Environment Report 1994

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Henkel's eco strategy

Eco leadership: a challenge and its consequences

In view of tomorrow's challenges, Henkel has formulated a strategic goal: in addition to product and quality leadership we are aspiring to ecological leadership, too. Translating this policy into practice calls for consistency in action, procedures and processes affecting all aspects of the Company's activities.

"We are ready to meet the economic and ecological challenges of the 21st century." These are the words that introduce the new corporate guidelines of Henkel KGaA. And in the principles that follow and outline the way the Company sees itself, we read, "Henkel is an ecological leader." Accordingly, alongside product performance, safety and convenience in use, we are assigning equal ranking to the environmental compatibility of our activities as the final stone in the mosaic that makes up total quality at Henkel.
The first stones were set years ago. Back in the 50s, Henkel researchers and application engineers were working on various assignments in order to understand and improve the environmental impact of substances and products. Increasing insight into ecological interactions, an appreciation of ecological exigencies, the pressure of public opinion and politicians have together resulted in a steady increase in the number and complexity of the questions raised. A major issue such as phosphate substitution in detergents is still a paradigm instance of the manifold interactions between vast quantities of a substance, nature, and the amenities of our civilization.

In 1982, our Policy Statement on Environmental and Consumer Protection in the Henkel Group defined the position of the Company on questions of production and product safety, and environmental compatibility.
Within the framework of an eco concept, then and still relevant, Henkel in the mid-80s then formulated three targets which were to be aimed for when dealing with ecological subjects:

- Fulfilling responsibilities to society
- Enhancing the Henkel reputation

- Gaining competitive advantages.

Henkel has always stressed that a sense of ecological and social responsibility is only viable on the basis of business success. It is interesting for us to note that discussions nowadays on environmental issues - such as conducted by the German parliament's commission to enquire into The Protection of Man and the Environment - likewise assign equal ranking to economic, ecological and social responsibility.
Initiated in 1988, Henkel's Eco Audit was the first world-wide and systematic analysis of the situation as it then was. The 1992 Environment Report dealt with it at some length.

This first Group-wide detailed survey involved at the time many different units of the organization. Besides the actual findings, the Eco Audit did show the need and importance for a common awareness of the problems.
The Company does in fact have adequate instruments for dealing with eco issues. For some time now, Research and Technology at Henkel has had two central units dedicated to these subjects. The Environmental Protection and Safety unit deals with all the production- and location-relevant aspects, including emissions and immissions, energy, exhaust air, wastewater, and noise. The Biology/Product Safety unit examines all matters relating to the safety of our products for people and the environment.

The two units cooperate with each other and with all the technical departments of the operational units, with Product Development/Application Technology, Production, Marketing, and Distribution.

This efficient structure is one reason why Henkel has become well known for environmental quality both with respect to production and product.
As Henkel sees it, four preconditions are necessary if further progress is to be made:
Receptiveness to an ever *changing awareness*, because new issues, rapidly changing scenarios and social values all call for new modes of thinking and attitudes.
Innovative power, because we need new kinds of instruments, products and processes if we are to come up with solutions.
Willingness to cooperate, because we can only solve interlinked problems with

interdepartmental team structures. And because we require for this new partners as well as new forms of cooperation.

And last but not least, *voluntary action*, because this is the only way to achieve credibility and, especially, competitive advantages.
The eco-leadership claim calls for comprehensive environment mindedness; ecological aspects must integrate conceptually with the targets and projects of the Company's operational and functional units.

The projects for improved environmental compatibility of products and processes are supplemented by environment-relevant projects from other areas of activity of the Company, for instance from Distribution, Administration, Purchase or Logistics.
In its Purchasing Guidelines, for instance, the Purchasing department has expressed preference for sourcing from suppliers manifesting a pronounced respect for the environment.

A team made up of members from Detergents/Household Cleansers, Logistics, and transport experts from German Rail worked out an "eco logistics" ("from road to rail") concept which we have just presented to the public. It will help Hans-Dietrich Winkhaus President and Chief Executive Officer to substantially cut back carbon dioxide pollution resulting from the distribution of our goods.

It is our intention to inform and to communicate, to encourage ideas and action and to assist in their implementation. And this includes external bodies such as eco groups, initiatives by local citizens and schools, provided these are aiming at sound progress. There must be no stifling of ideas, but we cannot avoid setting priorities. Particularly when it comes to environment-related activities, we have to look for the best "level of efficiency." This means that we give priority to those ideas that result in the most environmental progress or take effect where the environment is most endangered.

In order, on the one hand, to initiate as many activities as possible and, on the other, to achieve as much effect through coordination as possible, Henkel has founded its coordination circle Eco Leadership, headed by Dr. Wilfried Umbach, Executive Vice

President Research/Technology. All our business sectors are working toward a common goal, to extend the notion of Henkel quality to cover environmental compatibility.

The concept of a new Environment Manual for Henkel's largest location in Düsseldorf is, consequently, based on the DIN/ISO 9000 system.
The challenge for companies to respect the environment will continue to grow. At the same time the opportunities will grow for those companies willing to accept this challenge.

Hans-Dietrich Winkhaus
President and Chief Executive Officer

Eco management

A systematic environmental policy for more efficiency

Environmental protection has its roots in people's minds. The way they think and act day by day should pay due respect to aspects of ecology. This is where guidelines, manuals and procedural instructions can help. Needed are ongoing communication and close teamwork. Eco seminars and training courses attended by all levels of the hierarchy - from shopfloor to boardroom - convey the necessary specialized knowledge. In short, eco management is the order of the day!

Environment Manual: Systematic environmental protection

It goes without saying that Henkel complies with all legal requirements concerning environmental protection and safety. Over and above this, however, Henkel sets its own standards, and these are far more demanding than current legislation. Environmental protection must be an integral part of daily activity in the Henkel Group. Exactly how - well, that will now be specified in an Environment Manual. This will describe how environmental protection is organized, and the procedures that have to be followed when activities are carried out that could affect the environment.

Environment Manual as a guide for correct behavior

The Manual will provide specific answers to questions such as: "Who is responsible for what, where the environment is concerned?" or: "What precautions must be taken in order to avoid causing environmental pollution when potentially hazardous substances have to be handled?" These are questions that employees have to face each day in the course of their work. To ensure that they are always answered correctly, the planned Environment Manual will regulate, for instance, the Company's training courses on environmental protection. The Environment Manual will function as a reference work, facilitating compliance with all legal requirements, voluntary industrial agreements and the Company's own rules and regulations.

Suitable for all sizes of sites

The Environment Manual will be structured on the (DIN ISO 9001) quality standard, in which the organization of a quality management system is detailed. The Manual is therefore fully compatible with existing structures.
The concept for the Manual was developed by a work group with members from Henkel environmental Protection and COGNIS Gesellschaft für Bio- und Umwelttechnologie (Company for Biological and Environmental Technology) and has already received Henkel-internal approval. The project team interviewed employees who were active in key environmental protection posts throughout the Company and in this way built up a picture of environmental activities.
The concept is equally suitable for small and large sites. It makes use of existing institutions such as the legally required officers responsible for immission protection, water protection and waste, so that no new structures have to be created.
External companies can also benefit from the experiences of the work group; any company wanting to issue its own Environment Manual should get in touch with the Henkel subsidiary COGNIS in Düsseldorf.
Work is now proceeding at speed at the Henkel site in Düsseldorf to translate the principles into practice. The Environment Manual for the parent plant should be ready by the end of 1994.

Eco logistics: On the right track

Ecological? It's only logical! This is the motto for the new distribution concept for detergents and cleaning agents. Henkel has switched from road to rail for its long-distance freight transport in Germany. This has been made possible by a nation-wide network of nine regional depots, all of which are linked to the national railroad system, and by the new transit scenario, one of whose aspects is the deregulation of price structures within the European transport sector. The environment stands to gain considerably. Emissions of hazardous substances have been reduced substantially despite an increase of 18 percent in total freight movements; carbon dioxide emissions have decreased by 47 percent, dust and soot by 34 percent, sulfur dioxide by 36 percent, and volatile organic compounds and nitrogen oxides by as much as 73 percent each.

The above figures are based on data used by the Institut für Verkehrswissenschaften (Institute for Transit Science) at the University of Münster. The total reduction in emissions amounts to about 7,600 metric tons of hazardous substances each year.

Nine nationwide regional depots replace central depots

If we take a look into the past we can see that, as recently as last year, trucks used to pick up Henkel products from central warehouses in the direct vicinity of the production plants in Düsseldorf and Genthin. They hauled some 370,000 metric tons over an average distance of 300 kilometers, either directly to the customer or to the nearest transhipment point or external depot, from where customers with small deliveries of less than 2.5 metric tons were supplied. There were a total of 22,000 truck journeys annually, giving a total transport performance of 111 million metric ton kilometers.

The new eco logistics concept exploits the excellent opportunities for transporting freight by rail. Freight cars pick up the products directly from the production site and carry them straight to one of the nine regional depots in the immediate vicinity of areas of industrial concentration.

Each freight car can carry about 20 percent more than a conventional truck. Moreover, because the individual transport units are no longer dependent on the size of an individual customer's order, freight capacity can be more efficiently exploited than is the case in trucks carrying mixed loads.
Both these factors together result in an increase of about 60 percent in transport capacity. This means that, for the same total transport performance, Henkel needs only 13,500 freight cars, corresponding to some 350 freight trains, instead of 22,000 trucks.

Trucks only used over short hauls

Customers are supplied from the regional depots by trucks, whose average journey is now only 60 kilometers. And here too, considerable gains in efficiency have been achieved. unnecessary empty trips have been eliminated by working with experienced carriers, and exploitation of transport capacity has been much improved. One area has remained the same. About twelve percent of detergents and cleaning agents still go directly from the production plant to major customers without passing through intermediate storage.
Following on the heels of the ecological improvements achieved in production processes, ingredients and packaging, the new logistics concept is yet another element in Henkel's strategy of ensuring environmental and consumer protection with regard to its detergents and cleaning agents.
Henkel intends to introduce another modification to its logistics system for the transport of consumer goods in Germany. All products that cannot be dispatched by rail will continue to be transported by truck, but in this case by a new generation of trucks: height-adjustable double-deckers.
This concept for the transport of consumer goods was formulated in close cooperation with a prominent manufacturer of truck bodies, who developed the double-decker loading design.
Because the trailers can carry pallets with different heights on two levels, up to 30 percent more freight can be moved. The trucks then have to make correspondingly fewer journeys.

Environmental monitoring: Rivers under review

In 1958 Henkel launched an unusual project. It analyzed the water in the Rhine at regular and closely spaced intervals to determine the levels of oxygen, carbon, chlorides and anionic surfactants that were present - indicators of water pollution. A short time later Henkel also initiated annual examinations of the water in the rivers Main, Neckar and Ruhr. The number of analyzed parameters was later increased to include phosphate, boron and nonionic surfactants.
Since then, samples of water have been taken annually at 140 sites on the Rhine and its major tributaries and analyzed for chemical pollution that could be attributable to detergents and cleaning agents. In the course of this environmental monitoring, Henkel Research in Düsseldorf has accumulated an extensive collection of data, which gives an exact picture of the trend in water quality during the last 36 years (see charts *Environmental monitoring - surfactants in the Rhine* and *Environmental monitoring - boron and phosphate in the Rhine*). In 1992 Henkel extended this project to eastern Germany (the former German Democratic Republic), for which no easily accessible data were available concerning the chemical pollution of water courses.

