

# Environment Report 1993

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## Preface

For the second time, the Henkel Group is submitting an account of the Company's environment-relevant data with its Environment Report 1993. Specific examples from R&D, Engineering, Production and Marketing show the progress achieved over the past year in environmental protection.

Environmentally data, especially of the Company's largest production site, Düsseldorf-Holthausen, are listed on tables. They demonstrate that during the past decade, the production-related impact on the environment has been drastically reduced. They also point to problems yet to be solved.

Henkel sales in 1992 came to DM 14.1 billion. Net earnings reached DM 402 million, and expenditure on environmental and consumer protection totaled DM 355 million in 1992.

For decades now, Henkel has been processing renewable raw materials to conserve finite resources. Safe and environmentally compatible production and products enjoy equal ranking with other corporate goals.

In all markets, Henkel strives for a position of ecological leadership, and not just with niche products. In all our product ranges, we intend to offer superior ecological compatibility alongside first-class performance.

Examples of this goal are the [fatty alcohol sulfates \(FAS\)](#), the new, especially gentle class of [surfactants](#) known as [alkyl polyglycosides \(APG\)](#) that we are marketing worldwide under the name of Plantaren®, which is our trademark for fully degradable [surfactants](#). [FAS](#) is replacing in our powder detergents the prime surfactant based on finite mineral oil with [surfactants](#) mainly derived from renewable raw materials like oils and fats.

Following the decision to refrain from [phosphates](#), this is another significant step toward reduced impact on the environment and conservation of natural resources. Conserving natural resources and the environment is also a key concern in our product packaging. Our packaging developers are working intensely on methods of

cutting back on the amount of packaging materials used. And they see to it that the packaging used can be recovered and recycled. The success of these efforts is already evident: the "Eco lightweight pack" and the "Eurobottle" for liquids along with buckets made from recycled materials and refill cartridges for adhesives and technical consumer products are opening up promising potential. These products have been accepted by the consumers and received recognition from professionals. The protection of both the environment and the consumers is an indispensable element of our corporate strategy. Henkel's Environment Report will therefore annually review the progress we have made and the problems we are still facing.

*Hans-Dietrich Winkhaus*

President and Chief Executive Officer

## Products and production

Ecological responsibility for products and production worldwide

*The Henkel Group assigns high priority to environmental protection and plant safety. Its Principles of Environmental and Consumer Protection state that Henkel develops, produces and markets products and systems whose environmental compatibility is guaranteed in accordance with recognized scientific criteria. The environmental compatibility of its products and production methods undergoes continuous review. Plant safety and environmental protection are critical factors taken into account right from start when designing new production facilities.*

### **Plant safety: Better safe than sorry**

One thing is absolutely sure: there is no such thing as absolute safety. Risk is a part of everyday life. Working with chemicals also involves an element of risk. However, thanks to its tried-and-tested safety concepts, Henkel has not yet experienced a hazardous incident. Proven processes, comprehensive round-the-clock, plantwide safety measures and thorough training of the work force have maximized safety. However, no one can give any guarantees for the future. So Henkel is prepared for an emergency. Accident prevention plans detail the measures that have to be taken. The chains of communication to the relevant official bodies and the public are also defined. Regular exercises are carried out to perfect cooperation between the Henkel

fire department and the Düsseldorf municipal fire department. Henkel operates 21 production units on the site of parent plant in Düsseldorf alone. Chemical reactions take place in slightly less than half of these; seven of them are subject to the German "Störfallverordnung" (hazardous incidents order) and hence the focus of extra-special attention.

### **Hydrogenation facilities subject to hazardous incidents order**

They are subjected to the German hazardous incidents order because a combustible gas (hydrogen), a readily ignitable liquid ([methanol](#)), high pressure and high temperatures are all present. During the continuous [hydrogenation](#) process the raw materials, [fatty acid methyl esters](#) and hydrogen are pressurized, heated with steam, and passed through [catalyst](#)-filled reactors. The resultant mixture of [methanol](#) and [fatty alcohols](#) is cooled and its pressure reduced in stages until it matches the ambient pressure. A three-stage protective system ensures that the process, which has proved itself during decades of operation, proceeds smoothly. An electronic process control system regulates and automatically monitors all production stages. If malfunctions or power cuts occur, the facility is immediately switched into a safety mode.

The apparatus and pipes in the facilities are subject to the pressure vessel regulations. The German Technische Überwachungsverein (Independent Technical Inspection Association) checks them regularly, additionally to the regular internal service and maintenance work.

### **Collecting zones allow no liquid to escape**

Each [hydrogenation](#) facility is equipped with a safety release as a precaution against unpredictable major malfunctions. It can be activated manually on site, or from the main control room, and can relieve the pressure in the facility within a few minutes. The mixture of hydrogen and [methanol](#) is automatically ignited as it is vented, and burns off in the form of a torch. The only substances released into the atmosphere are [carbon dioxide](#), soot and water vapor.

The [hydrogenation](#) facility itself is located in a collecting zone with a floor slab that allows no liquid to pass through it. Contaminated quenching water or leakages can

be channeled into the Company's own collector tanks. However, Henkel is also well aware that even the finest technology relies on skilled employees if it is to function properly - employees who continuously undergo training. Reviews of environmental and safety topics keep them abreast of the latest developments. Since mid-1990, in the Düsseldorf parent plant alone, annually almost 2,000 employees - mainly from production, workshops and laboratories - have participated in intensive small-group seminars on safety and the environment (see diagram [Environmental protection courses](#)).

These activities date back to a works agreement, reached as long ago as 1988, concerning cooperation between the Management Board and the works council in the field of environmental protection. On the basis of this consensus, since 1991 the Henkel guidelines, Environmental Protection Information, have obligated all Henkel production sites and Group companies in Germany to hold departmental discussions on environmental protection at least twice a year.

A record is kept of the participants and the subjects dealt with.

### **Environmental protection courses**

These are more than just theoretical. Practical exercises, designed to teach how to react if failures or accidents occur, also play a key role. Operating instructions specify how materials and facilities should be properly handled, and describe in detail how to react rapidly and correctly.

However, responsibility involves more than ensuring safe production. All sites where chemicals are stored must be specially secured. Henkel's storage facilities are constructed so that no [emissions](#) into the atmosphere, water or soil can occur under normal circumstances. If fire should break out despite the extensive fire protection measures that are taken, this sets off the automatic fire detectors present in all storage areas. Henkel has focused special attention on its tank farms. In the Düsseldorf parent plant, for example, a systematic weak-point analysis was carried out and resulted in measures being implemented to improve the safety of 15 tank farms by the end of 1993. And at the subsidiary company Collardin, in Herborn-Schönbach in Hesse, a particularly sophisticated new tank farm went into operation

in 1992. Water-polluting liquids are stored in double-walled tanks that conform to the strictest safety regulations.

### **Renewable raw materials: From nature's garden**

Nature is the ideal source of raw materials. It produces sufficient amounts of vegetable and animal oils and fats, starch, sugar, cellulose, etc., and follow-up supplies are never a problem. After they have been used, renewable raw materials return to the natural cycle. They have no effect on the carbon-dioxide balance of the atmosphere, they are biodegradable, and in many fields of chemical production they are already replacing finite raw materials derived from petroleum and coal. The main supplier of vegetable oils are the palm tree plantations in South-East Asia. They are an important source of revenue for developing countries such as Malaysia and the Philippines. The plantations there will provide for years to come. There is therefore no need to cut down trees in tropical forests. On the contrary, fallow clearings can be reforested, thus preventing erosion. The palm trees in these plantations are a monoculture, but in their natural habitat. Their economic exploitation involves the use of only a minimum of plant protection products.

Nowadays, there is a growing trend toward processing the extracted vegetable oils into highly refined products in their country of origin. In 1992, for example, a modern fatty alcohol facility for which Henkel had contributed the know-how and the complete technology came on stream in Malaysia.

### **Natural oils and fats for chemical-technical applications**

Some 82 million metric tons of native oils and fats were produced worldwide in 1991, mainly for human and animal consumption. The proportion used in the chemical industry was only about 14 percent, and this was made up mostly of oils and fats that are only of limited suitability for nutritional purposes.

Henkel has long been an expert in the processing of renewable raw materials.

The founder of the Group, Fritz Henkel, used soap made from natural oils and fats in his first Persil back in 1907. Today, almost half a million metric tons of natural oils and fats are processed in the Düsseldorf parent plant and its oleochemical facilities.

Henkel's [oleochemicals](#) today yield almost 1,000 chemical products based on renewable raw materials. They are used for a wide range of applications: lubricants; [stabilizers](#) and [additives](#) for the plastics industry; fat liquors for the leather industry; lacquer auxiliaries; [surfactants](#) for cosmetic products, detergents and cleaning agents.

Besides [fatty acids](#), their derivatives and glycerin, Henkel uses renewable oils and fats to produce, above all, [fatty alcohols](#), 90 percent of which are processed to [surfactants](#).

Oils and fats have been supplemented by another natural raw material as a basis for the production of [carbohydrates](#). These substances occur in nature in abundance, as cellulose in wood, as sugar in fruits, and as starch in maize and potatoes.

In Germany, for instance, about one percent of the total agricultural production of starch goes to the chemical industry as a raw material.

### **Alkyl polyglycosides are the basis of new products**

Henkel researchers also availed themselves of nature's rich bounty. They developed many new products based on the class of [surfactants](#) known as [alkyl polyglycosides \(APG\)](#).

