| Vapour pressure:  | 33 mm Hg               |
| Dipole moment:    | 1.7 Debye              |
| Solvency power:   | (not available)        |

### Known applications

- **Cleaning agent** in the manufacture of printed circuit boards (PCBs) semiconductors, and for finishing of diamonds.
- **Solvent** in printing applications, particularly in flexography, gravure printing, and lithography. Solvent for paints and metal cold degreasing.
- **Component** of industrial products such as metal cleaners, paints and thinners, epoxy adhesives, flexographic inks, gravure inks and packaging inks.

- **Component** of household products such as household cleaners, shoe polish, nail polish, nail polish removers, rubbing alcohol, perfumes, aftershave and body lotions.

### Health concerns

IPA is not known to be carcinogenic.

**Short-term exposure** is typically marked by irritation of the respiratory tract with coughing and chest discomfort, and irritation of eyes and mucous membrane.

Further symptoms may include mild depression of the central nervous system (CNS) leading to a perception of general weakness and lack of coordination.

High concentrations may result in depression of the CNS with symptoms ranging from drowsiness to loss of consciousness.

**Long-term exposure** can lead to reduction of the fat content of the skin (see *Skin*).

**Skin:** On prolonged or repeated exposure IPA sensitises the skin and reduces the fat content. This may cause dry cracking skin (dermatitis) and, in rare instances, eczema.

## D-LIMONENE

*Common names:* Citrene; Cinene; Cyclohexene; (+)-Limonene; D-(+)-Limonene; (R)-(+)-Limonene; (+)-R-Limonene; (+)-(4R)-Limonene; (+)-Carvene.

|                   |                        |
|-------------------|------------------------|
| Type:             | Terpene                |
| CAS number:       | [5989-27-5]            |
| Price band:       | 350 Rs/litre* + VAT    |
| Flammability:     | Flammable              |
| Flash point:      | 43 °C                  |
| Boiling point:    | 176 °C                 |
| Specific gravity: | 0.84 g/cm <sup>3</sup> |
| Vapour pressure:  | 2 mm Hg                |
| Dipole moment:    | 2.6 Debye              |
| Solvency power:   | 67 KB                  |

### Known applications

- **Solvent** for cleaning and degreasing metal and machine parts. Cleaner for electronics and tar; graffiti remover.
- **Component** of household cleaner, aerosol formulations, printing press wash, metal cleaner and petroleum tank cleaner.
- **Used** as fragrance ingredient, fragrance additive or odour mask in formulated products due to its

pleasant orange fragrance. Used as a flavouring agent in food manufacturing.

- **Further use** as botanical insecticide, heat transfer fluid and asphalt release agent.

### Health concerns

d-Limonene is not known to be carcinogenic. It is considered biodegradable and environmentally safe.

**Short-term exposure** can cause nose, throat, and respiratory tract irritation, coughing and headache. Mild irritant to eyes; can cause redness.

**Long-term exposure** can lead to reduction of the fat content of the skin (see *Skin*).

**Skin:** Repeated exposure to d-Limonene may cause skin irritation and dermatitis.

\* Based on 1 quotation only

## METHANOL

*Common names:* Methyl Alcohol; Wood Alcohol; Wood Naphtha; Wood Spirit; Hydroxymethane; Methyl Hydroxide; Methyl Hydrate; Pyroxylic Spirit; Monohydroxymethane; Colonial Spirit; Columbian Spirit; Carbinol; Meths.

|                   |                        |
|-------------------|------------------------|
| Type:             | Alcohol                |
| CAS number:       | [67-56-1]              |
| Price band:       | 26 - 35 Rs/litre + VAT |
| Flammability:     | Highly flammable       |
| Flash point:      | 11 °C                  |
| Boiling point:    | 64 °C                  |
| Specific gravity: | 0.79 g/cm <sup>3</sup> |
| Vapour pressure:  | 96 mm Hg               |
| Dipole moment:    | 1.7 Debye              |
| Solvency power:   | (not available)        |

### Known applications

- **Solvent** for machinery manufacture and repair, electroplating, equipment cleaning, cleaning of semi-conductors, paint and varnish stripping, and for finishing of diamonds.
- **Used** in printed circuit board manufacturing, as dilution and extraction solvent, in liquid chromatography and as antifreeze.