Intensive scrutiny in eastern Germany

From March 1992 to February 1993 the Elbe and the Saale, together with their tributaries such as the Mulde, the Havel and the Schwarze and Weisse Elster, were closely monitored in cooperation with scientists from the University of Leipzig with which Henkel had started a joint project. In concrete terms, the University is given financial support and special measuring technology.

Measured values from selected sampling stations in eastern Germany (average values of the study period from March 1992 to February 1993)
Comparative values from the sampling station at Düsseldorf-Himmelgeist on the Rhine, 1992

	Oxygen mg/l	Oxygen saturation %	Boron mg/l	Phosphate mg/l	Anionic surfactants mg /l	Nonionic surfactants mg/l	COD mg/l	DOC mg/l
Elbe Schönbeck	10.4	96	0.16	0.16	0.057	0.046	29.9	5.4
Saale Groß-Rosenburg	10.4	97	0.31	0.17	0.135	0.039	39.4	6.9

Mulde Dessau	10.9	98	0.18	0.08	0.08	0.038	18.8	4.9
Havel Havelburg	12.7	118	0.24	0.24	0.036	0.035	38.4	8.4
Schwarze Elster Gorsdorf	10.4	97	0.12	0.03	0.044	0.024	19.1	4.7
Weiße Elster Obertbau	7.2	65	0.39	0.06	0.133	0.08	42.5	6.9
Rhine Düsseldorf-Himmelgeist 1992	9.7	90.8	0.13	0.126	0.056	0.009	14.4	3.4

The chart shows that at some places oxygen saturation exceeds 100 percent, an indication of excessive amounts of nutrients and eutrophication.

Fresh data on the chemical pollution of water courses

The ecologists took samples once monthly at 21 sites and determined general pollution parameters such as chemical oxygen demand (COD), concentration of the total and dissolved organic carbon (TOC, DOC) and dissolved oxygen. They also determined the concentrations of substances used in detergents, e.g. surfactants, phosphates and boron.
The results surprised the experts; the levels of pollution in the rivers of eastern Germany were many times lower than expected.
When the individual measurement data were assessed, only the Weisse Elster yielded relatively poor results. In the summer months its oxygen concentration falls to 3.4 milligrams per liter. Levels of less than 4 milligrams per liter are regarded as critical for fish. The ecologists are of the opinion that the situation will improve considerably with the construction of sewage treatment plants.

Once a month at 21 points, ecologists from the University of Leipzig analyzed the water from the eastern German rivers for chemical pollution.

Phosphate-free detergents make their mark

Environmentally compatible detergents are already making a contribution toward ensuring that the rivers can breathe again. For example the Saale; until mid-1990 its phosphate load still showed an upward trend, but with the introduction of phosphate-free detergents the load suddenly decreased by almost a third and is now only a quarter of its previous value.

Eco balances: Significant signposts

Eco balances have been a stimulating topic since the start of the nineties, and have even entered the realm of politics. In 1992 the German Bundestag established a commission to enquire into "The protection of Man and The Environment - assessment criteria and perspectives for environmentally compatible material cycles in industrial society" which, among other things, looked at the subject of eco balances. The European Union has issued a guideline for the award of an environment symbol for consumer articles, whose criteria will be based on eco balances.
Eco balances describe all environmentally relevant parameters that play a role in the manufacture, use and disposal of a product. The starting point for an eco balance is the extraction of raw materials. In the case of petroleum-based raw materials this means the recovery of petroleum from beneath the earth, and in the case of renewable raw materials mainly used by Henkel, such as palm oil or tallow, it means, for example, plantations in Malaysia or cattle rearing in Germany. Henkel can already present a range of eco balances that have been drawn up in recent years (see Environment Report 1993)

Useful instrument for probing weak points

It is true that eco balances do not provide any yes/no answers or clear pointers for further action, but their integral approach to products and production processes makes them a useful instrument for analyzing weak points, so that they can serve as a basis for formulating environmental measures. Moreover, all Henkel experts in the field of eco balances agree that they are a good basis for procurement and

purchasing. The Company has now created a databank in which the manufacturing processes for a large number of raw materials are stored in the form of modules: process description, evaluation of the process, number and type of feed materials, production materials (e.g. steam or electricity), emissions into air and water, waste and the necessary transport systems. Henkel does not keep the collected data to itself. Customers profit from this policy by incorporating the data in their own eco balances. Henkel specialists can now access data for 250 processes and 400 substances, and can use a computer program to extract the raw data for an eco balance for any specific product. Detergents, for instance, can contain up to 15 components, including enzymes, which can eliminate protein-based stains quickly and completely from laundry, and surfactants, which enable water to penetrate into fibers and thus dislodge the soil.
The life cycles of the surfactant fatty alcohol sulfate (FAS) and a new genetically engineered enzyme (protease) have been traced by scientific "detectives." The Henkel subsidiary COGNIS recently drew up a comparative eco balance for two enzymes. In the past, Henkel had been using proteases that were produced in the classical manner: the microorganisms that were needed to produce the proteases were taken from naturally occurring populations and optimized by a process of selection.

Genetic information transferred to proven strain

In the course of time, researchers replaced these first-generation enzymes with a protease that had also been isolated from naturally occurring microorganisms but exhibited much greater detergency. The genetic information has since been transferred to a production strain that has proved its value over many years.
In the course of the comparative study of the two enzymes, COGNIS scientists discovered a remarkable fact: the genetically engineered second-generation proteases reduced emissions during production by more than 60 percent. Moreover, the amount of primary energy saved during production is equivalent to the energy needed for 11.5 million 60 °C wash cycles in modern household washers. However, the proteases and their production strains are capable of even more; COGNIS researchers want to reduce environmental pollution by half in the near future by carrying out continuous improvements.

Henkel cooperates with external institutes in drawing up eco balances for various surfactants. In one case a study of the environmental consequences of the manufacture of fatty alcohol sulfates from natural oils and fats found that, in terms of material and energy consumption, fatty alcohol sulfates are more efficient than comparable detergent raw materials derived from petroleum. Thus, 650 grams of renewable raw materials were needed to produce 1,000 grams of surfactant. This means that most of the mass of the fatty alcohol sulfate molecule is supplied by the oil palm and is therefore ultimately derived from the carbon dioxide in the atmosphere.

Favorable effect on the carbon dioxide balance

The next good result: it was found that the manufacture of fatty alcohol sulfate, an especially important and versatile anionic surfactant, can result in a 30-percent reduction in petroleum consumption. The use of FAS therefore has a positive effect on the carbon dioxide balance. Although the carbon derived from the renewable raw materials is released as carbon dioxide during biodegradation in sewage treatment plants, this does not represent an increase in the concentration of carbon dioxide in the atmosphere because it was removed from the atmosphere by the oil palm many years before, i.e. it is recycled. With the support of Henkel, the palm oil research institute (PORIM) in Malaysia is currently carrying out research with the aim of providing an experimentally based scientific explanation of this great advantage of renewable raw materials.

Products

Environmental protection begins with product development

When a product is developed nowadays, Henkel specialists have to take account of more than its practical technical properties and customer requirements. Their aim is to reduce environmental pollution by creating products that generate little or no waste during their production, have no harmful effects on the environment when they are used, and are completely biodegradable after use, or can at least be disposed of

harmlessly. The success of this approach is reflected in, for example, smaller product packs and solvent-free paints.

Soil decontamination: Pollution solutions

It could happen at any time and anywhere. No matter how many safety measures are taken, gasoline or fuel oil can still escape into soil or water. And not just in spectacular tanker accidents. Sometimes it is only a matter of the steady seepage of a few drops into the soil through an unnoticed leak in a tank. Yet even the smallest amounts cannot be allowed simply to disappear; after all, a single liter of oil can contaminate one million liters of ground water.
Nature is capable of dealing with small amounts of oil itself; indeed, for some microorganisms it is a veritable feast. They break down the oil into harmless components and thus return it to nature's natural cycle. However, this may take a long time - up to 70 years may pass before the oil is completely degraded.
Researchers of the Henkel subsidiary COGNIS decided to exploit nature's capacity for self-healing when they developed a process for purifying contaminated soils. They discovered that the microorganisms reproduce better and eat more and faster under certain conditions if the mineral oil is made easier for them to digest. The microorganisms normally feed on carbon, phosphorus, nitrogen and trace elements from the soil, but if they are provided with more phosphorus and nitrogen than usual they multiply considerably.
Mineral fertilizers are an inexpensive source of these substances but have the disadvantage that, although they help to free the soil of oil, they also contaminate it with salt and nitrate.

Potent cocktail of biodegradable ingredients

COGNIS provides the microorganisms with a nutrient solution that is perfectly tailored to their needs and contains no mineral salts. 95 percent of the fully biodegradable ingredients of this highly potent cocktail have been licensed for use with food or animal feed. Phosphorus and nitrogen, bonded to an organic carrier, form an emulsion between oil and water, thus simplifying the task of the bacteria and considerably reducing the time needed to break down the contaminants.

The active substances of the COGNIS product adhere firmly to the contaminated particles, so that the ground water remains clean. The nutrient solution is therefore the key to an inexpensive in-situ technology, with which soil can be decontaminated without having to be excavated.
The diluted product is allowed to irrigate the soil or is fed into a drainage system that brings it into contact with deeper soil layers, where it can stimulate the appetite of the bacteria. Biological in-situ decontamination with the COGNIS product is up to 80 percent cheaper than conventional methods.
However, the COGNIS nutrient solution can be used to purify more than oil-contaminated soils. Intermediate and finished industrial products such as fatty acids and fats also have no chance.
COGNIS experts, who have decontaminated more than 40,000 metric tons of polluted soil since the product was first marketed in 1993, also solve other problems. The US Environmental Protection Agency, for instance, studied all known contaminated sites in the USA and came to the conclusion that lead pollution is one of the most urgent environmental problems today.
Large amounts of lead were present in the soil of a US forces munition factory in New Brighton. Munitions residues and gunpowder had been incinerated over a period of many years, and used cartridge cases had also been buried there. The lead content of the military site was 8.6 percent when the US army commissioned COGNIS to rehabilitate it. The fact that only 0.02 percent lead can be detected in the soil today is solely attributable to COGNIS' TerraMet technology. This is a two-stage process: large pieces of metal are screened out of the soil, then the residual lead contamination is removed with a special extraction agent. The purified metals can be used again.

