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Oxygenated and hydrocarbon solvents do not play a part in the stratospheric ozone problem. Under certain conditions, solvent emissions may contribute to create ground-level ozone. However, the solvents industry has substantially reduced its emissions and continues to contribute to the improved air quality in Europe.

Ozone can be found near the ground level (the tropospheric ozone commonly referred to as "smog") or high up in the stratosphere. Stratospheric ozone protects humans from excessive ultraviolet rays and helps stabilise the earth's temperature. Oxygenated and hydrocarbon solvents do not play a part in the stratospheric ozone problem. This is because solvents, like natural VOC emissions, are rapidly cleaned from the lower atmosphere by photochemistry. This means that they never reach the stratosphere.

Ground level ozone is formed when NOx and VOCs react with sunlight and heat. It also occurs naturally all around us. Under certain weather conditions, too much ozone is produced and results in reduced air quality. Ozone peaks, which are temporary, primarily occur in summer and are pertinent to certain regions in Europe.

Between 1990 and 2000, VOCs have been reduced by 30%[1]. Compared to 1980, improved solvent management and efficiency have reduced the amount of solvents needed to produce a finished object by half. Furthermore, industrial VOC emissions have been reduced by a factor of two (47% on average and up to 64% in some sectors) in about 10 years. (See also the ESIG fact-sheet *"Solvents and the Environment"*)

The extent to which NOx and VOCs participate in ozone formation varies. In order to develop efficient strategies to improve air quality, the EU industry is working on reducing emissions as well as understanding what contributes most to ozone formation. Reducing NOx would appear to be the most effective way to continue to reduce ozone levels in the EU.

The solvents industry playing its part to reduce ozone peaks

- Helping to develop new means of deterring solvents with negligible photochemical reactivity.
- Helping to create new formulas for coatings and other products with low ozone forming potential whilst maintaining high quality standards.
- Researching ozone formation and targeting efficient solutions such as promoting abatement techniques.
- Working with EU and national regulators to encourage development of products that meet environmental needs without compromising performance.

What are VOCs and NOx?

VOCs (Volatile Organic Compounds) are organic chemicals in the air that are a result of emissions from human activities (such as transport and industrial operations), as well as natural emissions from trees and plants. Natural VOCs represent the majority of the total VOC emissions in the world.

NOx (nitrogen oxide and nitrogen dioxide) are essentially emissions from vehicles (catalysts) and power stations. In most of Europe, NOx is the pollutant that controls the amount of ground level ozone.

1. Reference: the Co-operative Programme for Monitoring and Evaluation of the Long-Range Transmission of Air Pollutants in Europe - EMEP/MSC-W Note 1/2002, July 2002.

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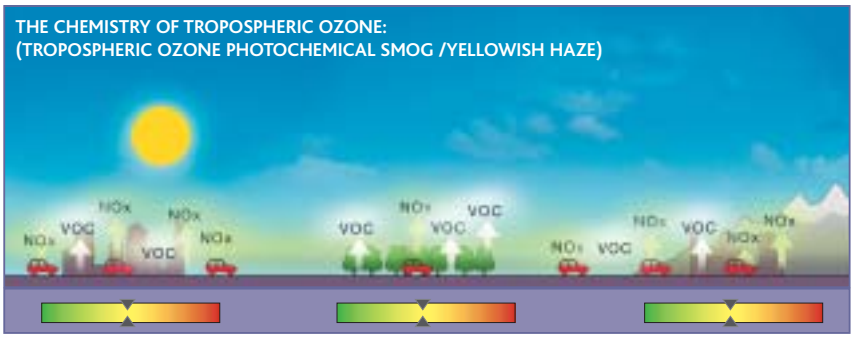
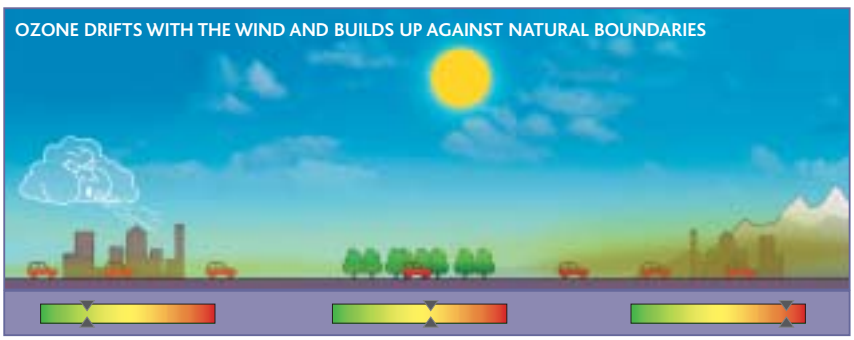
Ozone lifecycle