These reaction products of [fatty alcohols](#) and [carbohydrates](#) are usually used as [co-surfactants](#), because they considerably reinforce the action of other [surfactants](#).

Henkel has known for a long time that potatoes and maize can theoretically provide raw materials suitable for [surfactants](#).

However, results obtained in the laboratory and pilot plant are often difficult to translate into industrial-scale production. Specialists have been exploring for new processes with which [APG](#) can be manufactured in large amounts since the early eighties.

An additional complication in this context is that nature cannot guarantee to supply raw materials of consistent quality. It has been possible to manufacture [APG](#) on a large scale since March 1992. The largest [APG](#) facility in the world, that of the American subsidiary Henkel Corporation in Cincinnati, Ohio, produces some 25,000 metric tons of the new surfactant type annually. Another plant will soon be coming on stream in Düsseldorf. Because APGs are very gentle to the skin, their main

applications are dishwashing and cleaning agents, as well as shampoos, bubble baths and shower gels.

One clear advantage of the [APG surfactants](#) is their excellent biodegradability, even in the absence of oxygen, i.e. under anaerobic conditions. A test procedure developed by Henkel (Metabolite test) can be used to prove that the [surfactants](#) undergo complete biodegradation. [Fatty alcohol sulfates \(FAS\)](#) based on renewable oils and fats were also subjected to these thorough tests. The results confirm that they, too, are completely biodegradable - also in the absence of oxygen.

[Fatty alcohol sulfates](#) are used whenever soap fails to perform its function: in hard water. Soap, the oldest surfactant, loses its washing power in hard water and combines with hardness elements to form lime soaps, which leave a gray, rancid-smelling deposit on laundry.

Natural raw materials - for example from soybean, the fruit of the oil palm or domestic rape - are the basis for many of the oleochemical products that have been manufactured by Henkel for many years. They also go into modern detergents.

### **Industrial-scale production with improved process**

Henkel has used [fatty alcohol sulfates](#) derived from renewable raw materials for many years: in liquid detergents as well as in dishwashing and cleaning agents. In February 1993, under the Persil brand, the first powdered all-purpose detergent with [FAS](#) (Henkel brand name Plantaren®) was introduced on the German market. This was possible because of the development of suitable processes for achieving optimal blending [fatty alcohol sulfates](#) into detergent formulations. In addition, industrial-scale facilities for manufacturing sufficient [FAS](#) by means of improved processes have only recently become available.

### **Drilling fluids: Environmentally compatible oil exploration**

A fatty acid ester made from native oils is currently attracting considerable interest from the oil industry. This innovative Henkel product possesses all the advantages of the mineral oil-based fluids used in drilling for petroleum and natural gas, especially offshore, but unlike their traditional products it is also fully biodegradable.



Studies of the seabed carried out after the first drilling operations in 1990, have now demonstrated conclusively that the ester undergoes total biodegradation on the seabed. Drilling fluids stabilize the walls of the borehole, lubricate and cool the drill bit and rod, and carry crushed rock (drill cuttings) to the surface. The mineral oil-based fluids previously used on a large scale by the oil industry for their technical advantages are ecologically harmful because they are not adequately biodegradable.

A drill rod being extended on a drilling platform. Counter-rotating multiple toothed cones enable the drill heads to eat through the most stubborn rock.

### **Mineral oil-based drilling fluids pollute the oceans**

And so they play a major role in contaminating the oceans. It has been estimated that in 1989 some 30,000 metric tons of mineral oil and crushed rock were dumped in the North Sea alone. For this reason, the countries bordering the North Sea have long been considering a ban on all mineral oil-based fluids and the practice of cleaning drill cuttings on site. They want safe and controlled disposal inland.

Meanwhile the number of oil companies that are willing to take their responsibilities seriously by using the Henkel fatty acid ester is growing, even though it is more expensive than the conventional products. They realize that it is in their long-term interests to help keep the oceans clean.

Drilling fluid cycle and accumulation of drill cuttings. The drilling fluid flows down through the drill rod and flows back through the gap between the drill rod and the wall of the borehole, carrying the drill cuttings with it. After the drill cuttings have been removed, the drilling fluid can be used again. Part of the fluid remains on the drill cuttings.

### **Packaging developments: Compact packaging**

The notion of downsizing packaging material is nothing new for Henkel. The first "Eco pack" for liquid detergents was developed as long ago as the late seventies.

Unfortunately it was too far ahead of its time; although technically perfect it failed to catch on with consumers.

Now that everyone is talking of reducing and [recycling](#) packaging materials, Henkel packaging engineers are again facing a challenging task - to cut down the amount of packaging materials used without sacrificing any of the advantages they confer. It would be impossible to dispense completely with packaging. It protects products so they can be transported. Boxes, buckets and cans are easy to handle. Packaged products can also be stored more simply - as retailers and buyers readily appreciate. One really light creation of the packaging engineers is the "Eco lightweight pack". This is a puregrade, colorless [polyethylene](#) bottle, weighing only 24 grams, which can be easily reprocessed, and a reusable cardboard box, which stabilizes the lightweight bottle.

Today, 34 liquid products are marketed in lightweight ecological packaging in six European countries. They include Persil, Ata, Atlas, Sofix and Vernel. Thanks to these alternative packagings, Henkel uses 1,000 metric tons of plastic less each year.

In Germany, alone it saves 600 metric tons on a total of 7,000 metric tons, and by 1995 it is planned to save 1,500 metric tons each year. The lightweight went down well with the experts, too. In a national competition in Italy it won the "Oscar dell'Imballaggio", and at the international packaging competition of the "World Packaging Organsiation" in Birmingham, England, it was awarded the "World Star for Packgaging 1991" in June 1992.

The standardized "Eurobottle" uses a lot less plastic, too. The new shape of this updated version of the traditional plastic bottle requires 30 percent less plastic. Total savings: 300 metric tons each year.

The "Eco lightweight pack" consists of a colorless and only 24 gram heavy [polyethylene](#) bottle and a stabilizing outside box.

### **Less plastic - less waste**

In the long term, packaging engineers intend to dispense completely with plastic in the carrier straps and adhesive tapes used on cardboard boxes. Paper will replace it, because this will simplify the later [recycling](#) process. Planned savings: again 300 metric tons per year.

Less plastic - less waste is also the formula for detergent dispensers. The familiar measuring beaker vanished from the detergent packs in June 1992. In its place, consumers can request a free standard beaker. Environmental benefit: 45 million less dispensing aids to be discarded each year.

However, it will not prove possible to abolish plastics completely in the short term. For example, thin plastic sheets are a more efficient solution to the problem of protecting palletized goods against transport damage and effects of the weather than material-intensive alternatives. A great many parameters must be considered before a decision can be made on whether a packaging is ecologically worthwhile.

Returnable bottles, for example, are only advantageous than one-way bottles if they make a certain number of trips. In addition, the energy needed to transport the returned bottles must be taken into account. Because the parameters are so varied and the topics so complex, Henkel refuses to rely simply on first impressions, but attempts to obtain a comprehensive overview by drawing up ecological balances. The amount of packaging can also be shrunk by using product concentrations. Concentrated detergents will cut back the amount of packaging by some 40 percent compared with normal merchandise, and even greater concentrations will produce even further savings. The first of these products - Dixan Megaperls - is already on the market in the Benelux, Switzerland and Austria.

### **Eco balances: From the cradle to the grave**

Some people regard ecological balances as a certificate of environmental compatibility or a universal remedy for all ecological problems. These expectations are too high. Ecological balances describe all the environmentally relevant parameters that play a role in the manufacture, utilization and disposal of a product. They provide a basis for making decisions. These decisions themselves depend on evaluations of individual results. For example: if less energy is needed to produce product A than product B but product B is more biodegradable, a decision must be taken on which benefit weighs more heavily.

Ecological balances should accompany a product from the cradle to the grave. This involves collecting and processing all significant data relating to the extraction of raw materials; the production processes of the individual raw materials; the manufacture of the products and the packaging; distribution; consumption; and finally disposal.

Care must be taken in comparing ecological balances. Eco balances for identical products may differ, depending on what data were incorporated in the calculations, and to what extent.

In some products segments, however, ecological balances are a valuable instrument of refinement. A relevant example from the Henkel product range: the ecological benefits of compact detergents weighed against conventional powdered detergents. Compact detergents discharge less [emissions](#) into the atmosphere and water, and they use less energy than normal detergents. What's more, they generate less waste. However, one critical factor must be taken into consideration - the consumer.

### **Compact detergents are still often added in excess**

Numerous studies have shown that consumers pay limited attention to the dispensing prescriptions of the detergent manufacturers. At present, they're likely to add about 20 percent too much compact detergent. As a result, the environmental benefits of compact detergents are partially offset by the consumers themselves.

This shows it is not enough simply to draw up ecological balances. Consumers must always be kept informed so that they are able to play their part in environmental protection.

### **Cooperation with customers: Out of sight - but still in mind**

Any new product rolled out onto the market nowadays must have a lot more going for it than good applicational properties. There should be no or almost no environmental impact associated with its use, and when it has served its purpose, it should be recyclable or easily and inexpensively disposable. These demands by trade and industry - and increasingly legislators - are an integral part of product development. Feedback between customers and product developers is essential if a new or modified product is to meet the demands it is expected to.

For years there has been close interaction between Henkel Metal Chemicals and its customers - primarily caremakers - concerning the use of neutral cleaning agents and demulsifiers. One example: a new, now patented system for cleaning and corrosion protection by means of neutral cleaning agents.

