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ENVIRONMENTAL STANDARDS AND THE FERROALLOY INDUSTRY

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Abstract

This paper focus on some of the environmental challenges that the ferroalloy industry will meet in the future. It summarizes viewpoints on the need for environmental improvements, and it presents some alternative instruments for obtaining improvements. Some current principles for setting emission standards and emission limits are also presented, and some specific requirements and expectations for the ferroalloy industry are discussed. In the last part of the paper, future environmental management systems are discussed.

Introduction

In this paper I intend to focus on some of the environmental challenges that the ferroalloy industry will have to face in the future. I have chosen to divide the subject into three parts:

- Some basic environmental viewpoints
- Future environmental requirements and standards
- Environmental management systems

In the ferroalloy industry, as in most other industries, both the standard of the technology and the environmental standards vary considerably from country to country. Some manufacturers have achieved a standard marked by the best processing and cleaning technology available so far, while others still generate as much pollution as experienced in the industrialized countries 20-30 years ago. As a rule, there is a correlation between the requirements imposed by the authorities and the environmental standard of the industry.

The need for measures to protect the environment was first observed in connection with local pollution, such as dust (particulates) or hazardous substances with visible local effects.

Gradually, as many of the local problems were solved, the focus was turned towards the environmental problems that take no notice of national boundaries, and where regional or global measures are essential. This applies both to long-range transboundary air pollution and to pollution of rivers and oceans.

Problems that demand regional or global solutions must be dealt with through international cooperation. This cooperation has led to a number of conventions. The most important for the ferroalloy industry is The UN Convention on Climate Change (fig. 1)
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The UN Convention on Climate Change

The Convention is based on the Rio Conference in 1992. It has been signed by 150 countries and ratified by more than 90. The participants have undertaken to design and implement measures to counteract changes in climate.

Fig. 1

Also the ECE protocol on reduction of sulphur emissions is important for manufacturers in Europe (fig. 2).

Protocol to the ECE Convention on Long-Range Transboundary Air Pollution on Further Reduction of Sulphur Emissions.

Most European countries participate. The protocol is based on the principle of nature's critical load. This critical load is particularly low in Scandinavia, the Netherlands and parts of Germany and the United Kingdom, owing to the type of bedrock and the quality of the soil.

Fig. 2

In addition to promoting international agreements, the EU is also working on the preparation of common, binding environmental standards for industry. The primary purpose is to ensure an acceptable environment, but a second important objective is to prevent different environmental requirements from disturbing the balance of competition. The EEA Agreement implies that Norway has to follow the EU rules.

Most countries, in addition to complying with the national targets defined as a result of the international agreements, are placing increasing emphasis on management of natural resources, including energy use, waste minimization, recycling of waste and proper management of the remaining waste.

In the efforts to protect the environment it is necessary to follow certain main rules. Some of the most important are shown in fig. 3.

Some basic principles in environmental administration:

- Our actions must be based on current knowledge. Any doubt shall weigh on the side of the environment.
- The most important environmental problems should be addressed first.
- Decisions must be based on an assessment of benefit in relation to cost.
- Preventive measures should receive priority.
- The polluter should pay for damage to the environment, and for actions to prevent such damage.

Fig. 3

The motivation for the environmental efforts, and relevant instruments

Motivation

Traditionally, the most important driving force has been public opinion, which no longer accepts the pollution of the local environment. In this process, it is essential to have a free press. Pressure on the politicians has led to the establishment of environmental authorities who impose various requirements that a polluter must meet, and subsequently make sure that he does so.
Parallel with this development, industry has also entered the arena itself. The first measure was to install cleaning facilities. But because cleaning is expensive, industry has also invested resources in developing better production technology and more environmentally friendly products. As a result, new and more environmentally sound technology has become available, and this is now an important element of competition, both for manufacturers and for the firms that supply the technology. In many countries, Norway among them, the authorities try to stimulate this type of industrial development by directly supporting demonstration projects.

Demands from financing agencies, and from customers, that manufacturers show greater awareness of the environment, are becoming increasingly important.

The International Finance Corporation (IFC), the most important financing agency for private investments in developing countries, sometimes imposes very specific environmental criteria for the projects they intend to support. These requirements are coordinated with corresponding requirements from the World Bank as regards support to the public sector. One of Norway's largest institutional financing companies stated recently that it will only support companies that maintain an acceptable environmental standard.

Corresponding demands are also becoming much more common in the marketplace. This applies especially to manufacturers close to the final consumers.

The market also demands quality assurance, and the international standards apply to all the company's functions, including protection of the environment. Gradually, it is becoming generally accepted that quality assurance of all the company's activities is an important condition for profitability.