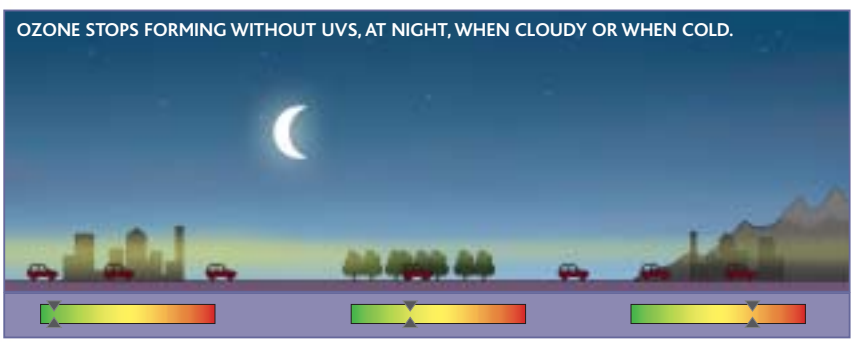


Approximate ozone level

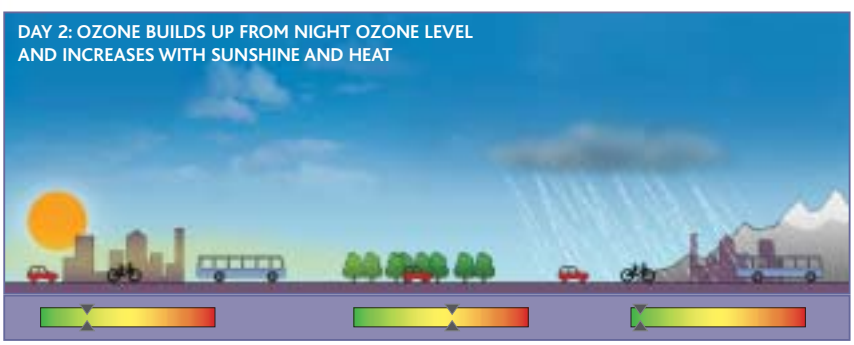
Tropospheric ozone forms in the low atmosphere, ground level, when NOx and VOCs react with sunlight and heat. Stratospheric ozone keeps the earth warm and protected from excessive UVs.



Forests and agriculture emit large amounts of natural VOCs that cannot be reduced. The highest ozone levels are often reached in rural areas down-wind of cities. Even if the man-made VOCs were absent, you would still have ozone pollution in the presence of NOx and sunshine.



Tropospheric ozone reaches its peak in the afternoon and its lowest level at night. If the next day is also sunny the build up will include the ozone left after the night and thus the second day may have a higher level of ozone.



Tropospheric ozone can only accumulate over a few days. However as soon as it rains or there is wind, ozone disappears or is dispersed.

Conclusion: Reducing man-made VOCs only marginally reduces ozone because of the large quantities of natural VOCs. Thus, to reduce tropospheric ozone, it is more efficient to reduce NOx with temporary and geographically targeted measures.