### Health concerns

Methanol is not known to be carcinogenic. It is foetotoxic and can harm the developing foetus. Pregnant and nursing women should avoid exposure.

**Short-term exposure** causes headache, dizziness, nausea and weakness.

Higher concentrations may affect the central nervous system (CNS) with symptoms ranging from convulsions to possible death.

Inhalation of Methanol vapours could also cause visual impairment and possible permanent blindness.

On eye-contact Methanol causes redness and irritation in the eyes. It is absorbed by the skin and causes dryness and redness (see *Skin*).

**Long-term exposure** may affect the central nervous system (CNS) causing recurring headaches and blindness. It can lead to reduction of the fat content of the skin (see *Skin*).

**Skin:** Methanol is absorbed by the skin and causes dryness and redness. Repeated or prolonged exposure may cause dermatitis.

## METHYL ETHYL KETONE (MEK)

*Common names:* Methyl Acetone; Butanone; 2-Butanone; 3-Butanone; Methyl 2-Propanone.

|                   |                        |
|-------------------|------------------------|
| Type:             | Ketone                 |
| CAS number:       | [78-93-3]              |
| Price band:       | 80 - 90 Rs/litre + VAT |
| Flammability:     | Highly flammable       |
| Flash point:      | - 9 °C                 |
| Boiling point:    | 79 °C                  |
| Specific gravity: | 0.81 g/cm <sup>3</sup> |
| Vapour pressure:  | 78 mm Hg               |
| Dipole moment:    | 2.8 Debye              |
| Solvency power:   | (not available)        |

### Known applications

- **Solvent** for grease, gums, resins, wax, cellulose acetate and cellulose nitrate.
- **Used** as metal degreaser and for cleaning of rubber cots in spinning mills.
- **Component** of adhesives, paints, lacquers, varnishes, paint removers, glues, magnetic tapes and printing inks.
- **Further uses** as extracting solvent in the food processing industry.

### Health concerns

MEK is not known to be carcinogenic. It is mildly foetotoxic. Pregnant and nursing women should avoid exposure.

**Short-term exposure** irritates the respiratory tract causing burning, coughing or difficulty breathing. It causes depression of the central nervous system (CNS), headache, dizziness and nausea.

MEK irritates the eyes causing redness, swelling or blurred vision.

**Long-term exposure** might cause nerve damage. In animals, chronic inhalation is known to cause slight neurological, liver, kidney and respiratory disorders. It can lead to reduction of the fat content of the skin (see *Skin*).

**Skin:** Contact with the skin can be irritating and repeated or prolonged exposure can lead to defatting cracking, dryness, and dermatitis.

## METHYLENE CHLORIDE

*Common names:* Methylene Dichloride (MDC); Methylene Bichloride; Methane Dichloride; Dichloromethane; Freon 30.

|                   |   |
|-------------------|---|
| Type:             | Chlorinated hydrocarbon                       |
| CAS number:       | [75-09-2]                                     |
| Price band:       | 60 - 80 Rs/litre + VAT<br>45 - 60 Rs/kg + VAT |
| Flammability:     | None  |
| Flash point:      | None  |
| Boiling point:    | 40 °C   |
| Specific gravity: | 1.33 g/cm <sup>3</sup>                        |
| Vapour pressure:  | 350 mm Hg                                     |
| Dipole moment:    | 1.6 Debye                                     |
| Solvency power:   | 136 KB  |

### Known applications

- **Cleaning solvent** for metal, electric components and plastic moulds; often as blend with Trichloroethylene or Perchloroethylene. Vapour degreaser for metal.
- **Used** for cleaning of rubber cots in spinning mills as blend with Trichloroethylene.
- **Solvent** in textiles and leather surface coatings; solvent for insecticides, resins, bitumen, lacquers, oils, waxes, and rubber.

- **Component** of preparations of paints, varnishes, and carbon removers.
- **Further uses** as blowing agent for flexible foams; as diluent for propellants in low pressure aerosols; as extracting agent for fats and oils; as fumigant; and as refrigerant.

### Health concerns

Methylene Chloride causes cancer in animals and is possibly carcinogenic for humans.

**Short-term exposure** irritates the eyes and causes depression of the central nervous system (CNS). Symptoms may include headache, nausea, dizziness, lack of coordination, confusion, and impaired vision.

High concentrations can cause unconsciousness and even death.