Incineration not the best way to resuscitate the soil

Conventional methods of removing oil and non-biodegradable pollutants from contaminated soil often still involve the use of incinerators. Although incineration breaks down the oil that is present, unfortunately it also destroys all the soil bacteria. The resulting soil is certainly absolutely clean, but it is also absolutely dead. And that is not a matter of indifference where the German Commission of Experts for

Environmental Problems is concerned. In an expert opinion of 1989 it refers explicitly to physico-chemical methods, which decontaminate soil just as well as incineration but without the unfortunate side-effects.
This decontamination method involves excavating the soil and washing it with special surfactants in an external treatment plant. The clean soil is then returned to the site where it belongs. The advantage of this method is that the organic components remain largely intact.
The demands made on surfactant cleaning agents for contaminated sand and soil are understandably very high. They must clean the contaminated site without creating any new pollution. This means that the surfactants should function at normal temperatures and be readily capable of treating the oil-in-water emulsions formed during the washing process. At the same time they must be free of phosphates and excellently biodegradable under anaerobic conditions, because surfactant residues adhere to soil particles and must not be rinsed into the ground water.
Henkel Metal Chemicals has recently developed a particularly comprehensive range of products for cleaning contaminated soils. These products are marketed by COGNIS and include not only combined surfactant systems for cleaning the soil but also process chemicals such as defoamers, organic demulsifiers, adsorbents, splitting agents and flocculation aids for subsequent process stages. All the products are mutually compatible and function without organic solvents. There are therefore no emissions of solvent vapors and secondary pollutants.

Surfactants make sure the soil particles are properly wetted

Surfactants reduce the surface tension of water. Only then can an object be thoroughly wetted, irrespective of whether it is a fiber or a particle of soil. When soil is washed, Henkel surfactants dislodge not only mineral oils such as gasoline, but also contaminants from higher mineral oil fractions such as diesel or lubricating oil, equally well from the particles and maintain them in a stable emulsion. The surfactants stabilize not only oil-in-water emulsions but also suspensions. This delays the sedimentation of very fine solid particles in the washing liquor and simplifies the separation of highly contaminated silt (very fine solid particles from the soil) from coarse particulate fractions.

After the washing process the liquor contains surfactants, emulsified oil and silt and coarse impurities such as paper or wood, which are screened out. The oil-in-water emulsion is split by an organic Henkel product. Oil and sludge phases remain, which can be separated from the washing water by flotation or sedimentation. The decontaminated washing water is returned to the cleaning cycle and used to prepare new washing solutions. However, it cannot be recycled indefinitely; the number of wash cycles depends on the extent and type of pollution. Once the cleaning solution is exhausted it is discharged as wastewater.
Product developers from Metal Chemicals have also marketed effective agents for the treatment of this wastewater.
If washing plants are appropriately designed, the section of the plant used to prepare the washing water can also be used to treat wastewater, instead of only for flotation and sedimentation. The same demulsifiers and flocculation aids used to resuscitate the soil can also be used here.

Dewatering used oil: Less is a lot more

Used oil is subject to the provisions of the German Federal Waste Act. Even if it is used as a source of energy or is recovered by rerefining, since November 1986 its disposal has no longer been free of charge. Until that date the Used Oil Act was in force, which guaranteed that used oil would be accepted free of charge, but this now applies only to engine oil from private users. Since the Waste Act came into force, all companies, etc. that have to dispose of used oil have to dig deeply - very deeply - into their pockets if the used oil is declared as hazardous waste. No wonder then that "producers" of used oil have been making efforts to reduce its volume. A first step is a suitable splitting process, with which used oil-in-water emulsions, for example from the automotive or metal working industries, can be split into their component phases. Such emulsions are used as drilling and cutting oils, etc. or are generated during the cleaning and degreasing of metal surfaces. Conventional plants work on the principle of acid/hydroxide splitting. This causes an oily sludge that has to be subjected to costly disposal as hazardous waste, and used oil that contains water and up to 60 percent foreign substances. The proportion of foreign substances is now limited to a maximum of ten percent, because then and only then does recovery present no problems. If the used oil is to be exploited as a source of energy its water content

must be less than five percent. This is why the splitting process with acids and hydroxides is now being challenged by other methods; organic demulsifiers from Henkel split the emulsions without creating additional sludge.

However, even these products do not decrease the high water content. This is done by special dewatering agents from Henkel. These are technically simple and inexpensive to use and remove up to 70 percent water and foreign substances from the oil phase. The used oil that remains can be recycled and also has a high calorific value, which makes it especially suitable for thermal utilization.

Laboratory studies of the best method of treating used oil

There is used oil and used oil. No one knows this better than the specialists of Henkel Metal Chemicals. This is why the product developers take a close look at used oil samples in their laboratory. Customers benefit because the results tell them exactly which Henkel product, and how much of it, is most suitable for treating "their" used oil.

Plastic bottles: Easy on the lightweights

Anyone who has ever carried a case of soda will appreciate the benefits of light, unbreakable and non-splintering plastic bottles. This is why bottlers of carbonated soft drinks have been promoting such lightweights for many years. However, plastic bottles are not only good for consumers, they are also good for the environment. Less gasoline and diesel are needed to transport them, so that there is a reduction in vehicle emissions.
Beverage bottlers currently use two different types of plastic bottle: recyclable one-way bottles which, after use, are comminuted, reprocessed and remarketed as raw material for new products; and returnable, refillable bottles which, just like glass bottles, are cleaned, refilled, relabeled, sold and emptied some 25 to 30 times. However, plastic bottles are not suitable for the conventional cleaning and labeling processes used on glass bottles. Whereas glass can withstand harsh cleaning agents and high temperatures during the cleaning process, plastic bottles require mild and yet powerful cleaning agents that are effective at low temperatures, so that

the bottle is not damaged and yet the level of sterility and cleanliness commensurate with consumer protection is guaranteed.
The Henkel-Ecolab joint venture has devised a special treatment concept that provides the bottles with the greatest degree of protection during the entire treatment process. Naturally this concept also takes account of ecological requirements such as, for example, the biodegradability of the cleaning agents used.
Similarly a new type of Henkel adhesive for bottle labels provides improved environmental protection. These adhesives are largely manufactured from renewable raw materials and contain no solvents.
This new development was needed because conventional adhesives were not suitable for labeling returnable bottles made from plastic. The adhesives used for labels on glass bottles provided insufficient adhesion when used for labels on plastic bottles. On the other hand, if conventional adhesives are used for one-way plastic bottles the labels adhere to the bottles so strongly that they cannot be removed quickly enough when the bottles are washed. By contrast the new Henkel adhesive is just right.

Surface treatment: The success story continues

In the Environment Report 1992, Henkel Metal Chemicals formulated its aims for the near future briefly and succinctly: "Henkel is pressing forward vigorously with the development of environmentally compatible processes for treating metal surfaces. A succession of small steps in this direction encourages us to hope that a chromium-free pretreatment process will be found for architectural aluminum in the foreseeable future."
After two years, just as briefly and succinctly, the announcement of success: aluminum elements for facades and other external structural components are today cleaned and protected against corrosion with the help of chromium-free products. Products that are completely free of environmentally polluting chromium have also been developed for the surface treatment of steel strip for car bodies, refrigerators and precoated steel sheets for neon ceiling lamps. Chromium's function of providing protection against corrosion has been taken over by zirconium and titanium together with organic polymers.

Another piece of good news is that substitutes have been found for the environmental pollutants nitrite and nickel in products used to phosphatize steel, galvanized steel and aluminum to protect them against corrosion. Nitrite's role as an accelerator has now been taken over by other inorganic salts.

As so often, the improvement in environmental compatibility has been matched by an additional advantage for users, in this case in the form of the better long-term stability of the accelerator. In contrast to nitrite, the accelerator does not undergo self-decomposition, so that the treatment baths are immediately ready for use even after they have been dormant for long periods, for example over the weekend.
Numerous users have already replaced nickel, which is classified as a hazardous substance under German water legislation, with manganese, which is regarded as posing no problems in connection with wastewater. Henkel Metal Chemicals' next target is the development of a nickel-free process for the surface treatment of, inter ail, car bodies, which consist of several different metal surfaces. Here, too, Henkel must comply with the strict requirements of the automotive industry with regard to paint adhesion and corrosion protection.

Industrial adhesives: Adhesives that stick out

Just the mention of organic solvents arouses a sense of unease. They pollute ground water, and many of them damage the ozone layer or promote the greenhouse effect. This is why many paint and adhesives manufacturers have dispensed with harmful aromatics and chlorinated hydrocarbons in recent years and replaced them with the world's most ecologically compatible solvent: water.
Henkel has been using water as a solvent in most of its bonding agent formulations for many years now and marketing them as "solvent-free adhesives" (see Environment Report 1992). Nevertheless, it seemed that solvents were essential for some adhesives because they guarantee the ultimate in adhesion and strength. In such cases the aqueous variety simply could not match their solvent-based cousins. However, Henkel product developers have now developed equivalent bonding agents based on aqueous dispersions even for such applications.
Rubber-to-metal bonding agents, for example: Permanent bonds between rubber and metal are essential in all applications involving the suppression of vibrations, the

transmission of forces through flexible shafts, and the elastic mounting of machine parts. This unusual combination of materials protects boilers against corrosion and seals rotating shafts. A rubber-to-metal bond has to be able to with-stand a wide range of stresses including high temperatures, corrosive agents, mechanical forces and vibrations. And so do the bonding agents that hold these two materials together permanently.

The metal parts can only be bonded under high pressure and temperature during the molding process, the vulcanization of the rubber. The bonding agent forms the internal bond by adhering firmly to the metal surface and simultaneously penetrating into the rubber surface, with which it reacts chemically. The solvent-based adhesives used in the past did not attack the metal, dried quickly and then formed flexible, sealed film - properties that aqueous systems could not match.
An impressive tension test now shows that Henkel has succeeded in developing an aqueous bonding agent that is on a par with solvent-based adhesives in terms of adhesive properties and strength. The rubber itself tears, but the contact areas between metal and rubber remain intact.

For example, adhesives for foil conversion: When plastics and/or metal foils are bonded together over their full surfaces the specialists refer to this as "lamination." High-gloss plastic film for books and catalogues is laminated, as are films for the food industry. High demands are made on these films: they must not tear and they must be impermeable to fats, flavors, moisture and odors. Moreover they must provide protection against external soil and moisture.
Multilayer combinations of different bonded materials meet these high demands extremely well, but in the past there was also a high price in terms of environmental pollution. Laminating adhesives that contain a substantial proportion of solvents can catch fire or even cause explosions. Moreover the solvents, which make up about 60 percent of the adhesive, evaporate during processing. They must be trapped in an exhaust gas scrubber and then incinerated or recycled to prevent them from polluting the atmosphere.

Processing options left a lot to be desired

Since 1989 the level of pollution from this source has been reduced by the use of "super high solid" laminating adhesives, which contain only 40 percent solvents. Nevertheless, the basic problems of organic solvents remained.
A glance into the past shows that the first solvent-free laminating adhesives were brought onto the market more than 19 years ago. They proved to be a mixed blessing, leaving a lot to be desired in terms of quality and processing options. They were highly reactive and underwent rapid cross-linkage, so that they could not be used on existing laminating machines. New machines and hence considerable investment were necessary.