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Over the past three decades, the solvents industry has implemented measures to address concerns about environmental performance, especially related to air quality. In fact, air quality in Europe has continuously improved during this period. Solvent manufacturers are committed to working with industry partners, scientists and legislators to further explore the need and the means to improve air quality in a cost-effective manner.
Most organic solvents rapidly biodegrade in the air, soil or water, i.e., they do not bioaccumulate or persist in the environment, and have relatively low ecotoxicity.

Man-made chemicals, including solvents, are used in everyday items such as paint, cosmetics and cleaners to protect, beautify and clean. Solvents used in products such as coatings, inks, and consumer products generally emit substances classified as VOCs (Volatile Organic Compounds). These emissions are controlled through incineration, recycling or using control technology. A solvent may, in certain situations, be emitted into the air after performing its function in an industrial application or in consumer products.

- Most organic solvents rapidly biodegrade in the air, soil or water, i.e., they do not bio-accumulate or persist in the environment, and have relatively low ecotoxicity.
- Air emissions from organic solvents degrade readily. Their typical atmospheric lifetime is of a couple of days. It is only in the presence of NOx and sunlight that solvents contribute to ground level ozone, which at a certain level can impact negatively on Air Quality (for more information on ozone, see also the fact sheet, "*Solvents and Ozone*").

What is industry doing?

The solvents industry is committed to protecting and enhancing both the environment and society as a whole by ensuring that solvents are used to their best advantage from the beginning to the end of their life cycle.

For over 25 years the solvents industry has made substantial investments to meet current and future market needs and environmental targets:

- New production facilities – to make more efficient solvents with reduced environmental impact.
- Research and development – to produce new solvents, formulations and ways to manage their use.
- Technical support – to help customers improve their own systems and understand the options for controlling emissions.
- Independent environmental research – to understand and identify the most efficient way to minimise the impact of solvent products.

Compared to 1980, improved solvent management and efficiency have reduced the amount of solvents needed to produce a finished object by half. Furthermore, industrial VOC emissions have been reduced by a factor of 2 (47% on average and up to 64% in some sectors) in about 10 years.

Technical performance: increased efficiency and lower maintenance costs

- Solvent-based paints are associated with durability (i.e. long-lasting finishes: if you use low VOC products but have to repaint more often, the net environmental balance is zero or negative); as well as cost-effective (the raw materials are cheaper) and appropriate for all weather conditions.
- Solvents can extend the life of products through durable protective coatings – this means less corrosion, rust prevention and scratch resistance and therefore a longer life for objects as diverse as cars and bridges (i.e. less repainting). It even means solvent based adhesives provide the most durable shoe soles!

The Solvents Industry and Responsible Care®

Responsible Care is the chemical industry's voluntary commitment to continually improve all aspects of health, safety and environmental performance and to openly communicate about its activities and achievements.

Reduced energy consumption, lower manufacturing costs

- Solvent based paints and inks mean faster, more controlled evaporation, reducing the drying temperature required and resulting in higher productivity with less energy use. For example, solvent based paints dry up to 10 times faster at room temperature than alternatives, keeping production rates up, costs down and minimising energy consumption. This is the primary reason why solvent-based coatings still account for a majority of the industrial coatings used in Europe. Where solvent-based formulations are needed, industry has found efficient ways of dealing with their emissions to protect health and the environment.
- The films in food packaging help protect and safeguard food. Solvents are used to produce these coatings and ensure a high quality film. Manufacturers reduce energy consumption during production by capturing evaporated solvents in direct-fired ovens. This fuels the process, thus conserving other fuel resources and reducing costs.

Conserving resources, reducing product costs, reducing waste

- Electrostatic paint spraying is the most efficient spray process from an environmental and cost perspective because it minimises the total amount of paint required and dramatically reduces spray waste. Solvent based paints make this technique possible because they are non conductive.
- Solvent based herbicides increase their success rate simply by making the agrochemical water-resistant, covering foliage efficiently. It therefore significantly reduces the total amount of herbicides and pesticides required.