This has resulted in a considerable increase in the useful life of cleaning baths. Largely as a result of bath care measures and [recycling](#) the aqueous phase. The cleaning baths can consequently be used for up to 18 months.

Specifically this means: individually regulatable and optimized process control has enabled considerable reductions to be made in water consumption and hence the amount of wastewater and its level of pollution. Henkel's liquid neutral cleaning agents have been used successfully for many years, because they clean iron, steel, copper and brass just as thoroughly as plastic. Neither do the different types of dirt pose any problems for the industrial cleaning agents. The cleaning properties of the neutral cleaners are complemented by their protective action. Their basic chemical components include not only biodegradable [surfactants](#) but also organic inhibitors, which form a thin, transparent coating on the surface, protecting it against rust for some time.

Nowadays, the soiled emulsions formed during the cleaning process are separated in the baths during the operating process into the main components, oil and water. The oil phase can be removed from the bath liquid with the help of separators, and subsequently recycled; the aqueous phase is reused. After a maximum of 18 months, however, even the best bath is "exhausted". This means that up to 200 cubic meters of cleaning liquid in a central plant have to be disposed of.

Product developers are convinced that there are possibilities of improvement here. In the future, they intend to recover certain raw materials from the aqueous phase.

Another example: contaminated oil/water emulsions inevitably arise whenever metal is shaped, worked or processed as drilling and grinding agents are needed as well as cooling lubricants and drawing compounds. It has been estimated that the annual demand for cooling and lubricant concentrates in Germany alone is about 100,000 metric tons.

The amount of emulsions is much higher - about two million metric tons per year. Companies now have to pay dearly for their disposal. In Germany, for example, since the water balance law was changed in 1988, it is forbidden to discharge this wastewater into sewers or [receiving waters](#) without subjecting it to preliminary treatment. The oil content, as well as the concentrations and loads of other ecologically suspect substances (including [heavy metals](#)) are limited for dischargers. However, it is almost impossible to comply with the threshold and recommended values by conventional demulsifying. Neither the acid nor the salt process which were

generally used previously, nor [ultrafiltration](#), can achieve the threshold values. In addition, these processes result in the formation of large amounts of oily sludge, acid flotates and concentrates from the [ultrafiltration](#), which also have to be disposed of at a high cost.

### **Wastewater needs pretreatment**

A new Henkel process, involving the use of selected [organic substances](#) as demulsifiers, avoids many of the disadvantages of conventional methods. In the new process cationic [polymers](#) break the emulsions. No sludge is formed; the hydrocarbon content and the heavy metal content are drastically reduced.

Water and oil can now separate owing to the difference in density; five to ten percent used oil floats on 90 to 95 percent water, and in many cases this satisfies the legal requirements for discharge. Depending on its quality, the used oil is recycled, employed as a source of energy or disposed of as hazardous waste. If very stable emulsions are involved, or the level of pollution fluctuates strongly, the organic demulsifier stage is followed by other [emulsion](#) breaking processes, usually [membrane](#) ones.

To make sure that the organic demulsifiers are always fed in just the right amounts, the Metal Chemicals product developers had to devise suitable automatic measuring and dispensing technology, with which the exact dispensing cut-off point can be determined. This technology enables the breaking process to be monitored until the end point is reached, thus avoiding the addition of excessive demulsifiers.

The emulsions formed when oil-containing metal parts are cleaned are broken directly. The oil phase can then be separated.

### **Less oil in wastewater: Smart cleaning agents**

Saturday morning in the carwash. Cars queued bumper to bumper, waiting to shed their dirt and dust. More than 30 million vehicles are registered in Germany today, and all of them are washed more or less regularly. No wonder that washing the bodies and the engines of this many vehicles accumulates enormous amounts of dirty and oily wastewater.

Obviously this oily wastewater should not be allowed to infiltrate the sewage network or - even worse - the groundwater; just one liter of mineral oil makes a million liters of drinking water unpalatable. This hazard cannot be treated lightly, and all wastewater that might contain oil must flow through an oil separator.

The oily water spends about five minutes in the oil separator. In this time, the lighter oil separates from the water surfaces.

The oil layer can now be skimmed off and disposed of as hazardous liquid waste.

The residual wastewater runs into the sewage network.

In many companies, this functions perfectly, but in some cases the oil and water fail to separate within the given time because they have formed an [emulsion](#) - for example in carwashes, because of the cleaning agent that is used.

### **Powerful cleaning performance during the washing process**

How can cleaning agents have their desired effect without simultaneously forming emulsions? This is a major environmental problem. According to the German Federal Environmental Protection Agency, some 30,000 metric tons of cold cleaning agents are used annually in Germany alone. The amount of emulsions formed each year as a consequence is therefore many times higher.

Henkel's product developers have come up with a solution: a "smart" cleaning agent. During the washing process it brings about a considerable reduction in surface tension, and as a result it has a powerful cleaning effect. Subsequently it is diluted during rinsing and loses this property; it then acts as a self-demulsifying and neutralizing agent. This means that the oils separator can again function as it should, and the residual oil separates out after only a short time. In addition, the [pH](#) falls from the weakly [alkaline](#) to the almost neutral range.

The amount of residual oil in the wastewater is less than Germany's legally permissible maximum of 20 milligrams per liter. The wastewater can be discharged without needing any further treatment.

## Floor coverings: Teamwork in the interests of clean air

A successful example of good cooperation between three different companies in the interests of environmental protection was trodden underfoot by visitors to the Düsseldorf Plastics Trade Fair in August 1992: a floor covering that had been printed by means of the gravure process with an aqueous [polyurethane dispersion](#) as binder. This printing ink binder was specially developed by Henkel, and it enables printing ink manufacturers to employ pigment preparations specially developed for water-based printing inks, with which the floor covering manufacturers then print their floor coverings.

### Printing ink binders for water-dilutable inks

The reason for this cooperation is to switch from solvent-based printing inks to aqueous systems. Volatile [organic substances](#) used for painting and printing contribute to air pollution. This is why in 1984, the German coatings industry voluntarily undertook to introduce suitable measures to reduce solvent [emissions](#) from paints and inks.

This changeover has proved to be extremely difficult. The development of suitable new printing ink binders has only been gradually successful. This is where Henkel employees achieved the decisive breakthrough. Over a three-year period they developed a new printing ink binder for water-based inks, with which plastic coatings can be printed just as well as with inks that contain [solvents](#). This could not have been done without the knowledgeable support of the printing ink and floor covering manufacturers. The result is purer air and enhanced industrial safety.

## Research and development

The aims of research and development: more quality, safety and environmental compatibility

Henkel employs more than 3,000 people worldwide in research and development. They create the basis for innovation as far as modern, efficient and ecologically



compatible production facilities and products are concerned. And they ensure that environmental protection aspects are taken into account even during the planning stage. Here, too, the Henkel Group sticks to the principle that new products, facilities and production processes should always be superior to their predecessors.

### Instead of CFCs: A genuine alternative

It happens without warning. One moment all the important data are present on the hard disk of the computer, the next moment they are gone. But it is not the feared viruses that have obliterated all the data in the machine. The villain: a tiny speck of dust on the hard disk that has been missed by the fine cleaning.

The efficient cleaning and degreasing of surfaces plays a key role in all metal processing industries and the electronics industry. This is a traditional field of application for [halogenated hydrocarbons](#) covers groups of substances such as [chlorofluorocarbons](#) (CFCs) and [chlorinated hydrocarbons](#) (CHCs). According to the German Federal Environment Protection Agency, these cleaning processes generate 80,000 metric tons of hazardous waste each year in Germany alone, and this waste includes a large proportion of halogenated [solvents](#).

One especially critical field of operations is the fine cleaning of electronic components, for which [chlorofluorocarbons](#) have always been held to be indispensable. However, CFCs are regarded as the main cause of damage to the ozone layer, and substitutes are therefore urgently needed. An environmentally compatible alternative has now come from the Henkel laboratories: an aqueous cleaning solution.

<b>CHC <a href="#">solvents</a> market in Germany (western Germany) in thousand tons</b>						
Year	1986	1987	1988	1989	1990	1991
Perchloroethylene	45	40	35	30	37	22
Trichloroethylene	30	25	22	18	14	11
1,1,1,-Trichloroethane	35	40	35	30	26	17
Methylene Chloride	60	50	45	37	33	26
<b>Totoal</b>	<b>180</b>	<b>155</b>	<b>137</b>	<b>115</b>	<b>100</b>	<b>76</b>

Source: German Chemical Industry Association

Increased use of aqueous cleaning systems made it possible to reduce the use of chlorinated hydrocarbon in recent years.

### **Tiny specks of dust with a devastating effect**

In cooperation with a computer manufacturer, Henkel has developed an alternative process for the fine cleaning of hard disk components. From the very start, all those concerned had only one aim in view - to develop a completely novel cleaning process based on aqueous cleaning systems rather than just to replace CFCs by other organic [solvents](#).

The task was a big one. In the computer industry, surfaces have to be extremely clean - even the tiniest speck of dust can have a devastating effect. In addition, residues of organic material must be completely removed from surfaces, otherwise they could become detached by the heat generated during operation and cause severe malfunctioning. Furthermore, the aqueous solution must not attack the surface of any of the components, which are made of not only metal but also plastic.