Aim: aqueous systems for all laminating purposes

In the meantime, the quality of Henkel's solvent-free laminating adhesives is just as good as that of their solvent-based predecessors and they are processed throughout Europe on special laminating machines. Since 1992 it has also been possible to use conventional laminating machines to process new aqueous laminating adhesives, one and two-component polyurethane dispersions, which contain no organic solvents. These adhesives have been well received by the market.
Customers who carry out high-gloss lamination already rely completely on the properties of aqueous systems. However, the adhesives specialists have no intention of resting on their laurels. Their next aim is to develop aqueous adhesive systems for all lamination applications.
For example, construction adhesives: The craftsmen who lay carpets and parquet can breathe a sigh of relief. Nowadays there is a solvent-free dispersion adhesive for almost every application. The only exceptions: products with a high solvent content must sometimes be used for stairs, where fast initial adhesion is needed; for moisture-sensitive parquet and wood types, which could be damaged by aqueous products; and for heavy-duty industrial flooring, which needs to be particularly strong.

Impregnation compounds for buildings: Water wards off water

Paradoxical as it seems, facades and foundation walls can be protected against water by, of all things, water-based impregnation compounds. Until recently the

construction industry relied on solvent-based products. The reason: solvents are associated with good flow properties and facilitate the penetration of the protective organic silicon compounds deep into the porous facade surface - a precondition for water-repellent action.

After intensive development work, Henkel can now supply aqueous impregnation compounds that are just as effective as their predecessors. Moreover the emulsions save packaging material because they are sold as concentrates, which are then diluted, as required by the application. Transport costs are also lower.

Product packaging: Keeping the lid on waste

Since the German Packaging Ordinance came into force in 1991, the amount of waste produced has been cut by one million metric tons. However, this seemingly large amount is still equivalent to only a small proportion of total waste production in 1993. In only twelve months, 11.8 million metric tons of packaging waste were generated in western Germany alone, and ten percent of this waste consisted of plastics. If Germans are not to be smothered in their own waste, the aims of "prevention, reduction, recycling" must be energetically pursued at all times, especially in the packaging sector.
The Henkel Group also makes a contribution toward ensuring that the annual waste mountain steadily shrinks. Less packaging is used in production plants as a consequence of the trend toward bulk containers and a switch to hired drums and containers.

In this context, Henkel's environmentally compatible packaging systems make a considerable contribution in Germany and Europe.

Lightweight packs: Not only detergents and cleaning agents but also fabric-care, household-care and building trade products are supplied in the eco lightweight bottles which contain only 24 grams of polyethylene (see Environment Report 1993). Savings of up to 80 percent plastic can be achieved by using these light-weight packs.

Henkel now supplies its sealants not only in plastic cartridges but also in tubular pouches. Savings in packaging waste: up to 97 percent.

Refillable paper pouches use 80 percent less packaging material

Refillable pouches: Since the middle of last year, powdered detergents and cleaning agents have no longer been supplied only in portable cartons but have also been available in refillable paper pouches. These pouches represent a saving of 80 percent in the packaging materials used. In Germany, products supplied in these pouches have already gained a market share of much more than half of total sales. Liquid products are also supplied in recyclable and refillable cartons, which are thus replacing plastic packaging.

Henkel companies: experts in avoiding waste

Concentrates: Highly concentrated products also minimize the cost of packaging materials. Alongside concentrates for detergents and cleaning agents, which are steadily extending their share of the market, Henkel now also supplies concentrated all-purpose detergents in lightweight plastic bottles. Liquid concentrates have also been developed for impregnation applications and household-care products. Savings in the amount of plastic used: up to 75 percent.
Other Henkel companies are now experts in preventing waste. For instance Henkel-Ecolab, a joint venture, sells highly concentrated cleaning agents and disinfectants to commercial and institutional clients, preferably in bulk containers. Customers can add the concentrates via automatic central storage and metering systems. A new system has been developed for different fields of application and is currently going through the launch phase in France (postal service and railways) and the Netherlands (various hotel chains). This system is made up of different active components that can be mixed together via the automatic metering units to create the required formulation, depending on the intended application. In this way commercial and institutional customers can themselves "formulate" a large number of application solutions with only a few raw materials. This results in considerable savings in packaging and transport costs.
Reusable tanks: After a one-year test with a major customer, Henkel Bautechnik is now marketing its emulsion primer in bulk tanks. On site, the product is always

poured into the same work vessel. When the tank is empty it is taken away for proper cleaning and then refilled. After the primers it should soon be possible to supply adhesives in tanks.

Reclaim: Henkel gives high priority to the use of plastic reclaim. Typical examples are to be found among building chemicals and products for craftsmen and Do-It-Yourself enthusiasts. Some of these products are sold in buckets, cans and cartridges made completely from plastic reclaim. Several prizes have even been won for excellent design and environmentally compatible packaging.
The use of refill packs and plastic reclaim is also being studied in the context of body-care products such as foam baths.

Outside packaging: For many years, Henkel has also been steadily reducing the packaging around the packaging. Toothpastes have long been supplied without folding boxes, and toilet-care products and adhesives are no longer supplied in blister packs. The plastic hoods of toilet deodorizer sprays weighed only 6.4 grams, but for Henkel this was exactly 6.4 grams too much. The new cardboard "eco cards" are not only much lighter, they are also largely made from recycled paper.

Drilling fluid additives: Award rewards efforts

Scarcely three years old and already an international celebrity: the new readily and completely biodegradable drilling fluid component from Henkel's development laboratories for gas and oil drilling operations. Based on renewable raw materials (see Environment Report 1993), this product is already being employed by eight international mineral oil companies, and the trend is upward.
Whether in the North Sea or the Gulf of Mexico, Malaysia or Australia, this product has fulfilled all expectations in more than 50 drilling operations. The additive is now manufactured by Henkel in Germany, Italy, France and Spain and has already replaced thousands of metric tons of mineral oil.
This success is gaining recognition. In the 1993/94 environmental protection competition of the "Bundesverband der Deutschen Industrie" (confederation of German industry), a jury of well-known figures from the fields of business, science,

politics and environmental organizations awarded the drilling fluid additive second prize in the category for environmentally compatible products.

Progress in technology and ecology

The engineering properties of Henkel's environmentally compatible drilling fluid were also recognized. After examination by a committee of experts from international oil companies it gained the "Special Meritorious Award for Engineering Innovation" from the renowned trade journal Petroleum Engineer.
The drilling fluid additive is impressive proof that product efficiency and environmental protection are not incompatible.

Henkel Austria: Recycling, Vienna style

The subject of waste prevention knows no boundaries. The Austrians are also looking at the problem of how to manage the mountains of waste in their country. The Henkel Austria Group is now providing energetic support to the capital city of Vienna, where a plant that can reprocess 1,000 metric tons of plastic waste annually recently came on stream.

Plastics not just processed but also reused

Henkel Austria's recycling facility can process not only the plastic waste from its own production plant but also some 80 percent of the polyethylene bottles that accrue in Vienna.
The ambitions of the Henkel subsidiary in Vienna, however, go beyond simply processing its own and others' plastics; it also wants to put the reclaim to good use. It has therefore been agreed that an Austrian customer will be supplied with some of the products in the form of new bottles and canisters made from recycled plastic. The first bottle manufactured totally from reclaim is already on the market.

Material recycling is only one part of the Austrian subsidiary's waste prevention policy. Another facet involves product packaging.
During the past four years, Henkel Austria's new packaging concepts and new compact products have resulted in savings of more than 1,500 metric tons of

packaging materials, including 600 metric tons last year alone. Moreover, the amount of waste generated by Henkel Austria itself has been reduced from 720 to 219 metric tons per year. Some 500 metric tons of residues are carefully sorted in a new collection center in Vienna. They are then recycled as reusable materials rather than simply disposed of as waste.

Waste prevention prize for an environmentally compatible concept

This waste prevention and recycling concept was awarded the 1993 Waste Prevention Prize of the Austrian clearing and saving banks. Henkel Austria is especially pleased to have been chosen for this award by the jury of prominent scientists from universities and technical institutes.

New generation of detergents: Mini pearls, maxi power

The grains are round, smooth and small, like colored pinheads. And yet, for some 60 Henkel researchers, product and process developers and engineers these "Megaperls" are simply the greatest. The new generation of powerful detergents is kinder to the environment in two ways. Firstly, because dosages of the new detergents are smaller, there is less water pollution. And secondly, because the new detergents occupy less space than the same weight of conventional detergents, there is less packaging to get rid of.

Three years of international development work

20 percent less weight and 40 percent less volume than a compact detergent - these figures are the result of three years of development work by Henkel employees in Germany and abroad. The new products are far superior to conventional detergents; Megaperls wash almost twice as much laundry as the same weight of a normal detergent (see chart *Detergent dosages, e.g. Persil*). The reasons behind this productivity: improved formulations. The grains of a normal washing powder have a large, uneven surface with numerous air pockets and hence more volume. They acquire their shape by being subjected to "spray drying." This production process involves forcing aqueous "detergent paste" through narrow nozzles at the top of a high spray tower, so that small droplets form. As they descend through the tower the droplets are dried with hot air and swell.

Compact pearls ensure optimal efficiency

The numerous pockets of air in the grains of normal powdered detergents restrict the weight of these detergents to a maximum of 600 grams per liter. This is only a quarter of the weight of the Megaperls, which are manufactured by means of an extrusion process.
As in a meat grinder, a strongly condensed detergent paste is forced through perforated disks. Strands of "spaghetti" emerge and are immediately cut into small pieces and then shaped into dense, almost air-free spheres.
The mini pearls with the maxi effect are now successfully removing soil from laundry in Austria, Switzerland, Spain, Italy, and
the Benelux countries.

Production

Avoid environmental pollution from the very start instead of repairing the damage later

Integrating environmental protection into production means achieving reductions in the consumption of energy and raw materials, generating less waste, and reducing air, soil and water pollution from the very start and at all subsequent stages. Pollution that isn't allowed to occur needn't be eliminated later with considerable engineering and financial input. Moreover, the safety of employees and neighbors is priority number one - at all the Henkel locations worldwide.

Waste: A clean slate

Henkel regards plant waste management as a major element of production-related environmental protection, and this is not simply a reaction to the steeply rising waste disposal costs.
Proper waste management must begin before a residue is created. The first commandment is: prevention is always better than reduction, recycling and disposal. Throughout the Company there are excellent examples of how new raw materials

and sources of energy, or modified processes, have resulted in the complete prevention of residues or considerable reductions.
For example, production materials: Since Henkel's own power plant in Düsseldorf-Holthausen started to use a considerable proportion of natural gas instead of hard coal, steadily decreasing amounts of ash and slag have been produced. A combined gas and steam turbine process - involving proven heat-and-power cogeneration - enables fuel to be used much more efficiently and residues to be reduced even further.
Extremely pure oleochemical raw materials have made bleaching clays redundant as production materials in the fatty alcohol facilities at the Düsseldorf parent plant. As cleaning auxiliaries, these clays had ensured excellent product quality but were costly to dispose of as waste.
For example, modified processes: The waste materials generated by Henkel's glycerin production facility at Düsseldorf include salt residues and polyglycerins as waste materials, both of which are cases for the underground disposal facility. However, waste has been reduced by more than one-third by using higher quality raw materials and improved processes.