**Long-term exposure** may cause irritability, a tingling sensation in the arms and legs, and numbness in the fingers and toes. In most cases, effects will recede after the exposure ends. Skin contact reduces the fat content of the skin (see *Skin*).

**Skin:** Methylene Chloride causes intense burning. Prolonged or repeated exposure reduces the fat content of the skin and may result into dermatitis.

## MINERAL TURPENTINE

*Common names:* Mineral Turpentine Oil (MTO); Mineral Spirit; Turps; Petroleum Spirit; Turpentine Substitute; HAWS (High Aromatic White Spirit). Not to be confused with *Wood Turpentine*.

|                   |   |
|-------------------|---|
| Type:             | Blend of aliphatic and aromatic hydrocarbons. Composition varies with manufacturer. |
| CAS number:       | (not available)   |
| Price band:       | 42 - 55 Rs/litre + VAT  |
| Flammability:     | <b>Flammable</b>  |
| Flash point:      | 36 - 38 °C (approx)   |
| Boiling point:    | 146 - 197 °C (approx)   |
| Specific gravity: | 0.80 - 0.86 g/cm <sup>3</sup>   |
| Vapour pressure:  | 25 mm Hg (approx)   |
| Dipole moment:    | (not available)   |
| Solvency power:   | 29 - 33 KB (approx)   |

### Known applications

- ➔ **Solvent** for removal of paints, varnishes and lacquers.
- ➔ **Component** in preparations for the manufacture of surface coatings, i.e. paints, varnishes and lacquers.

### Health concerns

Limited case studies indicated that Mineral Turpentine may increase the cancer risk. However, the human cancer risk of petroleum solvents such as Mineral Turpentine has been assessed as not classifiable.

**Short-term exposure** may cause irritation of mucous membranes and the respiratory system.

At high vapour concentrations inhalation may cause headache, nausea, dizziness and narcosis.

**Long-term exposure** to vapours can result in headaches, dizziness and unconsciousness and damage to liver, brain and central nervous system (CNS). Skin contact reduces the fat content of the skin (see *Skin*).

**Skin:** Mild skin irritant. Prolonged or repeated exposure to Mineral Turpentine reduces the fat content of the skin which may result in dermatitis and inflammation (eczema).

## NC THINNER

*Common names:* Nitro-Cellulose Thinner.

|                   |  |
|-------------------|--|
| Type:             | Blend of ketones, esters, alcohol and hydrocarbons |
| CAS number:       | (not available)                                    |
| Price band:       | 75 Rs/litre + VAT                                  |
| Flammability:     | <b>Highly flammable</b>                            |
| Flash point:      | - 15 °C (approx)                                   |
| Boiling point:    | 56 - 138 °C (approx)                               |
| Specific gravity: | 0.79 g/cm <sup>3</sup> (approx)                    |
| Vapour pressure:  | 60 mm Hg (approx)                                  |
| Dipole moment:    | (not available)                                    |
| Solvency power:   | (not available)                                    |

### Known applications

- **Solvent** for cleaning tools, circuitry flushing in RAC, and cleaning of rubber rolls of binding machines in offset printing.
- **Diluent and thinner** for paints, varnishes and pigmented lacquers.
- **Used** in coatings and finishes; in wood primers and sealants.

### Health concerns

NC Thinner is not known to be carcinogenic. The Methanol and Toluene component\* could harm the developing foetus. Pregnant and nursing women should avoid exposure.

**Short-term exposure** irritates nose and throat.

Inhalation of high amounts of vapours can affect the central nervous system (CNS) and cause headache, drowsiness, dizziness, loss of co-ordination, fatigue and nausea.

Vapour or direct contact with eyes can cause stinging, tearing, redness and swelling.

**Long-term exposure**, particularly repeated and prolonged occupational overexposure, has been associated with permanent brain and central nervous system (CNS) damage (sometimes referred to as Painter's Syndrome). Skin contact reduces the fat content of the skin (see *Skin*).

**Skin:** Prolonged or repeated exposure to NC Thinner reduces the fat content of the skin, causing redness, burning and dermatitis. Aggravation and worsening of pre-existing skin diseases.

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\* NC Thinner may contain other solvents such as Acetone (page 1), Cyclohexane (page 7), Methanol (page 19), and Toluene (page 31). Please refer to respective entries.