Solvents help protect the environment

- Pentanes have replaced CFCs (ozone depleters) in a number of applications such as polyurethane insulating foams.
- Solvents are key to the manufacturing of some water treatment chemicals, essential to treat waste water and make it drinkable.
- Solvents are used to dissolve fuel borne catalysts required for diesel particulate filters to control vehicle exhaust emissions (adding this type of catalyst to diesel fuel enables the diesel particulate filter to regenerate itself economically and safely, dramatically improving the operability and applicability of the diesel particulate filter).

The Solvents Industry and Product Stewardship

Product Stewardship is about managing responsibly the health, safety and environmental aspects of a chemical product throughout its lifecycle. It is Responsible Care® applied to products. The purpose of Product Stewardship is to prevent injury to human health and damage to the environment in two main ways:

- Reducing the actual and potential risks associated with the manufacture, packaging, distribution, handling, use and disposal of solvents.
- Improving product design, assessment practices, advice, education, communication and customer support.

Product Stewardship covers all stages of a product's lifecycle - initial concept, design, research and development, the sourcing of raw materials, manufacture, storage, distribution, applications, reasonably foreseeable uses, recycling and disposal. It requires management, employees, contractors, customers and all those involved in the supply chain to work together in following safe, environmentally sound practices.

By adopting Product Stewardship, companies of all sizes can play their part in protecting people and the environment from potential harm. Although companies are technically liable only for that part of the supply chain that they themselves manage, they need to be concerned with everything that happens to their products from start to finish.

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Solvents are used in a wide variety of everyday applications and play a vital role in providing solutions to many of the challenges of modern life: solvents are often simply the best ingredients for the job at hand. Maintaining the highest levels of safety and health standards in the production and use of solvents is an absolute priority for the industry. The solvents industry, and its downstream-users, therefore actively promote the safe use of solvents and also continuously develop new and improved products.

The solvents produced by ESIG members have been thoroughly tested for their health, safety and environmental properties. The European solvents industry is committed to complying with and, in some cases exceeding, health, safety, and environmental (HSE) requirements. Maintaining the highest levels of safety and health standards is an absolute priority. This is achieved by conducting continuous scientific research and development to improve products and by providing health, safety, and environmental information to users on an ongoing basis. The following is an overview of some industry HSE initiatives:

Classification and labelling

Some solvents need to be managed carefully due to their volatility and general flammability, in particular during loading and unloading, storage and when using large quantities. The solvents industry works closely with transporters, distributors and customers to ensure that adequate precautions and procedures are in place when handling solvents. In addition, ESIG also publishes several guidelines on the safe handling of solvents e.g. "*Best Practice Guideline 4, Flammability: a safety guide for users*". These documents are available via the ESIG website at www.esig.org.

Solvents are subject to the European Union's classification and labelling requirements that identify the main hazards of a product through symbols and risk/safety phrases on container labels. For example, where appropriate labels include information about:

- Flammability
- Risk of irritation to skin and eyes (a minority of hydrocarbon and oxygenated solvents)
- Risk of lung aspiration hazard if accidentally swallowed

Occupational workplace exposure limits

The main route of exposure to solvents is via inhalation. Occupational exposure limits (OELs) set the airborne concentration of a substance that workers can be exposed to, day after day without any adverse health effects. OELs are normally set for an 8 hour day and a 40 hour week and are continuously reviewed by national and EU authorities. OELs for the majority of hydrocarbon and oxygenated solvents are set between 10 and 1,000 parts per million depending on the volatility and toxicity of an individual substance.

The solvents industry is also working with scientists and regulators to understand the effects of solvents. One specific activity has been the development of OELs for hydrocarbon solvents where legal OELs are not available. A special solvents industry task force has developed guidelines for a uniform methodology to calculate OELs for complex hydrocarbon solvents and blends. In Europe and the USA, this methodology is used by hydrocarbon solvent manufacturers to provide harmonised and consistent OEL values to solvent users.