Relatively few residual materials are simply waste

Relatively few residual materials are disposed of as waste. Many of them are still useful in some way, and the experts refer to them as secondary raw materials, because they can be materially recycled or used as a source of thermal energy. Residual materials are also put to the best use in the Düsseldorf parent plant - only 26 percent leaves the plant as waste and has to be disposed of. By far the greater proportion is recycled: 51 percent is materially recycled and 23 percent is used as a source of thermal energy. And even the waste materials are not completely without value. More than a third of the waste is used in municipal incineration plants for the generation of district heating (see diagram *Amounts of waste and methods of disposal*).
Residual materials that are also secondary raw materials include aluminates from the manufacture of zeolite, and sodium sulfate, which is formed during flue gas desulfurization in the Henkel power plant. Both are valuable raw materials that can be recycled.

Residual materials utilized by Henkel KGaA, Düsseldorf in 1993	
Sodium sulfate	2 407 t
Detergent residues	4 103 t
Plastics	252 t
Scrap metal	3 289 t
Wood	753 t
Paper and films	5 230 t
Pallets and boards	433 t
Barrels and containers	1 182 t
Catalyst material	813 t
Special fuels	18 805 t
Methanol	488 t
Sulfuric acid	300 t
Ash	15 647 t
Lime residues from water softening	787 t
Building rubble	3 167 t
Excavated soil	3 445 t
Miscellaneous	90 t
Total	**61 191 t**

Experts monitor proper disposal

A total of 61,191 metric tons of reusable residual materials was produced by Henkel in Düsseldorf in 1993. Plastics, wood, scrap metal, paper, building rubble, excavated soil and ash are all collected - separately of course - in the plant.
The different types of residual materials are taken to a new residues center, staffed by experts who know exactly what can be reused or disposed of, and how. 37 percent of the waste that cannot be materially recycled is fed into Düsseldorf's municipal waste incineration plant. The remainder is largely dumped in the plant's own landfill or in special landfills for excavated soil and hazardous waste.

Precise records of all the waste that is disposed of or placed in temporary storage

All disposable wastes are monitored from the very beginning with the help of a data processing system and only leave the plant if they are properly labeled and registered. In this way Henkel maintains an exact record of wastes that are still in temporary storage and wastes that have been disposed of. In the past this system took no account of excavated soil from building work, or ash from the power plant boiler-house. These wastes did not appear in Henkel's "books" because they were directly disposed of by external contractors.
Since 1992, however, these wastes have also been included in Henkel's waste balance. The chart *Amounts of waste and methods of disposal* therefore shows higher amounts of waste for 1992 and 1993 than the two previous years although the actual waste situation at Henkel had not deteriorated.
Because all wastes are registered in a computer system, it is possible to assign the disposal costs to the individual waste producers. Departments that successfully avoid producing waste therefore benefit directly.
This is also intended to reinforce the environmental consciousness of each individual, because in the field of waste prevention even the best principles are ineffective without the commitment of the employees involved. Where the environment is concerned, grass-roots action is effective. Each individual who conscientiously collects and sorts residual materials, who refuses to use plastic beakers, who submits used printer cartridges and printer ribbon cassettes for reconditioning, has already taken a step in the right direction.

Acetic acid recovery: A recurring cycle

It looks impressive enough from outside, but its inner workings are really something out of the ordinary. Henkel Ireland's new, twelve-meter high extraction column in Cork is the heart of a plant that extracts 3,000 metric tons of pure acetic acid each year from industrial wastewater.
Acetic acid is a key chemical. Pungent and strongly corrosive in its pure state, when diluted with water this liquid is familiar to us all as the vinegar added to food or used for cleaning purposes. Henkel's Irish subsidiary also uses an acetic acid compound. With the help of acetic acid anhydride, Henkel Ireland produces environmentally

compatible auxiliaries with which copper and other metals can be extracted from their ores.
These extraction agents are also used to clean soils that have been polluted with heavy metals .
A washing raw material that serves as a bleach activator is also manufactured in Cork from acetic acid anhydride. Thanks to these activators, normal detergents can function with maximum effectiveness even at low temperatures, thus helping to save energy.
The manufacture of these products also results in the production of some 30,000 cubic meters of wastewater each year, and this wastewater contains between eight and twelve percent acetic acid.
In the past the company's sewage treatment plant coped easily with biodegradation, but it needed energy for the aeration and a large amount of lime for the neutralization of the acid. The sewage sludge that was formed then had to be disposed of properly in a landfill.

Irish rely on a proven extraction system

The new recovery plant, in which 99.5 percent pure acetic acid is extracted from the wastewater, has relieved the sewage treatment plant of some 60 percent of its total previous load. The Irish had good reasons for deciding on the proven extraction process. It needs little energy and, in contrast to some other processes, it separates acetic acid from water very efficiently.
The liquid-liquid extraction process used in Cork uses easily degradable ethyl acetate as the extraction agent. This does not mix with the mixture of acetic acid and water. When the two liquids come into contact two layers are formed, with only a small interphase between them.

Recycled solvent remains in the process cycle

If the two liquids are thoroughly mixed, for example with an agitator, solvent droplets with a large surface area are formed; as a result the acetic acid separates out of the aqueous phase faster and more efficiently.

Two streams leave the extraction column: the raffinate (water with traces of solvent and acetic acid) and the extract (solvent with acetic acid and a little water).
The two streams are treated separately. The raffinate is passed into a stripper, in which the residual ethyl acetate is driven out of the wastewater and condensed. The remaining wastewater flows into Henkel's own sewage treatment plant. The extract is fed into a distillation plant, where the acetic acid is separated efficiently from the ethyl acetate.
The solvent is then fed back into the process cycle; it is again used in the extraction column. The acetic acid is sold as a valuable raw material.

Zeolite residues: Finally good enough

When Henkel introduced zeolites more than a decade ago it took an important step toward using more environmentally compatible components in detergents. Zeolites are inorganic compounds that contain silicon, and they occur naturally as minerals in many parts of the earth. In detergents they perform the same function as phosphates. Phosphate compounds were used in powdered detergents until the 1970s for the purpose of rendering hardness elements (calcium and magnesium) ineffective. However, while hardness elements "only" stress the fabric and leave stains and/or a rancid odor on the laundry, the phosphates used to combat them can cause enormous harm to rivers and lakes owing to their fertilizing action (eutrophication). Zeolites, which are insoluble in water, do not have this effect. These ion exchangers also combine with hardness elements but do not promote eutrophication. They are manufactured in a multistage process. First of all sodium hydroxide solution is reacted with aluminum hydroxide, then water glass solution is added to the reaction mixture so that a detergent zeolite with a special particle structure is formed. This is separated off and the excess sodium hydroxide solution is returned to the aluminum hydroxide dissolver.

Chemically identical and yet not the same

During this plant-internal cycle, small amounts of water glass silicates find their way into the dissolver and react with aluminum hydroxide. As a result, zeolites are formed which are chemically identical to the detergent zeolites. However, these ion exchangers cannot ensure clean laundry. Their different particle structure makes

them unsuitable for detergents. Their only use is, when reprocessed, in the manufacture of aluminum hydroxide. Henkel Düsseldorf used to produce some 1,000 metric tons of these zeolite residues each year. They were made into a slurry with sodium hydroxide solution so that they were easier to transport, and then taken in trucks to an external recycling plant. Because the load included sodium hydroxide solution, under the terms of the German transport regulations the trucks were carrying hazardous waste. Many thousands of trips were needed each year, but no accidents occurred.

New process makes particle structure suitable

Nor will any accidents occur in future, because Henkel no longer needs to transport its zeolite residues. An internally developed treatment process has made their journey to external recycling plants unnecessary. The new process imparts a suitable particle structure to the formerly unsuitable residues, so that they conform to the demands made on detergent zeolites.

Chromium recycling: A good yield

Individually they are insignificant, but together they have a considerable impact. Every year some 20,000 metric tons of shavings are produced by the leather manufacturing industry in Germany. When hides of different thickness are evened out these shavings are unavoidable. Still, what the leather industry regards as waste contaminated with heavy metals is a valuable raw material for the Henkel subsidiary Grünau in Illertissen, Bavaria. Since the 1970s, Grünau has been extracting important basic materials for the textile and cosmetic industries from these shavings, which are no more than 20 millimeters in length. The experts refer to these protein materials as collagen hydrolyzates, and they are used today to manufacture, for example, especially skin-compatible surfactants.
The southern Germans used to extract collagen by means of two different processes. The shavings were either boiled in sulfuric acid (= acid manufacture) or treated with a calcium hydroxide solution (= basic manufacture).
Despite their differences, these two processes had one thing in common: after the valuable organic material had been separated it left a residue containing heavy

metals as a result of accumulation of the chromium compounds used for tanning leather. In 1993, some 3,000 metric tons of this residue had to be disposed of. The low chromium content of about 7.5 percent made recovery uneconomic.

Proteins now split by enzymatic-chemical action

At 15 percent things look different. The experts in Illertissen thought that doubling the chromium concentration would make recovery profitable, so they developed a new hydrolysis process. Since January 1994 they have been able to split the proteins by means of an enzymatic-chemical method. Moreover they can do this at half-power. The new process runs at much lower temperatures and generates only half the amount of residual material. And because this means a doubling of the chromium concentration, reprocessing is now worthwhile. In this way valuable chromium compounds can be recovered.

Less hazardous waste: Simple and safe

The Henkel subsidiary Sichel in Hannover is a specialist in the processing of liquid, powdered and paste-like raw materials from which colored seam sealants are manufactured on the basis of silicon, acrylate or polyurethane. There used to be some problems, however, associated with the seam sealants' journey from the preparing tanks in the production plant to the filling station, where the paste-like products were transferred to cartridges and pouches. Exposure to the air can cause a solid, elastic skin to form, and this can result in the presence of small amounts of impurities in the product.
This phenomenon of rapid skin formation may be fine for consumers, but the manufacturer is less impressed. This is why Sichel's employees always took care to cover the preparing tank quickly with a sheet before it was transported.
Innumerable covered tanks were transported each day; innumerable soiled sheets were left over. Together with the residues from tank cleaning they became a major environmental and financial burden for Sichel. Year by year numerous tons of residues from the cleaning agent treatment process, together with soiled sheets to which not yet hardened sealant had adhered, had to be disposed of as hazardous waste.

A new production process - known as a batch-in-batch operation - reduced this amount almost to nothing. The continuous production and filling plant does away with some 2,000 individual batches and therefore many tons of hazardous waste from the cleaning processes.