These attitudes will help to some extent to level out the difference in standard between countries. As regards the competitive situation within a particular branch of industry, however, it will be a problem if some countries continue to place little emphasis on the need to protect the environment.

Instruments

The demand from industry, that the instruments to be used by the public authorities must be predictable, is understandable. Otherwise industry will not know what the operating conditions will be in the long term.

In many countries, including Norway, discharge permits have been found to be an effective means of reducing emissions. The permit is granted for a number of years, which enables equal treatment of all establishments within a specific branch (but with necessary adjustments to local conditions), and provides opportunities for effective follow-up and control. Any economic consequences are usually related to reactions by the authorities if the conditions of the permit are not complied with.

A system of levies, or taxes, on pollution is appropriate when the company is able to influence the level of pollution. Such a system also gives the company a choice. It can either pay for its emissions or invest in cleaner production technology or measures to clean the emissions. Another alternative is to adjust the tax to the discharge permit. More stringent conditions in the permit could mean a smaller amount to pay in tax.

Charging a tax instead of imposing specific restrictions on emissions is most suitable in the case of pollution that does not directly affect the local environment, and when it is difficult to fix specific emission standards without limiting the company's potential for development. Several countries have imposed a tax on emissions of SO_2 and CO_2. This is in line with the tendency towards "green" tax reforms, which implies changing from taxing labour to taxing consumption of resources and energy.

Another variation is agreements on tradable quotas for specific emissions. This is presently being discussed in Norway as an alternative way of reducing emissions of SO_2. As far as the companies are concerned, this will imply that measures to reduce emissions are taken where they are cheapest to implement, and the economic burden can be distributed between several polluters. The disadvantage, from the standpoint of the environmental authorities, is that it becomes more difficult to make sure that the desired reductions will actually be achieved within a reasonable time, and that they occur where they are most needed, considering the local conditions.

The basis for the emission standards

In most countries' environmental legislation, the fundamental principle is that any kind of discharge or emission is undesirable. However, since zero pollution is impossible, the goal must be to keep the pollution down to as low a level as possible and to weigh the harmful effects against the cost of averting the problems.

This means that the emission standards must be fixed on the basis of the technological possibilities and limitations. This applies both to manufacturing and cleaning technologies.

The next criterion is the recipient conditions in the company's vicinity. This is a question of whether the pollution is acceptable, seen in relation to nature's and human beings' critical load.

For several pollutants, the emission standards must also be considered in relation to international agreements.

In addition, there is pressure from industry that the emission standards should be designed so as to have the least possible effect on the competition between companies. If conflicts arise between commercial interests and environmental standards, the decision to impose emission standards could become a matter for the politicians.

Widespread international cooperation will become a necessity, because it is the only way to safeguard the environment while still giving reasonable consideration to the need for equal competitive conditions. This will also make it less tempting to move industry to countries with the least stringent environmental requirements.

Best available technology

In the international efforts to protect the environment there is a clear tendency to base the emission standards on the "best available technology" (BAT). This requires consensus on how BAT should be defined. In principle, this is a question of which processes generate least pollution and waste. But the technology must also be technically and economically feasible. In practice, the principle is therefore limited to "best available technology not entailing excessive cost" (BATNEEC). Since the emission limits affect both the need for investment and the power to compete, the discussions on BAT can easily become a matter for international negotiation concerning what should be fixed as the upper limit for pollution. BAT will primarily be used in connection with emission standards imposed for hazardous substances. For other components, evaluations of the recipient and cost-benefit analyses can be used as well.

As to the work on BAT in Western Europe, the best progress has been achieved in connection with the Oslo-Paris Convention on discharges to the north-east Atlantic Ocean. Here the objective is to arrive at common upper limits for discharges both to air and to water. Work is going on in connection with non-ferrous metals, for example, aluminium, copper, zinc and lead, but has not yet begun for ferroalloys.

Pollution standards based on nature's critical load

When deciding the type and quantities of pollutants that can be permitted it is natural to base the evaluations on how much the natural environment and human beings can tolerate. Considerable work has been done internationally to establish such criteria, not the least under the auspices of WHO. Most industrial countries have now introduced more or less the same criteria, or recommended quality guidelines, for pollution to air, freshwater and sea water. Therefore, when fixing the terms of the discharge permit for a particular company, it is important to consider whether the discharges lead to values higher than these quality guidelines. This could mean that all the companies in a specific branch of industry do not necessarily have to comply with the same emission limits. One example is the differing requirements imposed for cleaning sulphur emissions from ferroalloy plants.

The ferroalloy industry - requirements and expectations

Technological possibilities and limitations

Although the most important element in the manufacture of ferroalloys, the electric smelting furnace, is based on a technology that is 100 years old, no alternative process has been developed. There is little doubt that the best furnaces, which also have satisfactory cleaning installations, can also be defined as BAT.