## PERCHLOROETHYLENE (PCE)

*Common names:* Tetrachloroethene; Perc; Perk; Perchlor; Tetrachloroethylene; Ethylene Tetrachloride; Carbon dichloride.

|                   |  |
|-------------------|--|
| Type:             | Chlorinated hydrocarbon                        |
| CAS number:       | [127-18-4]                                     |
| Price band:       | 97 - 105 Rs/litre + VAT<br>60 - 65 Rs/kg + VAT |
| Flammability:     | None   |
| Flash point:      | None   |
| Boiling point:    | 121 °C   |
| Specific gravity: | 1.62 g/cm <sup>3</sup>                         |
| Vapour pressure:  | 14 mm Hg                                       |
| Dipole moment:    | 0 Debye  |
| Solvency power:   | 90 KB  |

### Known applications

- **Cleaning solvent** for metal and electrical components, often as blend with Trichloroethylene or Methylene chloride. Used for flushing of circuitry in RAC. Vapour degreaser for metal.
- Predominant **dry-cleaning agent**.
- **Solvent** for grease, oil, wax, fat, rubber, tar, paraffin, gums, adhesives and sealants.

- **Component** in adhesives, aerosols, paints, coatings, and typewriter correction fluid.
- **Further uses** as metal drying agent, oil extraction agent, dyeing agent for fibres and fabric, and as heat transfer liquid in the sterilisation of canned food.

### Health concerns

PCE causes cancer in animals and is **probably carcinogenic** for humans.

**Short-term exposure** causes narcotic and anaesthetic effects including irritation, dizziness, confusion, nausea and headache.

Higher exposure levels can affect the central nervous system (CNS), eyes, skin, lungs, liver and kidneys.

Very high exposure levels can cause unconsciousness and even death.

**Long-term exposure** and frequent over-exposure may have long-lasting and possibly permanent effect on the central nervous system (CNS). Symptoms include fatigue, poor muscle coordination, difficulty in concentrating, loss of short-term memory and personality changes such as increased anxiety, nervousness and irritability.

**Skin:** PCE is a mild skin irritant.

## TOLUENE

*Common names:* Toluol; Methylbenzene; Methylbenzol; Phenylmethane; Methacide.

|                   |                        |
|-------------------|------------------------|
| Type:             | Aromatic hydrocarbon   |
| CAS number:       | [108-88-3]             |
| Price band:       | 53 - 85 Rs/litre + VAT |
| Flammability:     | Highly flammable       |
| Flash point:      | 4 - 7 °C               |
| Boiling point:    | 111 °C                 |
| Specific gravity: | 0.87 g/cm <sup>3</sup> |
| Vapour pressure:  | 21 mm Hg               |
| Dipole moment:    | 0.3 Debye              |
| Solvency power:   | 105 KB                 |

### Known applications

- **Used in** rotogravure printing processes, leather tanning, oil refining processes, and manufacture of paints, lacquers, glues and explosives (TNT).
- **Component** in paints, lacquers, varnishes, thinners, shellacs, nail polish, adhesives and glues, metal cleaners, rust preservatives, asphalt removers, flame retardants, high-octane gasoline blends and aviation fuel.

### Health concerns

Toluene is not known to be carcinogenic. It is suspected to harm the developing foetus. Pregnant and nursing women should avoid exposure.

**Short-term exposure** to Toluene causes depression of the central nervous system (CNS) and irritation of the eyes and mucous membranes. It can affect the brain the same way drinking alcohol does and has a synergetic effect with alcohol, increasing chances of accidents.

Exposure to extremely high concentrations can cause unconsciousness and even death.

**Long-term exposure** or frequent over-exposure is known to have long-lasting and possibly permanent effects on the central nervous system (CNS).

Symptoms include fatigue, sleeplessness, poor coordination, difficulty in concentrating, loss of short-term memory and nausea. Further symptoms may include impaired speech, vision and hearing, lack of appetite and personality changes including depression, anxiety, and irritability. Skin contact reduces the fat content of the skin (see *Skin*).

**Skin:** Toluene is a mild skin irritant. Prolonged or repeated exposure reduces the fat content of the skin and may cause dermatitis.