More information on OELs can be found at the European Agency for Health and Safety at Work (OSHA) website:
http://europe.osha.eu.int/good_practice/risks/ds/oel/

Safety handling guidelines

For the past 20 years, long before it became a legal requirement in Europe (legislation was passed in 1992), solvent producers have distributed Safety Data Sheets on their products. These datasheets, which are continuously updated, provide comprehensive safety and health information including:

- Safe exposure limits and techniques for managing flammability
- Information on the main hazards, how to protect against them and the steps to take in an emergency
- Occupational exposure limits (OELs)
- Handling, storage, transport, spills and disposal advice
- Regulatory information such as classification and labelling
- Toxicity and environmental information

Solvents@work

As part of its continuous effort to encourage responsible and safe handling of solvents, ESIG has developed an information pack with recommendations on how to use solvents safely in the workplace. Thousands of solvent using small-medium-enterprises in Belgium, France, Italy, and the UK participated in its launch pilot in 2004. The initiative has been expanded to other regions across the EU.

Product stewardship

Advice on the safe handling and use of solvents is provided by the European solvents industry under its Product Stewardship programme. This is part of a wider chemical industry commitment to Responsible Care® which focuses on the continual improvement of safety, health and environmental performance.

Hazards and exposure information

- For many years, the solvents industry has generated an extensive set of toxicity / ecotoxicity data that go beyond regulatory requirements.
- ESIG has also gathered a wealth of information about solvents exposure levels in the workplace. For example, in 1999, ESIG collated all publicly available data on solvent vapour levels in the workplace. This database is continually updated.
- ESIG has worked with research institutes such as TNO in the Netherlands and BRE (Building Research Establishment) in the UK, to simulate indoor painting situations. Results indicated that simple measures such as regular ventilation, shows that solvents may be used safely outdoors and indoors. The experimental work was used to develop a risk-based tool (Air Change Index) to quickly assess exposure to solvents released from decorative paints.
- ESIG subgroups, HSPA and OSPA, frequently work with regulators and scientific institutes to help general risk assessment reports and other data sets, e.g. data required for the OECD High Production Volume (HPV) programme.

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Why....
....do paints flow
....does the ink of this fact-sheet not smudge?
....can I apply perfume?
....can I see through my car window?

The answer is solvents: a liquid which has the ability to dissolve, suspend or extract other materials. Solvents make it possible to process, apply, clean or separate materials. Solvents have significantly changed modern living and are an invaluable solution for industries as diverse as pharmaceuticals and microelectronics to domestic cleaning and printing.

Organic solvents can be classified into three groups based on their chemical structure:

- **Oxygenated solvents** - Substances like alcohols, ketones, esters, and glycol ethers fall into this category. These types of solvents are used when high solvency power is needed. They can also be used for water based formulations such as detergents and water based paints.
- **Hydrocarbon solvents** - These are paraffinic, aliphatic and aromatic hydrocarbons. They are typically used in applications where there is low solvency power and good separation from water is required.
- **Halogenated solvents** - This category consists of chlorinated hydrocarbon solvents. To obtain more information on these solvents please visit the Euro Chlor website: www.eurochlor.org.

An organic solvent contains carbon molecules – one of the basic building blocks of life. Water is also a solvent but is classified as *inorganic* because its chemical structure does not contain carbon.

How are solvents made? Where do solvents come from?

With the exception of alcohol, all solvents are produced from oil. The amount of oil used for solvent production is, however, relatively low. Only about 1 - 2% of the world's oil production is used for solvent production. Many solvents are also recycled so that they can be used again.

How do solvents work?

Solvents are liquids that are used to dissolve other substances. Water, for instance, is also a solvent and it can dissolve many things but it cannot dissolve oily/greasy substances. Solvents work on the principle of "like dissolves like" e.g. solvents are chemically much more similar to greases than water and can therefore dissolve them more effectively.

Where and how are solvents used?

Thousands of producers and manufacturers and over 10 million workers in Europe rely on solvents every day. From penicillin to industrial paints, without solvents many of the products we rely on would not perform to the standards we demand today. Solvents are used in the following:

PAINT, COATING AND INK - Once the paint has been applied the solvent evaporates, allowing the resin and pigment to produce a film of paint that dries rapidly.