The strength of the process lies in the fact that large manufacturing units and effective operation have made it possible to gradually reduce both power consumption and consumption of reduction agents.

Another factor is that a relatively large share of the utilized energy can come from electricity. In an environmental context this is an advantage when the electricity is generated from hydropower or other renewable forms of energy. It is cheaper to transport metals than electric energy over great distances, and the ferroalloy industry can therefore benefit from utilising clean energy in remote areas.

In the ferroalloy industry, around 50% of the production costs relate to raw materials and energy, and a critical question is whether anything can be done in this respect which also has a positive effect on the environment.

Looking at the ferroalloy industry from the outside, it is still an open question whether the development of a closed ferrosilicon furnace should be on the agenda. In principle a closed furnace should be able to obtain a better energy recovery than a semi-closed furnace with an uncontrolled combustion of CO on top of the furnace, even if the industry has gradually become better at utilizing the waste heat from semi-closed furnaces, either for power production or for district heating. If cleaning of SO_2 becomes necessary in the future, this may also be done cheaper from a closed furnace due to the reduced gas volume. The objections to closed furnaces are the need to prevent crust formation, safety aspects connected to dry cleaning of gases containing CO, and the need for complete combustion of tar contaminated gases, partly to obtain high quality microsilica. A semi-closed furnace may also facilitate the use of coal instead of coke. So far the scales have tipped in favour of semi-closed furnaces. The question is whether a more critical view on energy utilization might alter this situation.

Another challenge is connected to utilization of materials in manganese production. During smelting, large quantities of manganese are transferred to the waste gas, owing to the high vapour pressure of the metal. Since this production takes place in closed furnaces, where waste gas containing CO is cleaned in wet scrubbers, the sludge that is produced contains around 20% Mn, which has to be placed on special deposit sites. It has been estimated that this sludge from Norwegian plants amounts to between 5000 and 8000 tonnes of manganese per year. The sludge cannot be used because it contains heavy metals, especially zinc, and also alkalis and tars. So far, compared with the cost of depositing the sludge, it has not been found profitable to convert it into pure raw material. However, a greater effort to find a solution to this problem might be stimulated if it becomes more expensive to deposit the waste, e.g. if more stringent requirements were imposed for the deposit sites.

It is possible that recycling could be made more simple by dry-cleaning the gas from the manganese furnaces. The problem has been partly solved in experiments in Norway supported by the Norwegian Pollution Control Authority (SFT).

In principle, the same problem arises in ferrochrome production, but because the sludge contains only a small percentage of chrome, the recycling potential is very moderate and the economic gain correspondingly poor.

I do not intend to discuss the refining process in detail, but would like to point to the need for more dust-free casting and processing of the cast metal. In the case of ferrosilicon, granulation is a good solution to such problems, and could possible be used for other ferroalloys. Here lies a challenge.

Other challenges are the possibility of utilizing the waste, e.g. dust and low grade slag.

Energy and greenhouse gases

The greenhouse gases include CO_2 and various other gases, but here I shall limit the term to CO_2, which is the most important as far as the ferroalloys industry is concerned.

Fairly reliable figures are available both for natural and anthropogenic inputs of CO_2 to the environment, for the ability of the vegetation and the oceans to absorb CO_2 and for the increase in the concentration of CO_2 in the atmosphere. Anthropogenic emissions were estimated to 22 billion tonnes in 1990. The emissions are expected to increase by 50% towards the year 2010, as a result of economic growth and a higher world population. Even if the emissions are stabilized to the 1990 level, the CO_2 concentration in the atmosphere in the year 2010 will be twice as high as its pre-industrial level. IPCC, the International Panel on Climate Change, has estimated that, if the level of CO_2 in the atmosphere is to be stabilized at

1990 level, then the anthropogenic emissions will have to be reduced by 60% relative to the level today.

Emissions per capita vary between 20 tonnes in the USA, 8 tonnes in Norway and 0.6 tonnes in typical developing countries. The OECD countries currently account for 45% of the total emissions of CO_2. 70% of the increase from now until the year 2010 is expected to come from countries outside the OECD. This illustrates the difficulty in combining stabilization of emissions with a higher standard of living in the poor countries, with population growth, and with a wish to maintain the standard of living in the rich countries.

However, how much the global temperature will rise, how quickly this rise will occur, and the regional effects are matters of great uncertainty. IPCC's best estimate is that, unless new significant steps are taken to reduce emissions of greenhouse gases, the global average temperature will rise by 3° C by the year 2010. Scientists have different opinions about the effects, but a major problem is that the consequences of any actions we take today will be not be seen until 20-30 years from now. This means that we must be careful to apply the precautionary principle when planning what measures to take.