## TRICHLOROETHYLENE (TCE)

*Common names:* Acetylene Trichloroethylene; Acetylene Trichloride; Benzinol; R-1120.

|                   |  |
|-------------------|--|
| Type:             | Chlorinated hydrocarbon                        |
| CAS number:       | [79-01-6]                                      |
| Price band:       | 88 - 100 Rs/litre + VAT<br>60 - 68 Rs/kg + VAT |
| Flammability:     | None   |
| Flash point:      | None   |
| Boiling point:    | 87 °C  |
| Specific gravity: | 1.47 g/cm <sup>3</sup>                         |
| Vapour pressure:  | 58 mm Hg                                       |
| Dipole moment:    | 0.8 Debye                                      |
| Solvency power:   | 129 KB   |

### Known applications

- **Cleaning solvent** for metal; often as blend with Perchloroethylene or Methylene chloride. Used for motor/generator cleaning, and for circuitry flushing in RAC. Vapour degreaser for metal.
- **Used** for cleaning of rubber cots in spinning mills as blend with Methylene chloride.
- **Solvent** for grease, oil, fats, waxes, gums, resins, rubber, paints, lacquers, rust preventives, adhesives, bitumen and tar.
- **Component** in paints, lacquers, paint removers,

adhesives, varnishes, typewriter correction fluid, spot removers and disinfectants.

- **Further uses** as dye lubricant in casting and stamping; as heat transfer agent; as refrigerant; as drying agent for metal, glass, wood and food; as freezing point depressant and as fumigant.

### Health concerns

TCE causes tumours and leukaemia in animals and is probably carcinogenic for humans. Pregnant women should avoid exposure since it may cause heart problems in the offspring. TCE has been found in drinking water supplies as a result of ground water contamination through industrial discharges.

**Short-term exposure** causes central nervous system (CNS) depression with symptoms such as drowsiness, headache and loss of coordination. It may also affect the heart.

High concentrations may cause nose and throat irritation, numbness and facial pain, reduced eyesight, unconsciousness and death.

**Long-term exposure** causes altered mood, loss of memory and inability to concentrate or sleep. It can cause liver damage. Visual disturbances including blurred, double or tunnel vision and poor eyesight have occasionally been reported.

**Skin:** TCE is a severe skin irritant. It can cause redness, irritation and blister formation.

## WHITE PETROL

*Common names:* Special Boiling Point Spirit (SBP).

|                   |  |
|-------------------|--|
| Type:             | Blend of paraffinic, naphthenic and aromatic petroleum hydrocarbons. Composition varies with manufacturer. |
| CAS number:       | (not available)  |
| Price band:       | 45 - 50 Rs/litre + VAT   |
| Flammability:     | <b>Highly flammable</b>  |
| Flash point:      | - 18 °C (approx)   |
| Boiling point:    | 50 - 120 °C (approx)   |
| Specific gravity: | 0.67 - 0.69 g/cm <sup>3</sup> (approx)   |
| Vapour pressure:  | 180 mm Hg (approx)   |
| Dipole moment:    | (not available)  |
| Solvency power:   | (not available)  |

### Known applications

- **Stain remover** for woven and knitted fabrics. By some manufacturers promoted as dry-cleaning solvent for certain cases.
- **Solvent** for machinery cleaning, polishes, cleaning and water-proofing compounds
- **Thinner** for varnish, paint and quick-drying printing ink; diluent for lacquers and enamels.

### Health concerns

White Petrol is not known to be carcinogenic. Individuals with pre-existent neurological diseases must avoid exposure to White Petrol due its Hexane content\*.

**Short-term exposure** irritates the respiratory tract, eyes and skin.

High concentration may affect the central nervous system (CNS) and cause headaches, dizziness and numbness (as an anaesthetic) and even lead to death.

**Long-term exposure** may, due to its Hexane contents, cause disturbances in sensations, muscle weakness and pain in the legs. In some cases it may lead to nerve disorders and/or paralysis of arms and legs. Symptoms include decreased muscle strength, numbness, and a tingling sensation in the arms and legs.

Changes in vision and tendency to colour discrimination may also occur. Skin contact reduces the fat content of the skin (see *Skin*).

**Skin:** Contact with the skin can be irritating and repeated or prolonged exposure can lead to defatting cracking, dryness, and dermatitis.

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\* This solvent may contain significant amounts of Hexane. Please refer to respective entry on page 13.