### **Cleaning performance outstrips CFCs**

This means that a sophisticated combination of [wetting agents](#), [emulsifiers](#) and inorganic salts had to be developed before all these requirements could be fulfilled. The cleaning performance of the individual test formulations was therefore monitored with Henkel's modern surface analysis techniques. The result certainly bears scrutiny: the cleaning performance is even better than that achieved with CFCs. The aqueous solution can be recycled. With the help of special processes, e.g. [ultrafiltration](#), the detached dirt can be removed from the cleaning agent components to such an extent that the reconditioned solution can be fed back into the cleaning process. Only the separated solvent-free residual dirt has to be disposed of. Unfortunately, the new cleaning method is not suitable for existing facilities, which must be adapted. Thanks to the experience gained by Henkel during the development of the new process, Henkel specialists are able to support customers with advice and help.

## Wastewater treatment: From eastern Westphalia to the world

Every do-it-yourselfer is familiar with white-colored wood glue. Its raw material, a [polyvinyl acetate dispersion](#), is produced by the Henkel subsidiary, Cordes, in the eastern Westphalian town of Porta Westfalica. During the process of conversion into adhesive, the [dispersion](#) and other components leave their traces in the water used to rinse the reaction vessel, tanks, pipes and returnable containers. In the past, Cordes removed the residues from the milky wastewater with the help of a process widely used in this sector, i.e. by adding iron salts and lime. In this way, the dispersed particles are attached to the iron hydroxide flocs, which are then filtered off. The filtered wastewater is [alkaline](#) and has to be neutralized by other chemicals. However, this has its problems. [Precipitation flocculation](#) involves the addition of a considerable amount of salt to the wastewater. In addition, large amounts of [filter cake](#) are formed, and these have to be disposed of at some cost. A new process used by Cordes produces only half as much [filter cake](#) and one third as much wastewater as the previous one; what's more, the new process does not involve the application of any new principles. It is in fact based on experience gained in reprocessing emulsions. [Dispersions](#) and emulsions behave very similarly.

### An electrical current cleans contaminated wastewater

Cordes broke new ground when starting to treat wastewater that contained emulsions. Although it was not certain whether the new process would work, those responsible had a clear picture of their objective, namely to remove all solids from the water without adding any chemicals, and to produce as little [filter cake](#) as possible while doing so.

During the course of numerous laboratory tests, one process gave by far the best results: electrolytic separation. And this process ultimately made the running. A voltage is applied across the electrode plates and the contaminated rinse water undergoes a combination of chemical and physical changes as it passes between them.

The electrical current releases the dispersed particles from their charge, causing them to agglomerate. At the same time, water undergoes electrolytic dissociation, releasing gas at the electrodes. The tiny bubbles rise to the surface, taking the

[dispersion](#) flocs with them. When the charge is transferred to the dispersed particles, very small amounts of metal compounds arise from the electrode to which further [dispersion](#) particles can then attach themselves. These heavy particles sink to the bottom and are later pumped off with the [dispersion](#) flocs. The process also destroys pollutants and in doing so it reduces biochemical and [chemical oxygen demand](#); this latter is important if the wastewater is to pass through a biological sewage treatment plant. The whole sequence in the reaction section is controlled and monitored by a process control system that immediately reports the source of error if a malfunction occurs. It is therefore ensured that rinse water only leaves the facility if adequate [flocculation](#) has occurred. The substances precipitated in a chamber filter press. Only a pH-neutral [filter cake](#) is left, which can be disposed of harmlessly in a landfill for domestic waste.

### **New process meets all expectations**

The [filtrate](#) that flows into the public sewage network is also neutral and contains no salts or other chemicals. However, not all of the water is discharged into the sewers. Because it is so pure, some of it is fed back into the purification process. This is equivalent to a saving of one third of fresh water.

The new process therefore fulfills all expectations. It creates less [filter cake](#), so disposal costs are lower; and no chemicals are added, so industrial and environmental safety are improved. Even if the composition of the rinse water fluctuates sharply, the facility can handle it without any problems. Compliance with the legally required discharge conditions is therefore ensured.

In the field of environmental protection, the experience gained with this new operation and the knowledge of the properties of [dispersion](#)-containing rinse water are of benefit not only to Cordes; other Henkel production plants that produce and process [dispersion](#) adhesives throughout the world can profit from the experience gained in eastern Westphalia.

### **Biotechnology and environmental engineering: Custom tailored**

COGNIS GmbH, established in 1991, synergizes Henkel Group know-how, i.e. the Company's R&D and production experience, in the fields of biotechnology and

environmental engineering. Through its locations in Düsseldorf, Genthin (eastern Germany), and Santa Rosa (California), COGNIS supplies environmental services and technologies to Henkel Group companies across the world. In this way, COGNIS helps to improve Henkel's environmental situation.

R&D capabilities progress existing expertise and upgrade even further achieved environmental standards. Action already taken indicates that economic advantages are frequently obtainable, too. A rigorous analysis of the environmental situation at existing production plants reveals possibilities for reducing pollution in waste air, wastewater and for minimizing the amount of solid waste. The overall objective is process optimization for eliminating pollutants.

This young consultancy and technology enterprise has about 100 employees who supply its clients with custom-tailored solutions to their problems. In 1992 alone, COGNIS was able to help some 30 Henkel production plants and Group companies in Germany and abroad, i.e. solutions for environmental problems were developed on site in cooperation with the employees of the companies in question. The company can provide a wide variety of services, ranging from proposals for improving the waste situation, through wastewater and waste gases, to biological soil renewal. Here are a few examples of COGNIS solutions to problems encountered within a Henkel Group:

After reviews of numerous audits (process description, wastewater, waste gases, energy, waste, noise) with Spanish colleagues, three key objectives were formulated and then jointly translated into practice: reduction of noise emission, [recycling](#) the rinsing and cleaning water of the detergent factory, and reduction of [emissions](#) from the spray tower.

COGNIS develops products for the environment. A new product for restoring soil contaminated by petroleum is being laboratory tested.

### **Worldwide service and technology**

In Japan, the problem was completely different: should be biological sewage treatment plant be extended to cope with the increased amounts of wastewater that had to be treated? The answer was no. In a joint effort it is possible through improved

aeration in the wastewater tank for hazardous substance decomposition to be raised from 50 to over 90 percent.

The customized concept for Herborn in Hesse was: separation of the oil and water phases by [distillation](#). The oil phase has a high calorific value and is therefore burned; the water is oxidized with [hydrogen peroxide](#). This eliminates its odor and reduces its [COD](#) load, so that the water can be discharged into the sewage network. France, too, has made use of experience from Germany. The following concept for extending a biological sewage treatment plant was agreed upon: an initial, highly efficient, biological stage replaced the inefficient parallel biological stage. The advantages: lower investment costs and increased industrial safety.

From its bases in Düsseldorf, Genthin in eastern Germany and Santa Rosa in California, COGNIS supplies service and technology worldwide. And not just to companies in the Henkel Group. In 1992, 115 outside firms, municipalities and institutions benefited from the knowledge and experience of COGNIS employees.

### **Experts in hygiene: A joint effort**

Where such a difficult subject as [hygiene](#) is concerned, Henkel-Ecolab does not just rely on its own judgement. This joint venture, which has been active throughout Europe since 1992 in the field of professional cleaning and [hygiene](#), also commissions expert opinions from competent institutes and scientists, both in Germany and abroad, when products in this field are tested. In this way, the first environmentally compatible chlorine-free and phosphate-free [hygiene](#) system for industrial dishwashing was developed.

This system is used in hospital kitchens and company canteens. It consists of cleaning agents, bleaching agents, disinfectants and clear rinsing agents, together with the associated dispensing and supply technology.

During the development phase the system had to demonstrate repeatedly that it can not only clean strongly soiled dishes very thoroughly, but that it is also microbiologically compatible, and economic.

### **Hygiene systems for mobile use, too**

[\(Experts in hygiene: A joint effort\)](#)

The electronically controlled dispensing technology ensures that chemicals are added exactly as required, so that their consumption is as low as possible, and that the dishwashing process as a whole is hygienically and economically efficient. Experts from two independent external hygiene institutes tested the process in practice and assessed it as "good". They therefore confirmed the results obtained by Henkel's own product developers, microbiologists and ecologists.

The cleaning system is also suitable for mobile applications in appropriate dishwashing machines. Its hygienic efficiency and environmental compatibility thus make it suitable for use at open-air events; disposal tableware is unnecessary and hygiene is not compromised.

The environmentally compatible cleaning system for industrial dishwashing machines is submitted to practical tests in Henkel-Ecolab's hygiene laboratory.

## **Waste disposal**

New plant concepts and innovative processes mean less environmental pollution

Henkel is constantly searching for ways of reducing the waste gas and wastewater burden at its production sites. Chemists and engineers from research and process development team up with their colleagues from production to design new processes and plants with lower levels of emission. Progress in the environmental sphere is put into practice not only at Henkel's Düsseldorf headquarters but also in the Group companies in Germany and throughout the world.

### **Microorganisms in the bioscrubber: Odor eaters**

The production of chemical raw material sometimes causes unpleasant smells. There were days when people living in the vicinity of the Kepec chemicals factory in Siegburg, where fragrances, specialty chemicals and [additives](#) are manufactured, had reason to complain about the waste gases emitted by the production facilities. That is now history. In the summer of 1992, the Henkel subsidiary put its bioscrubber

into operation - a waste gas purification plant designed by Henkel's process developers to take account of the company's special requirements.