Know-how transfer: Cross-border concern for the environment

Environmental protection does not stop at national frontiers as far as Henkel is concerned. Group companies throughout the world comply with the principles of environmental and consumer protection.
For example, Japan: The Henkel Hakusui Corporation in Japan had problems with its organically polluted wastewater. The company's four-stage sewage treatment plant purifies production wastewater. After passing through the plant the wastewater had a relatively high COD value of more than 2,000 milligrams per liter. Because the Japanese wanted to use the water on agricultural land, this value had to be reduced drastically. A value of 20 milligrams per liter was the target, but this seemed to be beyond the capability of the existing sewage treatment plant.
The fact that today's values are clearly below the specified limit and Henkel Hakusui has been spared the need to invest considerable sums of money is due above all to the know-how of COGNIS.
After an analysis of the performance of all stages of the sewage treatment plant, COGNIS and Henkel Hakusui jointly drafted a number of improvement proposals.
The result: optimization instead of costly expansion of the plant.
By using the existing buffer tank as the aerobic biological treatment stage and simultaneously improving the aeration of the fixed bed biological treatment stage, it proved possible to increase the overall efficiency of the biological stage by over a third to more than 84 percent.

Efficiency of sewage treatment plant in Japan more than 97 percent

Other improvements were also implemented and today the efficiency of the whole sewage treatment plant is more than 97 percent. The production plants also contributed to this success by subjecting wastewater to improved pretreatment before feeding it into the sewage treatment plant. These improvements not only made new investment unnecessary but also reduced annual operating costs considerably.

The colleagues in Japan are not the only ones to make use of COGNIS' know-how in the field of wastewater purification. The experts in environmental technology also identified possible improvements at Henkel-Ecolab in Belgium. And just as in Japan, COGNIS followed its tried-and-trusted procedures in close cooperation with the client: the wastewater situation was analyzed; the weak points were identified; detailed measures were drafted and put into practice.
The first results were soon apparent. Process improvements resulted in a 20 percent reduction in the volume of wastewater from production, and in some areas such as detergent manufacture wastewater was totally eliminated.
Neither company regarded these initial successes as sufficient; in a second phase Henkel-Ecolab and COGNIS intend to achieve still more reductions in the current volume of wastewater.

New hydrogenation facility: Experience to the benefit of the environment

The world's biggest hydrogenation facility for fatty alcohols: Henkel's new facility came on line in Düsseldorf in November 1993 and can produce some 80,000 metric tons each year. Thanks to their years of experience in the hydrogenation of fatty acid methyl esters, Henkel's process engineers succeeded in developing a new type of reactor and a unique technology that needs only half the process energy that was previously required. The HD9, as it is familiarly referred to in-house, is impressive not only for its high capacity and economic efficiency, but also because of the sophisticated technology that has been incorporated to protect the environment. The level of emissions is extremely low, because all sources of unavoidable emissions are connected to a collector system that channels waste gas into Henkel's own power plant, where it is burned (see Environment Report 1992). In addition the facility runs very quietly because it has been fitted with extensive sound insulation.

Environmental protection even when the catalyst is being replaced

The production of fatty alcohols is accelerated with the help of catalysts, which contain copper. Henkel has no intention of changing this tried-and-tested method, except with regard to the disposal of the used catalyst tablets.

Previously they were rinsed out of the apparatus with water and collected in open basins. The rinsing water, polluted with heavy metals, flowed into the drains of the Düsseldorf parent plant and was discharged into the municipal sewage treatment plant. Naturally the legal limiting values were not exceeded, but nevertheless the rinse water was a burden on the discharged wastewater.
Nowadays the used catalyst is loosened with a little water and drawn directly from the reactor vessel into a special truck, which also accommodates the small amount of rinse water. The contents of the truck are delivered to a recycling company that recovers the heavy metals for further use.
Traces of heavy metal also used to escape in the wastewater produced while the copper catalysts were being manufactured, and hence found their way into the sewage treatment plant. Here, too, measures were taken to benefit the environment. Today the polluted wastewater is adjusted to a weakly alkaline pH and passed through a tank filled with pieces of iron. Most of the heavy metals accumulate on the iron, so that the residual levels in the wastewater are well below the permitted limiting values.
Not only do the retained heavy metals relieve the burden on wastewater, they also result in financial savings. Experience has shown that the separator tank with the pieces of iron can bind zinc and copper for many years. When it finally becomes saturated it is not dumped in a landfill but delivered to a company that recovers the heavy metals.

Increased safety: Threefold benefit

They can be found everywhere: whether in production plants or in warehouses for packaging materials and finished goods, in laboratories for applied technology or offices - sprinkler systems are the first line of defence in case of fire. This is also true at the Henkel subsidiary in Reims. If a fire breaks out, numerous sprinklers are triggered immediately. However, there is a danger that contaminated sprinkler water could escape into the municipal sewerage system. And if the sprinklers prove inadequate and the fire department has to be called in, the firefighting water could also flow into the sewerage system.
This danger was eliminated in October 1993 when a new retention tank was completed. The semi-automatic valves of the collector tank buffer the municipal

sewerage system. The tank has a capacity of about 450 cubic meters, and can hold the contaminated water until it can be treated in a special facility.
The construction of the retention tank was the first of three environmental protection measures that were implemented within a period of ten months.
The second measure protects the soil against contamination. The production plants include four warehouses in which a total of up to 2,500 cubic meters of liquid raw materials are kept until they are needed. There was a danger that chemicals could seep into the soil from a leaking tank or with firefighting water. If a serious accident had occurred in the past, there was sufficient buffer capacity to accommodate half the available storage volume. Henkel had committed itself to providing such a facility. However, when one of the plants was recently extended and equipped with additional storage tanks, Henkel France regarded the available retention capacity as no longer adequate. It was therefore expanded by additional collection basins. No expense was spared: in one instance a collection basin could not be installed in the immediate vicinity of a storage tank, so the basin was simply constructed on the neighboring site.
Measure number 3: the underground pipelines for alkanes, which Henkel France needs to produce sulfonic acids, were relocated above ground. This has one great advantage: if a pipeline develops a leak, this can be detected immediately. One problem encountered when this measure was implemented was a road that had to be crossed. This was solved by taking the pipeline underground again, this time in a mini-tunnel that is accessible for monitoring and maintenance.

Less dust nuisance: The cyclone has had its day

In 1989 Henkel took over a detergent manufacturing company in Atalanti, a small town in the heart of Greece. However, the production plant, which had been built as long ago as 1974, did not conform to Henkel standards. It occasionally released too much dust into the atmosphere.
A cyclone in the plant did not always purify the exhaust gas sufficiently. In the past, emissions of fine dust sometimes exceeded the Greek norm of 100 milligrams per cubic meter. On some occasions this led to complaints from the neighboring farmers,

on whose fields the dust came to lie. The company reimbursed those affected for the inconvenience suffered, but it was clear to all parties that this situation could not be allowed to continue. The old cyclone was therefore replaced by a new end-of-stack filter - a dust separation technique that has proved to be very efficient in the past and is now installed in all the Henkel Group's detergent manufacturing facilities.
Extensive preliminary work had to be carried out before the filter was installed. The structure had to be reinforced considerably, because the filter is very heavy and the site is in an earthquake zone. Replacing the cyclone with a filter has brought more than just environmental benefits. Production losses due to interruptions for essential cleaning work have been eliminated, and it is no longer necessary to carry out additional weekend cleaning operations, so that there are savings in the maintenance budget.

Noise reduction: Dampers for loud operations

If a low-flying aircraft streaks across a residential area, the noise echoes through streets and gardens and often reduces the residents to despair. Undesirable noise can also be a cause of illness. Employees at their place of work are especially endangered. Deafness caused by permanent noise was for many years the number one occupational disease.
Those times are long gone. Henkel, too, has taken a close look at sources of undesirable noise in the workplace. Moreover, the reduction of the noise nuisance suffered by residents living in the vicinity of the Henkel parent plant in Düsseldorf has also been a priority item for more than a decade. From 1989 this noise was systematically reduced.
In the context of a noise reduction program, independent experts monitor the noise emissions and immissions of the production facilities in Düsseldorf-Holthausen. In the first year of the now completed project they regularly took readings from some 600 sources of noise and registered them. An analysis was then carried out to determine exactly which of the 600 noise producers were responsible for the high level of noise in the vicinity of the plant. A whole series of vacuum jets, suction plants, cooling plants, and cyclones were identified as major sources of noise.

The noise from the exhaust gas units of the five spray towers of the detergent manufacturing facility made an especially strong impression on the ears of the experts. This situation has now been remedied. The only noises that can be heard from the detergent production line are of moderate volume. In the fall of 1993 one of the five spray towers was given an especially powerful damper - 5 metric tons in weight and six meters high.

Sound waves cancel each other out by repeated reflection

This five-tonner was specially geared to the requirements of the detergent production line and the exhaust gases with their content of water vapor. It is made completely of steel and acts as a sound insulator by repeatedly reflecting the sound waves inside it so that they cancel each other out. Conventional absorptive sound dampers could not be used in association with detergent manufacture because their mineral fibers absorb water and become saturated, thus losing their sound-insulating properties. The search for suitable sound absorbers for other noisy plants proved to be less complicated. Noise protection walls and shielding walls, housings and insulation ensured that peace returned not only inside the plant but in the immediate outside neighborhood (see diagram *Noise immission trend*).
The result in figures: the total noise immission level in the nearest residential area was lowered by 60 percent to 54 decibel (A). The sound made by a car is 70 decibel (A).

Noise in figures

Noise is subjective. Some people can withstand the mind-numbing banging of a pneumatic hammer, while others jump at the sound of a piece of crisp-bread being snapped. However, it is an objective fact that a constant noise level of more than 90 decibels causes loss of hearing.
Noise is measured in decibels (dB), the unit of acoustic intensity, named after the inventor of the telephone, the American Alexander Bell. It is a logarithmic measure of the changes in air pressure caused by sound waves and is measured with a sound level meter. Because the sound measurement scale is logarithmic, a doubling or

halving of the "volume" is equivalent to a 3 dB increase or decrease in the sound level.
If measurements are carried out with instruments that possess a similar sensitivity to the human ear in a certain frequency range the results are shown with the suffix "(A)." The noise detection limit is about 25 to 30 dB(A) for humans. The noise emitted by a household fridge during operation is about 50 to 55 dB(A).
The German government has enacted a range of legislation to protect workers and the population at large. German environmental protection laws include the technical regulations on noise, the lawn-mower noise ordinance, the traffic noise protection ordinance and the sports facilities noise ordinance; occupational protection laws include the accident prevention regulations and the workplace ordinance.

Soil restoration: A new lease of life

No one would have thought it possible at one time, but volatile hydrocarbons are virtually unstoppable. They can penetrate even a 20 centimeter thick concrete slab without any trouble.
The Heidelberg company Teroson became acquainted with this disturbing fact when it decided to find out whether there were any contaminated areas on its works site - and discovered that there were. The soil under the 600 square meter store (building 15) was found to contain one gram chlorinated hydrocarbons per cubic meter of soil air - an extremely high level of contamination. Teroson, a Henkel Group company since 1991, produces among others sealants and adhesives as well as anticorrosive agents for the automotive industry. Until the mid-1980s Teroson used solvents that contained chlorinated hydrocarbons in some of its production and cleaning processes, and until 1988 these hydrocarbons were stored and transferred to other containers in building 15.