## XYLENE

*Common names:* Xylol; Xylenes; Mixed Xylene; Technical Xylene; Xylene (mixed isomers); Dimethylbenzene; Methyltoluene.

|                   |                        |
|-------------------|------------------------|
| Type:             | Aromatic hydrocarbon   |
| CAS number:       | [1330-20-7]            |
| Price band:       | 55 - 85 Rs/litre + VAT |
| Flammability:     | <b>Flammable</b>       |
| Flash point:      | 38 °C                  |
| Boiling point:    | 138 °C                 |
| Specific gravity: | 0.86 g/cm <sup>3</sup> |
| Vapour pressure:  | 6 - 16 mm Hg           |
| Dipole moment:    | 0.6 Debye (approx)     |
| Solvency power:   | 98 KB                  |

### Known applications

- **Solvent** for grease, gums, resins, rubber, castor oil, linseed oil, paint stripping, and finishing of diamonds.
- **Cold cleaning solvent** and degreaser for metal in electroplating and machinery manufacture and repair.
- **Component** of paints, lacquers, varnishes, inks, dyes, adhesives and cleaning liquids.
- **Used** as printing solvent in gravure printing; in leather industries; in the manufacture of

perfumes and insect repellents; as diluent in laboratories.

### Health concerns

Xylene is not known to be carcinogenic. It is a possible reproductive health hazard and retardant to growth and development. Pregnant and nursing women should avoid exposure.

**Short-term exposure** can cause irritation of eyes, nose and throat. Further effects may include delayed reaction, stomach discomfort and lung damage.

At high concentration, it can affect the central nervous system (CNS) causing headaches, dizziness, confusion, lack of muscle co-ordination and drowsiness.

Extremely high exposure levels may result into unconsciousness and even death.

**Long-term exposure** may cause headaches, lack of muscle coordination, dizziness, confusion, drowsiness and short-term memory loss. Long term effect on skin causes dermatitis (see *Skin*).

**Skin:** Xylene irritates the skin. Can cause dermatitis on repeated exposure due to degreasing action.

## REFERENCE PROFILE: CARBON TETRACHLORIDE (CTC)

*Common names:* Carbon Chloride; Carbon Tet; Tetrachloromethane; Methane Tetrachloride; Perchloromethane; Tetrachlorocarbon; Freon 10.

|                   |                         |
|-------------------|-------------------------|
| Type:             | Chlorinated hydrocarbon |
| CAS number:       | [56-23-5]               |
| Price band:       | - - - *                 |
| Flammability:     | none                    |
| Flash point:      | none                    |
| Boiling point:    | 77 °C                   |
| Specific gravity: | 1.59 g/cm <sup>3</sup>  |
| Vapour pressure:  | 91 mm Hg                |
| Dipole moment:    | 0 Debye                 |
| Solvency power:   | 124 KB                  |

### Known applications

- **Cleaning agent** for fabric, rubber, glass, paper, wax moulds and diamond.
- **Degreasing agent** for metals including steel, copper and brass.

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\* Drastic supply reductions lead to sharp price increases, particularly on retail quantities, while changing demand drives substantial fluctuations. No reliable information available.

### Health concerns

CTC causes cancer in animals and is possibly carcinogenic for humans.

**Short-term exposure** affects the central nervous system (CNS) causing headache, weakness, lethargy, nausea and vomiting.

Inhalation of high levels may damage the liver (swollen, tender liver, changes in enzyme levels, and jaundice) and kidneys (nephritis, nephrosis, proteinurea). Further an accumulation of fluid in the lungs (pulmonary oedema) has been observed, possibly as a result of kidney damage.

Exposure to very high levels may result into coma.

**Long-term exposure** can lead to swelling of the liver, destroying or damaging its cells. The severity of the effects on the liver depends on susceptibility, route of exposure, diet and co-exposure to other compounds such as alcohol. Kidneys may also be damaged, causing a build-up of wastes in the blood.