At the heart of the plant are innumerable [microorganisms](#) with a giant appetite. These bacteria regard the organic odorous substances in the waste gases as a choice delicacy. The employees at Kepec were aware of this in 1988 when, together with Henkel process engineers, they began the first tests in a small pilot plant.

Two years later a start was made on the construction of a full-scale plant. About 30,000 cubic meters of waste gases can now be purified each hour. The collected waste gases are passed into a scrubbing tower and sprayed with a scrubbing liquid. The impurities dissolve in the scrubbing liquid, which is then passed into a biological scrubber.

There the [microorganisms](#) in the sludge are waiting for nutrition. They fall on the scrubbed-out odorous substances, decomposing them into [carbon dioxide](#) and water, while the purified waste gases are discharged into the atmosphere through a chimney. However, the permanently hungry [microorganisms](#) cannot live on dirt alone. To ensure that they do not lose their appetite they are also provided with atmospheric oxygen and nutrient salts, which are added to the sludge in controlled amounts. The bioscrubber at the Kepec chemicals factory is the first in the Henkel Group. The novel waste gas purification plant has been a great success. This technology can therefore serve as a model of other Henkel companies.

## **Wastewater treatment in Malaysia: Two steps to clean water**

The Henkel Group's Principles of Environmental and Consumer Protection state that safety and environmental protection have to be taken into account from the very start when new facilities are planned. This applies to production facilities as well as the associated disposal facilities - and it applies worldwide. The latest example: the wastewater treatment plant of Henkel Malaysia, where the same wastewater standards apply as in Germany. Henkel Malaysia produces [fatty alcohols](#), [fatty acids](#) and [methyl esters](#) from renewable raw materials. About 700 cubic meters of wastewater are produced on the entire site each day. The wastewater comes from the various process stages and contains rinse, wash and purification water, as well as all of the rainwater.



Water protection has gained considerable importance in Malaysia in recent years. Strict official conditions now ensure that water can only be discharged after it has undergone sufficient preliminary treatment or purification.

The threshold values are comparable to those in Germany: 100 milligrams per liter for [chemical oxygen demand \(COD\)](#), and 50 milligrams per liter for 5-day [biochemical oxygen demand \(BOD<sub>5</sub>\)](#). These two parameters are yardsticks for the contamination of wastewater with [organic substances](#) and their biodegradability. The threshold value for oils and fats from renewable raw materials is 10 milligrams per liter. The [pH](#) must be between 6 and 9. The environmental protection requirements, and the experience gained by Henkel during many years of disposing of wastewater from applications in the field of oleochemistry have been incorporated in the plans for the new plant in Malaysia. It consists of two stages: preliminary clarification, followed by biological regeneration.

The impurities in the wastewater are reduced to the level of a few milligrams per liter. The threshold values in Malaysia are as strict as in Germany.

#### **Biological oxygen demand (BOD)**

Inlet 2 000 - 6 000 mg/l

Outlet 50 mg/l

#### **[Chemical oxygen demand \(COD\)](#)**

5 000 - 10 000 mg/l

Outlet 100 mg/l

#### **[pH](#)**

Inlet ca. 3 (after acid separation)

Outlet 6 - 9

### **Tiny air bubbles lift particles to the surface**

In the preliminary clarification step, the wastewater undergoes chemical and physical treatment. The oil/water [emulsion](#) is broken (this process is referred to as acidic [emulsion](#) breaking), then the oil and water are divorced in a separator.

The separated oil is recycled into the production process, and the residual water neutralized with [lime suspension](#). During the subsequent [flotation](#), tiny air bubbles stream through the wastewater tank and carry dirt particles to the surface, where they

are skimmed off. This process for separating fine solids from liquids removes part of the organic pollution and residual fat residues before the biological purification stage.

### **Bacteria in sewage sludge need oxygen, too**

Biological regeneration is carried out in an open tank. The tank is filled with preclarified wastewater, which is homogeneously aerated by a stream of fine air bubbles entering at the bottom of the tank. In this way, the bacteria in the sewage sludge are provided with the atmospheric oxygen they require for their work.

After a number of hours they have biodegraded the substances in the wastewater, so that the organic pollutants are reduced to the officially prescribed level.

As soon as the air stream is cut off, the sewage sludge settles out. It is separated, dehydrated and then disposed of. Part of the sludge together with its bacteria, remains in the tank, waiting for new wastewater. The purified water leaves the plant through an open channel running toward the sea.

Analytical laboratory checks and modern instrumentation and control technology continuously indicate that the permissible threshold values are not exceeded and ensure that the new plant operates safely.

### **Nickel recovery: Doubly purified is simply better**

In accordance with the latest state of technology, Henkel uses a nickel-containing [catalyst](#) for the [hydrogenation](#) of unsaturated oils, fats and [fatty acids](#). Only in this way can the hydrogen be attached to the double bonds of the carbon. During this process (also known as hardening, because it causes substances that are liquid or pasty at room temperature to become solid) a small proportion of the fatty acid reacts with the [catalyst](#) to nickel soaps.

The Henkel oil facility in the Düsseldorf parent plant is therefore responsible not only for extracting the highly pure hydrogenated [fatty acids](#) but also for purifying the associated [distillation](#) residues. The nickel soaps are dissolved in sulfuric acid.

Previously they had flowed into a branch stream of the process wastewater as nickel

salts, and from there they were carried into the Düsseldorf-South municipal sewage plant, which drains into the Rhine.

### **Greatly reduced amounts of heavy metal in wastewater**

In late 1992, Henkel ceased to discharge the unpurified wastewater branch stream containing the nickel salts into the sewage treatment plant. A new, automatically controlled processing plant now reduces the amounts of heavy metal to less than a milligram per liter.

Before the processing plant was constructed, extensive tests were carried out to enable all the relevant physical and chemical factors to be assessed. Process Technology, Production, and Engineering were involved. The unambiguous result: the [precipitation reaction](#) is currently the most suitable and the operationally safest technology.

The way the plant operates is well thought out. [Lime suspension](#) is added twice to the wastewater, once in coarse form in an alkalization vessel, into which the [lime suspension](#) is metered, so that the [precipitation reaction](#) can proceed under uniform conditions. Poorly soluble nickel compounds precipitate out during this reaction.

### **Latest instrumentation and control technology**

Wastewater and precipitation product collect in a sludge tank. From there they are passed through an automatically operated filter press. The resulting clear, almost nickel-free [filtrate](#), is continuously checked for particles before it flows into the plant sewer. If the filter press suffers a malfunction, a backup filter takes over. The nickel-containing [filter cake](#) ends up at a [recycling](#) plant, where the nickel compounds are processed to nickel suitable for industrial applications. The new plant is fitted with the latest control and safety technology. This means that, if an accident occurs, the nickel-containing wastewater stream will be contained within the plant.

The new plant has sharply reduced the amount of nickel present in wastewater. Instead of 2.5 metric tons, only ten kilograms are now discharged per year - another stone in the mosaic of environmental protection measures.

## Problem-free nickel: Separating system instead of complexes

The problem proved too much even for specialists from notable companies in the field of wastewater treatment. How do you crack the extremely stable [complexes](#) of nickel and ethylenediaminetetraacetic ([EDTA](#)) that form in wastewater and which have as yet proved impossible to break down with normal methods? The solution is ingenious yet simple: prevent the [complexes](#) from forming at all!

Putting this into practice is not as easy as it sounds. Contaminated wastewater must be separated in the plant where it is formed, and passed through various pipes into two tanks. The first tank is mainly for inorganic wastewater, in which [heavy metals](#) such as nickel are present; the second is mainly for organic wastewater in which no [heavy metals](#) are present. The separating system has been implemented at Collardin, which has belonged to Henkel Group since 1956.

Its production plants in Herborn-Schönbach in Hesse mainly manufacture products for cleaning, degreasing, derusting or phosphating surfaces. Its main customers are the metal processing industry, the beverage industry, dairies and breweries. The demands made on the company's products vary widely. It's not surprising that Collardin processes more than 600 raw materials, including [phosphates](#), acids, lyes, [surfactants](#), perfumes and metal salts, in order to fulfill its customer's requirements. Wastewater of widely varied composition are produced and their treatment posed considerable problems. The nickel [complexes](#) were especially difficult to handle. They pass through the purification process unchanged. Only a combination of powerful acids and high temperatures can dissolve the extremely stable bonds and break the [complexes](#) into their individual components. However, this radical treatment cannot be used for large volumes of wastewater such as those generated in Herborn. So many [complexes](#) remained in the wastewater that their concentration was often higher than the officially prescribed threshold values. Unsuccessfully treated wastewater then had to be subjected to special treatment: it had to be disposed of by specialized companies at a high cost.

At Henkel subsidiary Collardin in Herborn four tanks, each with a capacity of 80 cubic meters, collect the purified wastewater. Only after thorough analysis it is discharged into the municipal sewage network.

## Two treatment tanks for individual purification

In 1988, Collardin developed the separation system. It had to be possible to integrate existing plant components into this overall concept. Four years passed before the two large collector tanks could receive the first wastewater.

The wastewater flows from the collector tank to two treatment tanks. The purification treatment applied depends on the type of pollution in the water, and may involve a number of stages, e.g. [chromate](#) reduction, neutralization, and [flocculation](#). The wastewater is then passed through a filter press. The [filtrate](#), whose heavy metal content is now well below the permissible threshold values, undergoes strict internal checks before ending up in the municipal sewage treatment plant. The [filter cake](#) is disposed of.