PRINTING - Whether magazines or food packaging and labels, they all need to be printed and solvents help these printing inks to be applied, stay put, and stay bold and bright. In printing inks, solvents are used to control viscosity (thickness) and to allow ink to flow without damaging printing rollers or sprayers. Solvents assist in optimal drying for today's high speed printers.

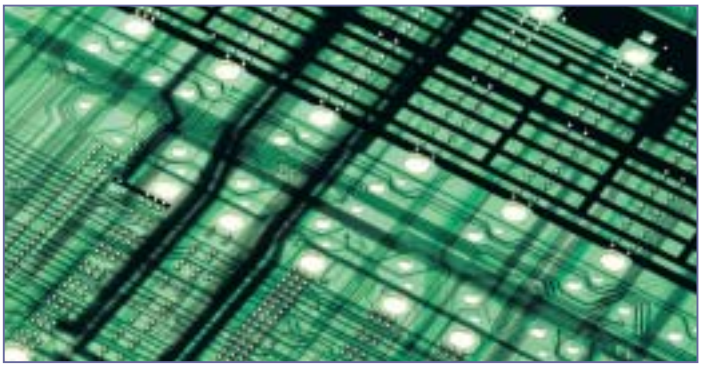
ADHESIVES - Solvents are used in domestic and industrial adhesives and are particularly effective when a high performance is required in the case of applications such as metal-to-metal bonding and products such as footwear and car tyres.

PHARMACEUTICALS - Used for the manufacturing of many health care products such as penicillin, aspirin and cough syrup as well as hundreds of other pharmaceutical products, solvents provide molecules to build drugs and are also used as a reaction medium, for extraction and purification.

SKIN CARE, SOAPS, HAIR CARE - In many products, solvents such as alcohol are used to deliver active ingredients, antibacterial agents and fragrances. Some solvents can form appropriate carriers for skin care products.

PERFUMES - Nearly all perfumes are alcohol-based. Spraying perfume in the right place, and for the right duration only happens because of solvents. Fragrance oils from fruits, flowers, roots or bark are also extracted and purified using solvents.

AGROCHEMICALS - Solvents play an important role in crop protection by dissolving the active chemicals in pesticide formulations. The solvents help crop protection agents work efficiently by drying at a slow enough rate to allow adequate absorption, but fast enough to ensure efficient action.



FOOD AND DRINK - In food processing, solvents are used to extract the substance from natural products e.g. fats and oils for making margarine, flavour extracts such as caffeine from coffee, and sugar from molasses. In addition, solvents are also used to make the plastic packaging which keeps food fresh and clean.

AUTOMOTIVE - Solvents play an important part in making car travel safe by, for example, preventing fluids from freezing in winter and helping the windshield washer fluid dissolve dirt on the window, rapidly without residue.

MICROCHIPS - The microelectronics industry uses electronic-grade solvents (i.e.: solvents with very low levels of metal ions) to produce microcircuitry and to clean sensitive components.

HOUSEHOLD CLEANING PRODUCTS - The solvents in household cleaners helps us clean our kitchens, showers, toilets, carpets and other household items. For example, solvents used in dry cleaning machines help clean our clothes by dispersing and dissolving dirt. Solvents also help with disinfectant tasks by lowering surface tension and enabling the disinfectant to get into all the nooks and crannies of the surface. Solvents give products a longer shelf life and also ensure product stability: the first capful is as effective as the last capful.

INDUSTRIAL CLEANING PRODUCTS - Solvents are also used in the cleaning of high precision mechanical parts such as ball bearings: for this application, perfect cleaning is essential to the proper functioning of the mechanical piece (remaining dirt would damage the metal) and critical to the safety in the application.