**Skin:** CTC is a mild skin irritant. May cause dermatitis and defatting of skin.

## FIND AND COMPARE

| Solvent †                   | CAS number | Price<br>Rs/litre | Specific gravity<br>kg/l |  | Vapour pressure | Solvency power | Dipole moment | Boiling point | Flash point | Cancer hazard |
|-----------------------------|------------|-------------------|--------------------------|--|-----------------|----------------|---------------|---------------|-------------|---------------|
|                             |            |                   |                          |  | mmHg            | KB             | Debye         | °C            | °C          |               |
| <i>Ordinary solvents</i>    |            |                   |                          |  |                 |                |               |               |             |               |
| Methanol                    | 67-56-1    | 26-35             | 0.79                     |  | 96              | n/a            | 1.7           | 64            | 11          | -             |
| Mineral Turpentine          | n/a        | 42-55             | 0.80-0.86*               |  | 25*             | 29-33*         | n/a           | 146-197*      | 36-38*      | -             |
| Hexane                      | 110-54-3   | 45-50             | 0.69                     |  | 124             | 29             | 0             | 63-70         | -23         | -             |
| White Petrol                | n/a        | 45-50             | 0.67-0.69*               |  | 180*            | n/a            | n/a           | 50-120*       | -18*        | -             |
| Ethyl Acetate               | 141-78-6   | 50-65             | 0.90                     |  | 76              | n/a            | 1.8           | 77            | -4          | -             |
| Acetone                     | 67-64-1    | 50-75             | 0.79                     |  | 180             | n/a            | 2.9           | 56            | -20*        | -             |
| Toluene                     | 108-88-3   | 53-85             | 0.87                     |  | 21              | 105            | 0.3           | 111           | 4-7         | -             |
| Xylene (mixed isomers)      | 1330-20-7  | 55-85             | 0.86                     |  | 6-16            | 98             | 0.6*          | 138           | 38          | -             |
| Benzene                     | 71-43-2    | 60-68             | 0.88                     |  | 75              | 107            | 0             | 80            | -11         | Yes           |
| Isopropyl Alcohol           | 67-63-0    | 65-85             | 0.79                     |  | 33              | n/a            | 1.7           | 82            | 12          | -             |
| Cyclohexane                 | 110-82-7   | 70-130            | 0.78                     |  | 78              | 58             | 0             | 81            | -20         | -             |
| NC Thinner                  | n/a        | 75                | 0.79*                    |  | 60*             | n/a            | n/a           | 56-138*       | -15*        | -             |
| Methyl Ethyl Ketone         | 78-93-3    | 80-90             | 0.81                     |  | 78              | n/a            | 2.8           | 79            | -9          | -             |
| d-Limonene                  | 5989-27-5  | 350               | 0.84                     |  | 2               | 67             | 2.6           | 176           | 43          | -             |
| <i>Chlorinated solvents</i> |            |                   |                          |  |                 |                |               |               |             |               |
| Dichloroethane              | 107-06-2   | 43-86             | 1.24                     |  | 64              | n/a            | 1.6           | 84            | 13          | Likely        |
| Methylene Chloride          | 75-09-2    | 60-80             | 1.33                     |  | 350             | 136            | 1.6           | 40            | none        | Likely        |
| Chloroform                  | 67-66-3    | 67-89             | 1.48                     |  | 160             | 67             | 1.2           | 62            | none        | Likely        |
| Trichloroethylene           | 79-01-6    | 88-100            | 1.47                     |  | 58              | 129            | 0.8           | 87            | none        | Likely        |
| Perchloroethylene           | 127-18-4   | 97-105            | 1.62                     |  | 14              | 90             | 0             | 121           | none        | Likely        |
| Reference: CTC              | 56-23-5    | ---               | 1.59                     |  | 91              | 124            | 0             | 77            | none        | Likely        |

† Listing in order of ascending price, separately for each category

\* Value estimated

## EDITORIAL NOTES

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For most solvents several names exist. Those used more frequently are listed under **common names**. The best identifier is however the **CAS number** which is unique for every substance.

**Prices** given are in Indian Rupees based on enquiries with solvent retailers in Bangalore for a purchase volume of 5 litres of industrial grade solvent as of July 2006. Unless indicated otherwise, the price band reflects quotations of three to five retailers. Prices include excise duty but exclude VAT. They are indicative and subject to change with time, quantity and location. Smaller quantities may increase the price by multiples. Solvents with a specific gravity below 1 g/cm<sup>3</sup> are typically traded in litres and heavier solvents in kilograms.

**Flash point** (in °C) is the lowest temperature at which a flammable solvent can form an ignitable mixture with air. As a rule of thumb, the higher the flash point temperature the lower is the fire hazard risk. Non-flammable solvents do not have a flash point. Values provided are derived at by the 'closed cup' testing method.