Some 50 cubic meters of wastewater are currently purified in this way daily.

Employees are closely familiarized with the new process, so that they can ensure that the wastewater flows correctly and is collected properly.

# Environmental data

## **Expenditure on environmental and consumer production**

Although there has been a steady increase over recent years in expenditure associated with operating environmental protection equipment, and on research and development oriented toward environmental and consumer protection, environmental investment itself has been subject to considerable fluctuation. It is directly dependent on the implementation of concrete investment measures.

## **Sulfur dioxide and nitrogen oxide emissions**

### **Henkel parent plant, Düsseldorf**

The emissions are largely caused by the power plant and the water glass factory. The measures taken there to reduce sulfur dioxide and nitrogen oxides have lowered emissions considerably. Compared with the emissions values stated in the Environment Report 1992, there has been a switch from the plan values of an emission reduction program to the actual emissions declaration regulations.

## **Emissions of organic substances and dust**

During recent years it proved possible to achieve considerable reductions in emissions of organic substances by means of numerous individual measures. For example, local waste gas incineration units were installed for adhesives production and printing shop. In other facilities, odor-intensive waste gases were collected with the help of pipeline systems and incinerated in the Henkel power plant. The reduction in dust emissions up to 1987 is largely attributable to the dedusting of all water glass furnaces.

## **Power generation**

The Henkel power plant operates on the principle of heat-and-power cogeneration. Steam, after passing through the turbines to generate electricity, provides heat to the production lines. Cogeneration is much more efficient in terms of energy utilization than simple power generation.

## **Sulfur dioxide and nitrogen oxide emissions from the Henkel power plant, Düsseldorf**

Switching to low-sulfur fuels has resulted in a considerable decrease in sulfur dioxide emissions since 1984. A further drastic reduction has been achieved since 1991, when the flue gas desulfurization plant came on line. Nitrogen oxide emissions have been reduced since 1985 by the step-by-step introduction of the HERENOX process. The special firing technology largely prevents the formation of nitrogen oxides, so that subsequent denitrification measures unnecessary. The dramatic decrease in sulfur dioxide in 1992 is attributable to the shutting down of a coal-fired boiler unit.

## **Dust emissions from the Henkel power plant, Düsseldorf**

The reduction in dust emissions in recent years is attributable to shutting down an old boiler unit and to dust separation in the flue gas desulfurization plant.

## **Wastewater**

### **Henkel parent plant, Düsseldorf**

Daily wastewater volume, excluding water from atmospheric precipitations. Henkel has a completely mixed sewage system. Atmospheric precipitation water, cooling water, process water and water from on-industrial activities are jointly discharged and fed into the Düsseldorf-South municipal sewage treatment plant.

## **COD and sulfate loads in wastewater**

Because Henkel, as an indirect discharger, feeds its wastewater into the Düsseldorf-South municipal sewage treatment plant, the given COD loads do not find their way into the environment. Studies in model have demonstrated that some 90 percent of the COD load is eliminated. Sulfates are formed when sulfuric acid is neutralized. They are not critical from an environmental point of view, but in high concentrations they attack concrete sewage pipes. However, such critical concentrations are not found in Henkel wastewater.

## **Nickel and AOX loads in wastewater**

Nickel is used as a catalyst in some production processes and traces of it "leach" into the wastewater. As a result of specific process changes, the nickel loads have been considerably reduced in recent years. The nickel precipitation unit that came on stream in late 1992 will bring about a further decrease.

The AOX load has been considerably reduced by measures which include less reliance on chlorinated solvents.

\* Data have only been recorded since 1986.

## **Copper and chromium loads in wastewater**

Copper and chromium are used as solid catalysts in the hydrogenation of fatty acid methyl esters. Trace of them are "leached" into the wastewater. Specific process improvements brought about a reduction of water pollution by chromium in recent years.

\* No comparable chromium data available before 1989.

Other heavy metals - especially ecologically suspect cadmium and mercury - are not used or processed in the production facilities at the Henkel parent plant in Düsseldorf.



## **Residual substances, 1992**

A comparison of the years 1987 and 1992 shows that noise reduction measures in production units have improved the noise situation around the parent plant. The noise level of 50 decibels (A) is comparable with a normal conversation in a room.

## **Reportable industrial accidents**

Environmental protection and occupational safety are closely linked in the chemical industry. In the same way that facilities with a high standard of environmental protection have high safety standards, the environment-conscious and safety-conscious attitudes of employees result from the same positive approach to these themes.

## **Environmental protection courses**

### **Henkel parent plant, Düsseldorf Employees with environmental protection training**

Since mid-1990, employees have undergone training with regard to company-specific and plant-related environmental questions. The target groups include, primarily, all employees in production, workshops and laboratories. In addition, discussions of environmental protection and safety are held at least twice yearly. For many years, environmental protection seminars, which are open to all, have been held in the context of advanced training, and managerial personnel have been able to attend special advanced training courses on environmental subjects.

## **Dust and nitrogen oxide emissions from water glass production**

Dedusting equipment was installed between 1985 and 1987 for the purpose of reducing dust emissions from [water glass production](#). The precipitated dust is not disposed of as waste but is returned to the production cycle. Until now, it has only been possible to limit the - nitrogen oxide emissions from the water glass furnace by

improving the firing technology. It is planned to reduce the nitrogen oxide emissions from all water glass furnaces in future by means of non-catalytic secondary measures. The preliminary tests have already been concluded.

### **Solvent consumption in adhesives production**

Years of intensive efforts aimed at finding substitutes for organic solvents have brought about considerable savings, especially of the critically regarded aromatic and chlorinated solvents. Because not all adhesive systems can be switched to an aqueous basis, consumption of some of the less critical solvents has increased in some cases.

### **Consumption of chlorinated hydrocarbons**

Increase outside of Germany attributable to the acquisition of other companies, e.g. the acquisition in 1990 of the largest British manufacturer of pickling agents, which contain chlorinated hydrocarbons, and the purchase of Hungarian company in 1991. Targeted substitution measures have been established.

### **Environmental monitoring - surfactants in the Rhine**

Since 1958 Henkel has carried out systematic analyses of the concentration of anionic surfactants in the Rhine and its major tributaries - long before government inspection bodies took up this theme. These analyses have impressively demonstrated the success of the switch, in 1964, from poorly degradable to readily biodegradable surfactants. Since that time, the degradability of the surfactants has been steadily improved. As a result, and also as a result of the construction of sewage treatment plants, the surfactant pollution of the rivers has been reduced still further. After the introduction of nonionic surfactants on a large scale, in 1972 the analyses were also extended to include this product group.

## **Environmental monitoring - boron and phosphate in the Rhine**

For many years, detergents used to contain phosphates, which formed bonds with water hardness elements. Phosphates from this source made a major contribution to the phosphate pollution of bodies of water. Reduced-phosphate detergents came onto the market from 1980, and by 1989 Henkel had switched to phosphate-free formulations for all of its detergents in Germany. These measures, together with the introduction of the third purification stage in sewage treatment plants, have considerably reduced the phosphate pollution of bodies of water. Boron is also included in detergents, in the form of the bleaching agent sodium perborate. The introduction of bleach activators improved the efficiency of the sodium perborate, so that lower amounts could be used.

By developing ever more efficient detergent formulations and dispensing with fillers and auxiliaries as far as possible, considerable reductions have been achieved in the recommended detergent dosage per wash cycle. This means that the chemical pollution of domestic wastewater has also been reduced.

# Glossary of chemical terms

## Additives

([Natural oils and fats for chemical-technical applications](#), [Microorganisms in the bioscrubber: Odor eaters](#))

Substances that are added for the purpose of imparting specific properties to a product.

## Alcohols

([Esters](#), [Fatty acid esters](#), [Fatty alcohols](#), [Methanol](#))

Organic compounds whose molecules contain an OH-group. This makes them more soluble in water than the [aliphatic hydrocarbons](#) from which they are derived.

## Aliphatic hydrocarbons

([Alcohols](#))

Class of organic compounds with molecular structures in the form of straight or branched chains. Unlike the [aromatics](#) they do not contain a benzene ring.

## Alkaline

([Powerful cleaning performance during the washing process](#), [Wastewater treatment: From eastern Westphalia to the world](#), [Nonionic surfactants](#), [pH](#))

Aqueous solution with a [pH](#) above 7.

## Alkyl polyglycosides (APG)

([Preface](#), [Natural oils and fats for chemical-technical applications](#), [Alkyl polyglycosides are the basis of new products](#))

New type of [surfactants](#), made only from natural raw materials such as starch, sugar and [fatty alcohols](#).

## Anionic surfactants

[Surfactants](#) that break down into electrically charged [ions](#) in aqueous solutions, and whose special surfactant properties are attributable to the negatively charged [anions](#).

## Anions

([Anionic surfactants](#))

Negatively charged [ions](#).

## AOX value

Measure of the sum of the organic halogen (especially chlorine) compounds in wastewater.

## Aroma chemicals

Raw materials for the manufacture of perfumed oils. These perfumed oils sometimes contain up to 100 aroma chemicals, whose combined action results in the characteristic odor of the perfumed oil.

## Audit

Technical term for review or hearing.

## Aromatics

([Aliphatic hydrocarbons](#))

Class of organic compounds derived from benzene. The characteristic structural feature of its molecules is the hexagonal benzene ring.