They can even penetrate concrete: chlorinated hydrocarbons

When the company built the store in 1950 it did so in line with the prevailing standards and state of knowledge. No one suspected that halogenated solvents could also penetrate concrete. Nowadays the experts know that chlorinated

hydrocarbons can penetrate almost anything, and must also be assessed extremely critically as contaminants in soil, ground water and the atmosphere. The Heidelberg company therefore reacted very quickly when it became aware of the findings. In consultation with the relevant authorities a clean-up program was drafted and an appropriate suction plant was installed, with 23 "trunks" penetrating into the soil to a distance of four meters.
The contaminated soil air drawn off was passed through two underground ring lines into an active carbon filter, where it was purified. It took only five months to decontaminate the soil. Measurements today show that the concentration of residual pollutants is below the limiting value of one milligram per cubic meter that applies in the state of Baden-Württemberg.
There is no need to fear any further pollution of the soil with chlorinated hydrocarbons in future: Teroson no longer uses them in its production processes.

Henkel Corporation USA: A paragon of protection

The Henkel subsidiary Emery in Cincinnati, Ohio, has been processing oils and fats since 1840. In those days it produced candles and lamp oil, but these have long been replaced by today's oleochemical products and chemical specialties based on renewable raw materials. More than 800 people are currently employed at the Cincinnati plant, which joined the Henkel Group in 1989 and is now its biggest production location in North America.

US environmental protection requirements fulfilled with room to spare

The employees in Cincinnati are in a good position to describe what a milestone in Henkel's corporate history looks like - after all, their new plant for manufacturing surfactants on the basis of renewable raw materials is precisely such a milestone. Since 1992 it has produced 25,000 metric tons of alkyl polyglycosides (APG) each year, with virtually no emissions. The new APG plant at this Henkel Corporation site is exemplary even by American standards, because it not only conforms to the strict US regulations but does so with room to spare.

The fatty alcohol facility that came on-line a short time later is also an excellent example of the integration of environmental protection in production. Methanol

emissions were never a problem from the very start. This is in contrast to other production lines, for methanol is used very frequently by Emery in Cincinnati. For example in esterification and the separation of saturated and unsaturated fatty acids. Although methanol is widely used in production, it has no place in the atmosphere. In reality the situation was quite different, even as recently as 1990. At that time methanol was responsible for 60 percent of the annual emissions of organic substances. Thanks to extensive development work, the Cincinnati company was able to announce a number of initial successes at the start of this decade, and by 1993 undesirable losses and emissions of methanol into the atmosphere, water, products and wastes had fallen from about 800 metric tons to some 300 metric tons per year - despite an increase in the number of products for which methanol is used.

Future target: more reductions in methanol emissions

This improvement was achieved by updating process specifications and installing two new pieces of environmental protection equipment. A new exhaust gas scrubber with a high separation efficiency has considerably reduced the atmospheric emissions from plants in which saturated and unsaturated fatty acids are separated. And in a new recovery plant in the esterification production facility, methanol is distilled from the reaction water and subsequently reused in production processes. Another plant is planned to help achieve the short-term target of reducing methanol emissions by a further 30 percent.

Environmental Data

Milestones in the history of environmental protection at Henkel

1953
Start of first scientific ecological studies and research projects.

1955
Development of laboratory test methods to assess the environmental behavior of products.

1958
Start of regular environmental monitoring of German rivers, initially for surfactants but later for other detergent components.

1959
Introduction of regular ecological quality controls of detergents and cleaning agents.

1965
Start of research project to develop substitutes for phosphates in detergents.

1971
Office for Environmental and Consumer Protection set up as central coordinating body for questions of product safety.

1973
Patent application for use of sodium aluminum silicates (zeolite) as substitutes for phosphates in detergents.

1976
Market launch of the first detergent to contain zeolite and a reduced amount of phosphate.

1982
Principles of Environmental and Consumer protection in the Henkel Group are bindingly defined worldwide.

1983
Market launch of first powdered detergent based on zeolites and containing no phosphate.

1987
The Corporate Guidelines are amended to give environmental protection the same priority as, for example, achieving profits.

1988
Corporate Management and the Works Council conclude an agreement concerning cooperation in the field of environmental protection. This gives the Works Council far-reaching rights with regard to information and participation.

1989
A worldwide eco audit records the actual environmental situation at all production facilities of the Henkel Group and all products, in accordance with uniform criteria.

1990
Start of systematic employee training in the field of environmental protection.

1991
In a directive Information on Environmental Protection, corporate units are obliged to carry out and document regular environmental protection discussions.

1991	1992
Henkel becomes one of the first German companies to accept the principles of the "Business Charter for Sustainable Development" formulated by the Environment Commission of the International Chamber of Commerce.	Henkel publishes its first Environment Report.

Sulfur dioxide and nitrogen oxide emissions

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.
* Provisional value; at the time of going to press not all data had been finally evaluated.

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 the 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 mid-1991, when the flue gas desulfurization plant came on line. The full benefits were first felt in 1992. 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 are unnecessary. the decommissioning of a coal-fired boiler plant also contributed to the reduction in sulfur dioxide emissions in 1992.
* Provisional value; at the time of going to press not all data had been finally evaluated.

Dust emission 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 non-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 sewage treatment plants 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 reduction of the nickel load in 1993 is attributable to the commissioning of a nickel precipitation unit. The connection of other components to this unit is expected to result in a further reduction in 1994. Changes in production quantities resulted in a rise in AOX loads for 1993. Steps have been taken to decrease this.
* 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. Traces 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, 1993

A comparable waste statistic, distinguishing between waste and useful substances, is not available for the years 1985, 1986 and 1988. The individual methods of disposal have been recorded since 1991. From 1992 the waste figures include excavated soil and power plant ash, which were disposed of by external contractors.

Noise immission trend

Distance between grid lines: 200 meters
A comparison of the years 1987, 1992 and 1993 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.

Odor immission, 1993

In by far most instances no odor was detected. Strong to extremely strong odors were not detected during any of the inspections.

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; the necessary public authority approval procedures for implementation have been initiated.
* Provisional value; at the time of going to press not all data had been finally evaluated.

Solvent consumption in adhesives production

Henkel parent plant, Düsseldorf

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 prickling agents, which contain chlorinated hydrocarbons, and the purchase of a Hungarian company in 1991. Targeted substitution measures have been started and show first results.

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.

Detergent dosages, e.g. Persil

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

Acetic acid anhydride
(Acetic acid recovery: A recurring cycle)
Very strongly concentrated chemical compound, similar to acetic acid, formed by removing water from acetic acid.

Acrylates
Salts of acrylic acid. Used especially as raw materials for special polymers.

Adsorption
Accumulation of gaseous or dissolved substances on a carrier material with a large surface area. Adsorption can be used to remove substances from gases or liquids.

Aerobic
(Know-how transfer: Cross-border concern for the environment)
Conditions characterized by the presence of free oxygen.

Aliphatic hydrocarbons
(Alkanes)
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
(Environmental protection even when the catalyst is being replaced, Nonionic surfactants, pH, Water glass)
Aqueous solution with a pH above 7.

Alkanes
(Increased safety: Threefold benefit)
Aliphatic hydrocarbons whose molecular structure does not include a double bond.

Alkyl polyglycosides (APG)
(US environmental protection requirements fulfilled with room to spare)
New type of surfactant, made only from native raw materials such as starch, sugar and fatty alcohols.

Aluminum hydroxide
(Zeolite residues: Finally good enough, Chemically identical and yet not the same)
Poorly soluble aluminum compound. Formed as an intermediate product during the processing of aluminum ores.

Anaerobic
(Incineration not the best way to resuscitate the soil)
Conditions characterized by the absence of free oxygen.

Anionic surfactants
(Environmental monitoring: Rivers under review)
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
Measure of the sum of the organic halogen (especially chlorine) compounds in wastewater.

Aromatics

(Industrial adhesives: Adhesives that stick out, Aliphatic hydrocarbons)
Class of organic compounds derived from benzene. The characteristic structural feature of its molecules is the hexagonal benzene ring.

Bleach activator
(Acetic acid recovery: A recurring cycle)
Detergents contain bleaching agents and bleach(ing agent) activators. The activator ensures - usually by releasing active oxygen - that the bleaching agent is effective even at low temperatures.

Bleaching clays
(Waste: A clean slate)
Special minerals capable of bonding with certain impurities and therefore used to purify some products.

Carbon dioxide
(Eco leadership: a challenge and its consequences, Eco logistics: On the right track, Genetic information transferred to proven strain, Favorable effect on the carbon dioxide balance)
Gaseous combustion product of all organic substances that contain carbon. Carbon dioxide contributes considerably to the green-house 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
(Relatively few residual materials are simply waste, Environmental protection even when the catalyst is being replaced)
Special substance that accelerates a chemical reaction while itself remaining unchanged.

Chemical oxygen demand (COD)
(Intensive scrutiny in eastern Germany, Fresh data on the chemical pollution of water courses, Know-how transfer: Cross-border concern for the environment)
Measure of the sum of all organic substances in wastewater. The COD indicates how much oxygen is needed to oxidize these substances completely.

Chlorides
(Environmental monitoring: Rivers under review)
Salts of hydrochloric acid. Most widespread representative: sodium chloride = common salt.

Chlorinated hydrocarbons
(Industrial adhesives: Adhesives that stick out, Soil restoration: A new lease of life, They can even penetrate concrete: chlorinated hydrocarbons)
Organic solvents that lose their flammability owing to the chemical incorporation of chlorine. They are therefore safe to handle, but pose problems in the fields of health and environmental protection.

Collagen hydrolyzates
(Chromium recycling: A good yield)
Substances formed by the hydrolysis of leather. Valuable surfactant raw materials for especially skin-compatible products.

Condensation
(Polyglycerins)
1. Formation of liquid from the vapors formed during distillation.
2. Chemical reaction in which water is formed as a secondary product.

Cyclone

(Less dust nuisance: The cyclone has had its day)
Plant component used to separate dust from exhaust gases. The gas stream is deflected in the cyclone, causing the heavier dust particles to separate out.

Deregulation of price structures in the European transport sector
On January 1, 1994 the deregulation of European goods transport came into force. The fixed transport prices that had previously been defined by the German government ceased to be effective.

DIN ISO 9001
(Suitable for all sizes of sites)
International standard that describes a universal and comprehensive quality assurance system covering all product stages from development through materials procurement and production to customer delivery.

Dispersion
(Industrial adhesives: Adhesives that stick out, Aim: aqueous systems for all laminating purposes, Emulsion, Suspension)
Finely distributed solid particles in water.

Distillation
(Recycled solvent remains in the process cycle, Condensation)
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.

DOC
(Intensive scrutiny in eastern Germany, Fresh data on the chemical pollution of water courses)
Dissolved organic carbon. Measure of the total load of dissolved organic compounds.