HOSPITALS - Solvents offer an alternative to traditional washing with soap and water through the use of alcohol-based antiseptic gels and rinses which reduce bacteria. These antiseptic gels are also very portable and can be placed in every patient's room, allowing staff to reach for a hand pump and disinfect in a matter of seconds.

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The role of the European Solvents Industry Group (ESIG), a sector group of Cefic (European Chemical Industry Council), is to support the sustainable and responsible use of oxygenated and hydrocarbon solvents through ***dialogue, information sharing*** *and* ***delivering solutions*** *that address health, safety and environmental performance. ESIG brings together 31 member companies from across Europe. The solvents producing industry employs over 10,000 people throughout Europe.*

ESIG provides a single point of contact for information about oxygenated and hydrocarbon solvents in Europe. Through its work with industry and industry partners, the group cultivates best practice in solvent usage, health, safety, and environmental protection. Its prime focus is to promote the responsible use of solvents and to advocate on issues that may affect solvent producers.

ESIG is a joint activity of OSPA (the Oxygenated Solvents Producers Association) and HSPA (the Hydrocarbon Solvents Producers Association). To see a complete list of ESIG members, please visit the ESIG website.

Facts and figures - the European solvents industry in brief

- All of us use and rely on solvents everyday to perform a wide variety of tasks.
- Solvents manufacturers across Europe have an estimated combined turnover of about € 2.5 - 3 billion and annual sold volumes total approximately 5 million tonnes.
- Over half a million European companies, ranging from pharmaceutical to agrochemical and paintproducers, are solvent users. These companies have a combined turnover of € 200 billion and employ more than 10 million people.
- The solvents industry employs over 10,000 people throughout Europe.
- The European solvents industry is committed to meeting the highest safety standards and environmental protection. It spends over € 20 million per year on research and development.
- The solvent producing industry is composed of both small-medium sized enterprises as well as multinationals. Downstream users generally tend to be SMEs and micro-SMEs.

Dialogue

SOLVENT STEWARDSHIP AWARDS - The Solvent Stewardship Awards promote and encourage best practice and continuous improvements in the use of solvents. Awards are presented to companies that best demonstrate improvements in health, safety and environmental aspects in their use of solvents

ES-VOC-CG - Established by Cefic in 1992, the European VOC (Volatile Organic Compounds) Co-ordination Group is a dynamic association comprising of both solvent producers and associations of European downstream solvent-using industries. ESVOC-CG works in close co-operation with regulators and other European Union representatives to develop efficient methods to improve air quality and safeguard health and safety in Europe.

OSHA - ESIG works closely with various EU agencies and national safety and health authorities, including the Bilbao-based European Agency for Safety and Health at Work (OSHA). Developing activities within the European weeks for Safety and Health is an important aspect of ESIG's commitment to promote a safer and healthier work environment.

Information sharing

SOLVENTS @ WORK - As a key part of its continuous effort to encourage responsible and safe handling of solvents, ESIG has developed an information pack, containing a leaflet and poster as a guide to safe working practices. Thousands of solvent using small-medium-enterprises in Belgium, France, Italy and the UK participated in its launch pilot in 2004. The initiative has been expanded to other regions across the EU.

COMMUNICATIONS - ESIG has a pro-active communications programme which includes the production of a bi-annual newsletter as well as an extensive website tailored to solvent users, as well as regulators and the media.

Delivering solutions

SOFTWARE - To help solvent users create a safe and environmentally friendly work environment, ESIG has developed a number of software packages that are available via the ESIG website. These include:

- An abatement advisor program, which allows users to quickly and efficiently compare the technical and economic aspects of all the main VOC abatement techniques.
- A vapour pressure tool that allows users to calculate whether hydrocarbon solvents are VOCs, as defined by the EU Solvent Emissions Directive (or VOC Directive). The tool enables users to establish vapour pressures of hydrocarbon solvents of low volatility.

BEST PRACTICE GUIDELINES - ESIG Best Practice Guidelines are technical guides, which outline methods that solvent users can use to create safer and more efficient work environments. Topics covered include flammability, solvent vapours and exposure.

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