## Biochemical oxygen demand (BOD)

([Wastewater treatment in Malaysia: Two steps to clean water](#))

Measure of the sum of the biodegradable organic pollutants in wastewater. The BOD is the amount of oxygen consumed by [microorganisms](#) when they degrade these pollutants.

## Carbohydrates

[\(Natural oils and fats for chemical-technical applications, Alkyl polyglycosides are the basis of new products\)](#)

Naturally occurring vegetable raw materials. Examples of carbohydrates are sugar, starch and cellulose.

#### Carbon dioxide

[\(Collecting zones allow no liquid to escape, Microorganisms in the bioscrubber: Odor eaters\)](#)

Gaseous combustion of all [organic substances](#) that contain carbon. Carbon dioxide contributes considerably to the greenhouse effect. The main source of carbon dioxide is the exploitation of fossil raw materials such as coal and mineral oil (mainly for energy production or vehicle traffic).

#### Catalyst

[\(Hydrogenation facilities subject to hazardous incidents order, Nickel recovery: Doubly purified is simply better\)](#)

Special substance that accelerates a chemical reaction while itself remaining unchanged.

#### Cations

Positively charged [ions](#).

#### Chemical oxygen demand (COD)

[\(An electrical current cleans contaminated wastewater, Worldwide service and technology, Wastewater treatment in Malaysia: Two steps to clean water\)](#)

Measure of the sum of all [organic substances](#) in wastewater. The COD indicates how much oxygen is needed to oxidize these substances completely.

#### Chlorinated hydrocarbons

[\(Instead of CFCs: A genuine alternative\)](#)

[Halogenated hydrocarbons](#) that contain chlorine.

#### Chlorofluorocarbons (CFC)

[\(Instead of CFCs: A genuine alternative\)](#)

Non-toxic, non-flammable [halogenated hydrocarbons](#) that contain fluorine and chlorine. They damage the ozone layer.

#### Chromate

[\(Two treatment tanks for individual purification\)](#)

Special salts of metal chromium, which are used mainly for surface treatment of metals and for tanning leather. The presence of chromates in wastewater is regarded as especially critical, and they therefore always have to be converted to less critical chromium compounds.

#### Colloids

[\(Microfiltration\)](#)

Systems in the transition zone between [dispersions](#) or emulsions and genuine solutions. In colloids, the particles are so finely distributed that they cannot be recognized with the naked eye.

#### Complexes

[\(Problem-free nickel: Separating system instead of complexes, Ethylenediaminetetraacetic acid \(EDTA\)\)](#)

Higher order compounds, including those of [heavy metals](#), which are often characterized by considerable stability and excellent solubility in water.

#### Dispersion

[\(Floor coverings: Teamwork in the interests of clean air, Wastewater treatment: From eastern Westphalia to the world, An electrical current cleans contaminated wastewater, New process meets all expectations, Colloids, Emulsion, Polyvinyl acetate,](#)

### Suspension)

Finely distributed solid particles in water.

### Distillation

([Worldwide service and technology](#), [Nickel recovery: Doubly purified is simply better](#))

Process for splitting and purifying liquids by vaporizing and subsequently liquefying the vapor. Liquids with different boiling points can be separated by distillation. Impurities remain in the distillation residue.

### Electrolysis

([Wastewater treatment: From eastern Westphalia to the world](#))

Decomposition of dissolved and melted substances, especially salts, with the help of a direct current. Used, for example, to extract very pure copper from solutions of copper salts.

### Emissions

([Environmental protection courses](#), [Eco balances: From the cradle to the grave](#), [Printing ink binders for water-dilutable inks](#), [Biotechnology and environmental engineering: Custom tailored, "Störfall"](#))

Gaseous, liquid or solid substances that enter the atmosphere from industrial production plants, motor vehicles with internal combustion engines, domestic heating systems or during the course of other industrial processes.

### Emulsifiers

([Cleaning performance outstrips CFCs](#))

Substances that support the formation of stable emulsions.

### Emulsion

([Wastewater needs pretreatment](#), [Less oil in wastewater: Smart cleaning agents](#), [Tiny air bubbles lift particles to the surface](#))

Dispersion of fine drops of a liquid in another liquid, for example water in oil.

### Energetic exploitation

Exploiting the energy content of residues and wastes. Energetic exploitation can take the form of direct incineration of wastes, or materials with a high caloric value can be sorted out for later incineration.

### Esters

([Fatty acid esters](#), [Methyl esters](#))

Widely varied class of compounds formed by reactions between alcohols and acids.

Esters are not only valuable starting materials for chemical syntheses but are also used for a large number of applicational purposes.

### Ethylenediaminetetraacetic acid (EDTA)

([Problem-free nickel: Separating system instead of complexes](#))

Nitrogen-containing organic compound that reacts with heavy metals to form very stable complexes. Used in metal treatment.

### Fatty acid esters

([Fatty acid methyl esters](#))

Products obtained when fatty acids reacts with alcohols. The best known fatty acid esters are the natural oils and fats. Other fatty acid esters are intermediate and end products in the widely branching field of oleochemistry.

### Fatty acid methyl esters

([Hydrogenation facilities subject to hazardous incidents order](#), [Fatty alcohols](#), [Methyl esters](#))

Fatty acid esters with methanol; intermediate product in the manufacture of fatty alcohols.

### Fatty acids

([Natural oils and fats for chemical-technical applications](#), [Wastewater treatment in Malaysia: Two steps to clean water](#), [Nickel recovery: Doubly purified is simply better](#), [Fatty acid esters](#), [Fatty alcohols](#))

Class of substances that are found - bonded to glycerin - in all vegetable and animal fats and oils. Important oleochemical derivatives.

Fatty alcohol sulfates (FAS)

([Preface](#), [Alkyl polyglycosides are the basis of new products](#), [Industrial-scale production with improved process](#))

Important group of [surfactants](#) based on [fatty alcohols](#).

Fatty alcohols

([Hydrogenation facilities subject to hazardous incidents order](#), [Renewable raw materials: From nature's garden](#), [Natural oils and fats for chemical-technical applications](#), [Alkyl polyglycosides are the basis of new products](#), [Wastewater treatment in Malaysia: Two steps to clean water](#), [Alkyl polyglycosides \(APG\)](#), [Fatty acid methyl esters](#), [Fatty alcohol sulfates \(FAS\)](#))

Long-chain [alcohols](#), which Henkel obtains from [fatty acid methyl esters](#) or directly from fats by reacting them with hydrogen ([hydrogenation](#)). [Fatty acids](#) are important raw materials for the manufacture of [surfactants](#).

Filter cake

([Wastewater treatment: From eastern Westphalia to the world](#), [An electrical current cleans contaminated wastewater](#), [New process meets all expectations](#), [Latest instrumentation and control technology](#), [Two treatment tanks for individual purification](#))

Solids left on the filter after filtration.

Filtrate

([New process meets all expectations](#), [Latest instrumentation and control technology](#), [Two treatment tanks for individual purification](#))

Clear liquid freed from solid matter after having passed through a filter.

Flocculation

([Wastewater treatment: From eastern Westphalia to the world](#), [An electrical current cleans contaminated wastewater](#), [Two treatment tanks for individual purification](#))

Process for removing finely dispersed solid particles from a liquid. The fine solid particles agglomerate, forming larger flocs that can be easily removed from the water.

Flotate

Solid particles carried to the surface with the air bubbles during [flotation](#). The flotote can subsequently be removed.

Flotation

([New process meets all expectations](#), [Tiny air bubbles lift particles to the surface](#), [Flotate](#))

Process for separating fine solid particles selectively from others in liquids. Air is blown into the liquid, so that air bubbles attach themselves to the selected solid particles - e.g. pigments from printing inks - and carry them to the surface of the liquid, where they can be skimmed off.

Flue gas desulfurization plant

([Sulfur dioxide](#))

Plant that removes [sulfur dioxide](#) from the flue gas of power plants, furnaces, etc.

Gravure printing

Printing process in which the printing areas are below the non-printing surface of the cylinder.

Halogenated hydrocarbons

[\(Instead of CFCs: A genuine alternative, Chlorinated hydrocarbons, Chlorofluorocarbons \(CFC\)\)](#)

Organic [solvents](#) that have lost their combustibility as a result of having had halogens (fluorine, chlorine, bromine, iodine) incorporated into their molecular structures by chemical means. This means that they are safe to handle, but this advantage is offset by numerous disadvantages with respect to health protection and environmental protection.

Heavy metals

[\(Cooperation with customers: Out of sight - but still in mind, Problem-free nickel: Separating system instead of complexes, Complexes, Ethylenediaminetetraacetic acid \(EDTA\)\)](#)

Metals with a density greater than 4 grams per cubic centimeter. Because many heavy metals and their compounds are toxic and environmentally hazardous, they are the subject of critical attention. There are, for example, strict limits on the amounts of heavy metals in drinking water and food, arable soil, and wastewater discharged into sewage treatment plants or bodies of water.

Hydrogenation

[\(Plant safety: Better safe than sorry, Hydrogenation facilities subject to hazardous incidents order, Collecting zones allow no liquid to escape, Nickel recovery: Doubly purified is simply better, Fatty alcohols\)](#)

Chemical reaction with hydrogen.

Hydrogen peroxide

[\(Worldwide service and technology\)](#)

Liquid used as an oxidizing, bleaching and disinfecting agent. Hydrogen peroxide is regarded as especially advantageous from an environmental point of view, because its decomposition products are water and oxygen.