Enzymes
(Useful instrument for probing weak points, Genetic information transferred to proven strain)
High-molecular proteins that function as biocatalysts. Certain enzymes are included in detergents to remove stubborn stains because they accelerate their decomposition.

Emissions
(Eco leadership: a challenge and its consequences, Eco logistics: On the right track, Useful instrument for probing weak points, Genetic information transferred to proven strain, Incineration not the best way to resuscitate the soil, Plastic bottles: Easy on the lightweights, New hydrogenation facility: Experience to the benefit of the environment, Less dust nuisance: The cyclone has had its day, Noise reduction: Dampers for loud operations, US environmental protection requirements fulfilled with room to spare, Future target: more reductions in methanol emissions, Immissions)
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.

Emulsion
(Potent cocktail of biodegradable ingredients, Surfactants make sure the soil particles are properly wetted, Dewatering used oil: Less is a lot more, Product packaging: Keeping the lid on waste, Henkel companies: experts in avoiding waste)
Dispersion of fine drops of a liquid in another liquid, for example water in oil.

Esterification
(US environmental protection requirements fulfilled with room to spare, Future target: more reductions in methanol emissions)
Chemical reaction used to manufacture esters from acids and alcohols.

Ethyl acetate

(Irish rely on a proven extraction system, Recycled solvent remains in the process cycle)
Frequently used organic solvent. Contains no chlorine. Readily biodegradable. Used, for example, in nail lacquer removers.

Eutrophication
(Intensive scrutiny in eastern Germany, Zeolite residues: Finally good enough, Phosphates)
The introduction of excessive amounts of nutrients into bodies of water promotes increased growth of algae and aquatic plants. This can lead to temporary oversaturation of the water with oxygen. When the plants die, however, large amounts of oxygen are consumed during their decomposition in deeper layers of the body of water. This can lead to an acute shortage of oxygen in the water and bring about a massive disturbance of the biological equilibrium.

Fatty acid esters
(Fatty acid methyl esters)
Products obtained when fatty acids react 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
(New hydrogenation facility: Experience to the benefit of the environment, Fatty alcohols)
Fatty acid esters with methanol; intermediate product in the manufacture of fatty alcohols.

Fatty acids
(Potent cocktail of biodegradable ingredients, US environmental protection requirements fulfilled with room to spare, Future target: more reductions in methanol emissions, Fatty acid esters, Fatty alcohols)
Class of substances that are found - bonded to glycerin - in all vegetable and animal fats and oils. Important starting materials for numerous oleochemical derivatives.

Fatty alcohol plant
Plant for manufacturing fatty alcohols.

Fatty alcohol sulfates (FAS)
(Useful instrument for probing weak points, Genetic information transferred to proven strain, Favorable effect on the carbon dioxide balance)
Important group of surfactants based on fatty alcohols.

Fatty alcohols
(New hydrogenation facility: Experience to the benefit of the environment, Environmental protection even when the catalyst is being replaced, Alkyl polyglycosides (APG), Fatty acid methyl esters, Fatty alcohol plant, 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.

Fixed bed biological treatment stage
(Know-how transfer: Cross-border concern for the environment)
Biological wastewater purification plant in which the microorganisms are not freely distributed in the water but grow in the form of a "biological" carpet on a substrate.

Flocculation
(Incineration not the best way to resuscitate the soil, Surfactants make sure the soil particles are properly wetted)

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.

Flue gas desulfurization

(Relatively few residual materials are simply waste, Sulfur dioxide)

Process for removing sulfur dioxide from the flue gases emitted by power and other firing plants.

Glycerin

(Waste: A clean slate, Fatty acids, Polyglycerins)

One of the two main components of all oils and fats; serves as a solvent and as an intermediate product in the manufacture of numerous other substances.

Halogenated solvents

(They can even penetrate concrete: chlorinated hydrocarbons)

Organic solvents that have been made non-flammable by the chemical incorporation of halogens (fluorine, chlorine, bromine, iodine). They are therefore safe to handle, but pose problems in the fields of health and environmental protection.

Hardness elements

(Zeolite residues: Finally good enough, Zeolites)

Calcium and magnesium ions dissolved in water. Because they reduce the efficiency of surfactants they have to be inactivated during the washing process by bonding them to other substances. Zeolites are used for this purpose.

Heavy metals

(Potent cocktail of biodegradable ingredients, Acetic acid recovery: A recurring cycle, Chromium recycling: A good yield, Environmental protection even when the catalyst is being replaced, Hydroxides)

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

(New hydrogenation facility: Experience to the benefit of the environment, Fatty alcohols)

Chemical reaction with hydrogen.

Hydrogenation facility

(New hydrogenation facility: Experience to the benefit of the environment)

Production facility in which chemical reactions with hydrogen are carried out.

Hydrolysis

(Proteins now split by enzymatic-chemical action, Collagen hydrolyzates)

Chemical decomposition involving reaction with water.

Hydroxides

(Dewatering used oil: Less is a lot more)

Compounds formed especially at high pH. The hydroxides of most metals are poorly soluble and can often be used to extract heavy metals, for example from wastewater.

Immissions

(Eco leadership: a challenge and its consequences, Noise reduction: Dampers for loud operations)

Effects of atmospheric pollution, noise, vibration or radiation on humans, animals, plants or objects. In the context of clean air legislation it refers to the emissions absorbed by the atmosphere and distributed up to a certain concentration.

Impregnating agents

Products that are used to prevent moisture from penetrating into materials, and to protect materials against the effects of moisture. Impregnating agents are used to make textiles waterproof and prevent moisture from penetrating into the walls of buildings.

Ions

(Anionic surfactants, Anions, Hardness elements, Nonionic surfactants, Zeolites)

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

Inorganic compounds

(Zeolite residues: Finally good enough)

Substances that, in contrast to organic compounds, are not based on the key elements carbon and hydrogen. Inorganic compounds include, for example, minerals, acids and salts.

Methanol

(Relatively few residual materials are simply waste, US environmental protection requirements fulfilled with room to spare, Future target: more reductions in methanol emissions, Fatty acid methyl esters)

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

Microorganisms

(Useful instrument for probing weak points, Genetic information transferred to proven strain, Soil decontamination: Pollution solutions, Potent cocktail of biodegradable ingredients, Fixed bed biological treatment stage)

Microscopically small organisms, for example bacteria.

Nitrogen oxides

(Eco logistics: On the right track)

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

(Environmental monitoring: Rivers under review)

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

Oleochemicals

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

Organic carbon

(Fresh data on the chemical pollution of water courses, DOC, TOC)

Carbon that is present in the form of organic compounds.

Organic substances/compounds

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

(Environmental protection even when the catalyst is being replaced, Alkaline, Hydroxides)

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

(Fresh data on the chemical pollution of water courses, Incineration not the best way to resuscitate the soil, Zeolite residues: Finally good enough, New process makes particle structure suitable)

Salts of phosphoric acid. They are essential plant nutrients, but over-fertilization can cause them to be present in too high concentrations in bodies of water (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.

Phosphatization

Treatment of metal surfaces (steel, galvanized steel) to give them a thin coating of phosphate as protection against corrosion.

Polyglycerins

(Waste: A clean slate)

Substances formed by the condensation of several glycerin molecules. Occur as secondary products during the manufacture of glycerin.

Polymers

(Surface treatment: The success story continues, Acrylates)

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

Polyurethane

(Aim: aqueous systems for all laminating purposes, Less hazardous waste: Simple and safe)

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

Primary energy

(Genetic information transferred to proven strain)

Energy from original, naturally occurring sources of energy such as coal, petroleum or water power. Often converted into more easily handled secondary energy, e.g. electricity.

Protease

(Eco balances: Significant signposts, Useful instrument for probing weak points, Genetic information transferred to proven strain)

Enzyme that is capable of breaking down specific proteins.

Proteins

(Proteins now split by enzymatic-chemical action, Enzymes, Protease)

High-molecular substances containing a mixture of amino acids. Basic constituents of living organisms.

Residual substances

The substances that are left by a production process. If they cannot be exploited in any way they have to be disposed of as waste.

Shavings

(Chromium recycling: A good yield)

Residual material produced when hides of different thickness are evened out.

Silicones

Group of compounds based on silicon. Owing to their elasticity and water-repellant properties they are used for sealing compounds, to impregnate buildings, etc.

Sodium hydroxide solution

(Zeolite residues: Finally good enough, Chemically identical and yet not the same, Sodium sulfate)

Very strong lye. A key raw material, used in large amounts in the chemical industry.

Sodium sulfate

(Relatively few residual materials are simply waste)

Salt formed by reacting sodium hydroxide solution with sulfuric acid.

Solvents

(Incineration not the best way to resuscitate the soil, Plastic bottles: Easy on the lightweights, Industrial adhesives: Adhesives that stick out, Processing options left a lot to be desired, Aim: aqueous systems for all laminating purposes, Impregnation compounds for buildings: Water wards off water, Soil restoration: A new lease of life, Chlorinated hydrocarbons, Halogenated solvents)

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.

Stripper

(Recycled solvent remains in the process cycle)

The part of a production facility in which dissolved gases and vapors are driven out of and separated from liquids.

Sulfates

Salts of sulfuric acid.

Sulfonic acids

(Increased safety: Threefold benefit)

Intermediate products that contain sulfur; used to manufacture certain surfactants.

Sulfur dioxide

(Eco logistics: On the right track, Flue gas desulfurization)

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.

Surfactants

(Environmental monitoring: Rivers under review, Intensive scrutiny in eastern Germany, Fresh data on the chemical pollution of water courses, Useful instrument for probing weak points, Genetic information transferred to proven strain, Incineration not the best way to resuscitate the soil, Surfactants make sure the soil particles are properly wetted, Chromium recycling: A good yield, US environmental protection requirements fulfilled with room to spare, Anionic surfactants, Fatty alcohol sulfates (FAS), Fatty alcohols, Hardness elements, Nonionic surfactants, Sulfonic acids)

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

Suspension

(Surfactants make sure the soil particles are properly wetted)

Dispersion of finely distributed solid particles in a liquid, e.g. lime suspension.

Thermal utilization

(Dewatering used oil: Less is a lot more)

Utilization of the energy content of residual materials by burning them.

TOC

(Fresh data on the chemical pollution of water courses)

Total organic carbon. Measure of the total load of organic substances.

Ton kilometers

(Nine nationwide regional depots replace central depots)

Mathematical product of the volume of transported freight and the distance covered. Serves to compare different transport performances.

Vacuum jet

(Noise reduction: Dampers for loud operations)

Device for generating a vacuum, for instance in production facilities. Such devices can use, for example, the flow of a jet of water.

Water glass

(Zeolite residues: Finally good enough, Chemically identical and yet not the same)
Alkaline silicon compound that is soluble in water. Important intermediate product in inorganic chemistry, but also a corrosion-inhibiting component of detergents.

Zeolites

(Zeolite residues: Finally good enough, Chemically identical and yet not the same, New process makes particle structure suitable, Hardness elements)
Sodium aluminum silicates whose three-dimensional structure contains cavities, enabling them to combine with ions of hardness elements in water.

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