**Specific gravity** (in g/cm<sup>3</sup>) indicates the comparative weight. Ordinary hydrocarbons range generally below 1 g/cm<sup>3</sup>; chlorinated hydrocarbons are

heavier and show specific gravity values well above 1 g/cm<sup>3</sup>.

**Vapour pressure** (in mm Hg) is an indicator for the rate of evaporation under atmospheric conditions. The higher the value the faster the solvent evaporates. If the substance is stored in an open container it can also be considered as a measure of evaporation losses.

**Dipole moment** (in Debye) is a measure of the polarity of a solvent. It determines what type of compounds it can dissolve and with what liquids it is miscible. Typically, polar solvents dissolve polar compounds best and non-polar solvents dissolve non-polar compounds best, or in brief, like dissolves like. Similarly, polar contaminants dissolve best in polar solvents, while non-polar compounds, like oils or waxes, dissolve best in non-polar solvents. Water, for comparison, is a polar solvent with a dipole moment of 1.8 Debye.

**Kauri-Butanol** (KB) value is a measure of the solvency power. The higher the value, the more aggressive a solvent is. A solvent should be selected based on a KB value that matches the contaminant to be removed and at the same time does not affect the substrate.

Some solvent properties are **temperature sensitive**. Values at one given temperature will differ from those of another. Particularly specific gravity, vapour pressure and dipole moment depend on the

temperature. The values given are for a temperature of 20 °C. In a few cases, where 20 °C values were unavailable, the values for 15 °C or 25 °C were provided instead.

**Known applications** listed are based on product information, secondary resources and findings in the industry. It is assumed that most products may be suitable for additional applications which have not been listed here as well. However, an evaluation of their suitability for applications of CTC is yet to be carried out.

**Health concerns** present a summary of known hazards associated with the use of the substance at the workplace. Unless mentioned otherwise, effects are described for inhalation of solvent vapours. Effects for solvent ingestion have by and large been omitted as this is not a common route of intake at the workplace. Given the complexity of the subject of occupational health it cannot be dealt with in detail in this publication. For more details, please consult Material Safety Data Sheets (MSDS) prepared by the manufacturer and available with the retailer of respective solvents. Reality, however, often proves MSDS to be unavailable.

**Cancer risk**, wherever applicable, is described based on the assessment by the International Agency for Research on Cancer (IARC). Depending on the weight of scientific evidence available, IARC classifies the cancer risk of substances as follows:

- Group 1: Confirmed human cancer hazard
- Group 2A: Probable human cancer hazard
- Group 2B: Possible human cancer hazard

Descriptions in this publication followed the IARC classification system. For ease of use, however, the cancer risk for both Group 2A and 2B solvents has been summarised as 'likely' in the table on page 41.

### **Disclaimer**

*Though all care has been taken while researching and compiling the contents provided in this booklet, GTZ Proklima accepts no liability for its correctness.*

*The reader is advised to confirm prices, specifications and health hazards prior to purchase or use. No claim is made here in respect of the suitability of any solvent as substitute for CTC in any application. Suitability of a product for a particular application requires to be verified through trials prior to any larger-scale application with due consideration of health and safety aspects.*

*Information provided here does not constitute an endorsement or recommendation of any product by GTZ Proklima.*



**Ozone Cell**, Ministry of Environment and Forests, Government of India, is the central agency coordinating the phase-out of CTC. The cell has established the regulatory framework and national phase-out plan. It ensures that domestic CTC production and import progressively decrease in compliance with national targets.

**Deutsche Gesellschaft für Technische Zusammenarbeit (GTZ)** is a German development assistance organisation mandated by the German Ministry for Economic Cooperation and Development (BMZ). GTZ implements bilateral and multilateral projects, assisting partner countries in fulfilling their obligations to international conventions. Germany is one of the largest bilateral partners of the Multilateral Fund and BMZ has mandated GTZ to assist developing countries in the implementation of the Montreal Protocol with its sectoral programme Proklima. In the current project GTZ holds an additional mandate from Agence Francaise de Developpement (AFD) on behalf of France who provides financial support through Fonds Francaise pour l' Environnement Mondial (FFEM).



## National CTC Phase-out Plan

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Email: [ctc-phaseout@airtelbroadband.in](mailto:ctc-phaseout@airtelbroadband.in)

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