Hyperfiltration

[\(Membrane filtration\)](#)

(Reverse osmosis) Reverse osmosis - used to concentrate and ultrapurify substances - is carried out with an extremely thin "pore-free" [membrane](#), through which water and a few [solvents](#) can only pass at high pressure (20 to 100 bar). As they pass through, dissolved substances such as salts and larger molecules are held back. Reverse osmosis is suitable for extracting potable water from sea water, and for obtaining extremely pure water (superpure water).

Immissions

Action of atmospheric pollution, noise, vibration or radiation on people, animals, plants or objects.

Inhibitor

Substances that inhibit or prevent an undesirable process (for example corrosion inhibitors).

Ions

[\(Anionic surfactants, Anions, Cations, Nonionic surfactants, Water hardness\)](#)

Electrically charged particles, created when certain substances dissolve in water.

Lime suspension

[\(Tiny air bubbles lift particles to the surface, Greatly reduced amounts of heavy metal in wastewater, Suspension\)](#)

Lime suspended in water.

Membrane

[\(Wastewater needs pretreatment, Hyperfiltration, Membrane filtration, Microfiltration, Ultrafiltration\)](#)

Thin films or sheets, usually of plastics or natural products, whose pore structure



permits liquids and small particles to pass through while larger particles are held back. This effect is exploited in [membrane filtration](#).

#### Membrane filtration

([Membrane](#))

Process for removing very fine particles or even dissolved substances from solutions. On the basis of the pore diameter and the dependent particle size, a distinction is drawn between three [membrane](#) filtration processes: [microfiltration](#); [ultrafiltration](#); [hyperfiltration](#).

#### Metabolites

Intermediate products when substances are degraded or decomposed by biological or other action. The metabolite test is used to test whether substances are completely biodegradable.

#### Methanol

([Hydrogenation facilities subject to hazardous incidents order](#), [Collecting zones allow no liquid to escape](#), [Fatty acid methyl esters](#), [Methyl esters](#))

Simplest compound in the group of substances known as [alcohols](#). Toxic, flammable, readily biodegradable liquid, which is miscible with water.

#### Methyl esters

([Wastewater treatment in Malaysia: Two steps to clean water](#))

[Esters](#) that contain [methanol](#) as their alcohol component ([fatty acid methyl esters](#)).

#### Microfiltration

([Membrane filtration](#))

Microfiltration is an intermediate between conventional filtration and [ultrafiltration](#) techniques. It is used for applications in which substances have to be separated or conditioned. A very thin [membrane](#) with pore dimensions between 0.1 and 1.0 micrometers is used. (A micrometer is a thousandth of a millimeter. By comparison, a hair has an average diameter of 100 micrometers.) [Membrane](#) openings of this size enable undissolved substances and [colloids](#) to be removed from solutions, while dissolved substances can pass through with the solvent. Microfiltration can be used, for example, to remove bacteria and yeast from solutions, a process known as "sterile filtration."

#### Microorganisms

([Microorganisms in the bioscrubber: Odor eaters](#), [Biochemical oxygen demand \(BOD\)](#))

Microscopically small organisms, for example bacteria.

#### Molecular weight

([Ultrafiltration](#))

Measure of the mass of a molecule.

#### Nitrogen oxides

Compounds of nitrogen and oxygen, formed for example from atmospheric nitrogen during all combustion processes. In order to keep the atmosphere clean, the permissible concentration of nitrogen oxides in exhaust gas is limited.

#### Nonionic surfactants

Group of [surfactants](#) that do not form [ions](#) in aqueous solutions and are surface-active in both acid and [alkaline](#) environments.

#### Oleochemicals

([Natural oils and fats for chemical-technical applications](#))

By analogy to petrochemicals, collective term for industrial chemicals based on natural oils and fats.

#### Organic substances

([Wastewater needs pretreatment](#), [Printing ink binders for water-dilutable inks](#), [Wastewater treatment in Malaysia: Two steps to clean water](#), [Carbon dioxide](#), [Chemical oxygen demand \(COD\)](#))

Substances whose characteristic main elements are carbon and hydrogen. Organic substances occur naturally, but can also be manufactured synthetically, for example from coal or mineral oil.

pH

([Powerful cleaning performance during the washing process](#), [An electrical current cleans contaminated wastewater](#), [Wastewater treatment in Malaysia: Two steps to clean water](#), [Alkaline](#))

A measure of the basic ([alkaline](#)), acidic or neutral character of aqueous solutions. pH 7 is neutral; [alkaline](#) solutions have a pH greater than 7; acidic solutions have a pH lower than 7.

Phosphates

([Preface](#), [Problem-free nickel: Separating system instead of complexes](#))

Salts of phosphoric acid. They are essential plant nutrients, but their presence in too high concentrations in bodies of water can cause over-fertilization (eutrophication). The main sources of phosphates in bodies of water are faeces and fertilizers. The phosphates that were previously present in detergents can now be replaced.

Polyethylene

([Packaging developments: Compact packaging](#))

Plastic manufactured solely from ethylene. Used for consumer articles and packaging materials.

Polymers

([Wastewater needs pretreatment](#))

Substances that are composed of a large number of repeated basic units, for example plastics.

Polyurethane

([Floor coverings: Teamwork in the interests of clean air](#))

Plastic with an extremely wide range of specifically adjustable applicational properties, for adhesives, sealants, foams, molded articles and many other applications.

Polyvinyl acetate

([Wastewater treatment: From eastern Westphalia to the world](#))

Plastic usually manufactured in the form of a [dispersion](#) and used, for example, as adhesive.

Precipitation flocculation

([Wastewater treatment: From eastern Westphalia to the world](#))

Combined process for the physiochemical removal of dissolved substances from water. The dissolved substances are first precipitated out of the wastewater ([precipitation reaction](#)), then the precipitated fine solid particles agglomerate to larger flocs that can easily be removed from the water.

Precipitation reaction

([Greatly reduced amounts of heavy metal in wastewater](#), [Precipitation flocculation](#))

Chemical reaction in an aqueous solution, involving the formation of an insoluble reaction product that is precipitated out of the water.

Receiving water

([Cooperation with customers: Out of sight - but still in mind](#))

Waters into which wastewater is discharged. In order to prevent receiving water from becoming polluted, wastewater must usually undergo suitable prior purification.

Recycling

([Packaging developments: Compact packaging](#), [Less plastic - less waste](#), [Cooperation with customers: Out of sight - but still in mind](#), [Biotechnology and environmental engineering: Custom tailored](#), [Latest instrumentation and control technology](#))  
Reuse of old materials.

#### Solvents

([Printing ink binders for water-dilutable inks](#), [Instead of CFCs: A genuine alternative](#), [Tiny specks of dust with a devastating effect](#), [Halogenated hydrocarbons](#), [Hyperfiltration](#))

Substances in which high concentrations of other substances can be dissolved. Often understood to refer only to organic solvents, although water is frequently used as a solvent.

#### Stabilizer

([Natural oils and fats for chemical-technical applications](#))

Additive that increases the resistance of products to external influences such as heat, light and atmospheric oxygen.

#### "Störfall"

(hazardous incident) Disturbance of normal operations, as a consequence of which a specific substance can cause serious danger, either immediately or later, as a result of events such as major [emissions](#), fires or explosions. (Definition in line with the German hazardous incidents order.)

#### Sulfates

Salts of sulfuric acid.

#### Sulfur dioxide

([Flue gas desulfurization plant](#))

Gaseous combustion product of sulfur and its compounds. Because sulfur is present in coal and fuel oil, sulfur dioxide is present in the flue gases of these products. In order to keep the atmosphere clean, this sulfur dioxide must be removed in [flue gas desulfurization plants](#).

#### Suspension

[Dispersion](#) of finely distributed solid particles in a liquid, e.g. [lime suspension](#).

#### Surfactants

([Preface](#), [Natural oils and fats for chemical-technical applications](#), [Alkyl polyglycosides are the basis of new products](#), [Cooperation with customers: Out of sight - but still in mind](#), [Problem-free nickel: Separating system instead of complexes](#), [Alkyl polyglycosides \(APG\)](#), [Anionic surfactants](#), [Fatty alcohol sulfates \(FAS\)](#), [Fatty alcohols](#), [Nonionic surfactants](#), [Wetting agents](#))

Surface-active substances that reduce the surface tension of water.

#### Ultrafiltration

([Cooperation with customers: Out of sight - but still in mind](#), [Cleaning performance outstrips CFCs](#), [Membrane filtration](#), [Microfiltration](#))

Ultrafiltration is suitable for applications where substances have to be conditioned or concentrated. The [membrane](#) surfaces have small pores through which dissolved substances with low [molecular weights](#) - for example salts - and the solution itself can pass. Substances with a high [molecular weight](#) and undissolved substances are held back. Ultrafiltration is carried out at low pressure (2 to 10 bar). The membranes are permeable to substances between 0.005 and 0.05 micrometers. A well-known example of an ultrafiltration [membrane](#) is the artificial kidney (dialysis).

#### Viscosity

Measure of a substance's resistance to flow. Substances with a high viscosity flow with difficulty, whereas substances with a low viscosity flow readily.

#### Water hardness

Property of water associated with its content of calcium and magnesium [ions](#). Water hardness is expressed in millimole per liter (mmol/l). Soaps form calcium and magnesium salts in hard water, and as a result they lose their washing power. Calcium soap is formed, and this not only leaves rings in washbasins but causes stains on fabrics and imparts a rancid odor to them.

Wetting agents

[\(Cleaning performance outstrips CFCs\)](#)