The UN Convention on Climate Change has now been ratified by more than 90 countries. The final goal is to stabilize the concentration of greenhouse gases at a level that will prevent harmful anthropogenic impacts on the climate system. The convention does not include any quantitative obligations, but the countries are committed to adopting national climate strategies and to take action in accordance with these. The industrialized countries must also report on strategies and actions. For the industrialized countries, the goal is to return to the 1990 level, either through individual or common measures. This has been defined as a specific target in several countries, including Norway. Some countries undergoing significant growth have not fixed any targets for their CO_2 emissions.

The instruments used to stabilize emissions vary. Most countries have focused on economizing on energy, often combined with voluntary agreements and different systems of subsidies. USA, the Netherlands and the United Kingdom have been pioneer countries as regards voluntary agreements. Many countries are also concentrating on renewable sources of energy and utilization of waste heat.

A few countries, including Norway, have preferred a tax on the carbon in fuels. Attempts to apply this as a common instrument in the EU have so far been unsuccessful. For competitive reasons, many countries are tending to postpone charging such a tax until other countries do the same. Most countries have introduced, or are planning to introduce, special arrangements for energy-intensive industry which competes on the world market. In Norway, for example, there is a temporary dispensation for coal and coke used as reduction agent. This dispensation is currently being re-assessed.

Another critical question is how large the carbon tax must be in order to stabilize the emissions. Calculations carried out by OECD indicate a tax ranging between 6 and 20 USD per tonne CO_2. The calculations show large regional differences. For heavy fuel oil the Norwegian tax, currently the highest in the world, is 20 USD per tonne CO_2. If the CO_2-

emissions are to be kept at 1990 level after the year 2010, the tax will have to be significantly increased.

So, what about the ferroalloy industry as generator of CO_2? One positive factor is that parts of the ferroalloy industry are based on hydropower, implying no emissions of CO_2 from the energy used for smelting, but only from the reduction agents.

Another important factor is the ferroalloy industry's flexibility - i.e. its ability to use charcoal as fuel to some extent. In this connection the profitability is largely associated with transport costs, and a future carbon tax could also change this situation. It is also well known that production of charcoal have other environmental impacts.

In a branch of industry where the profitability is marginal, a carbon tax could be regarded as very unreasonable if it does not also apply to the most important competitors. However, this is the environmental authorities' dilemma - if they wait until everyone feels justly treated, they would never be able to start taking the action that is needed.

For existing industry, an important part of the improvement potentials for reduction of CO_2 lies in reduced energy consumption and recycling. Technical solutions have been developed and put into operation at several plants. However, because much of the ferroalloy industry is located in regions where electricity has traditionally been cheap, energy recycling has not been very profitable. If the authorities take the climate situation seriously, what is profitable and what is not could easily change.

Emission standards

General

Let us take a closer look at the pollutants that are especially relevant for the ferroalloy industry, other than greenhouse gases.

The requirements will vary from country to country, but the future IPPC Directive, now being prepared by the EU, will probably stand as a sort of common denominator for the requirements imposed in the industrialized countries. IPPC stands for Integrated Pollution and Prevention Control, and the directive is a general directive regulating emissions from industry.

The Directive requires all polluting industry, including the metallurgical industry, to have a discharge permit. This requirement applies as from 30 June 2005 for existing industry.

The actual directive does not define emission standards; these are contained in supplementary directives. But it lays down some important conditions presented in fig. 4.

Some principles of the IPPC Directive

The consideration of applications for a discharge permit shall be integrated, so that all types of pollution (discharges to air and water, noise and waste) are considered collectively.

The discharge limits for the relevant components shall be based on BAT (Best Available Technology). In addition, the upper limit for the discharges must be set at a level that implies that the environmental quality standards or guidelines laid down by EU or WHO are complied with. If these environmental quality standards are complied with, larger discharges than would be achieved with BAT can be permitted in certain cases.

Fig. 4

In the same connection, EU is working on directives for environmental standards. For example, air quality goals will be made compulsory minimum standards for the whole of EU within 10-15 years.

Dust (particulates)

For many years, the usual emission limit for the ferroalloy industry has been 100 mg/m^3, because this fitted the cleaning plants of the time, and was also close to the visibility limit for emissions.

Gradually, however, as much better cleaning plants have been developed, and greater demands are being made for clean air, the limits have been changed. One of the reasons for doing this, is that particulates can carry adsorbed components such as SO_2 and PAH. The discharge permits for Norwegian ferrosilicon and silicon metal manufacturers will be renewed in 1995, and the new emission limit for particulates will certainly not be higher than 50 mg/m^3. In the case of ferrochrome manufacture, where the emissions are considered to be more toxic, the Norwegian air quality criterion is 25 mg/m^3.

In reality, emissions of particulates from furnaces and refining units are under good control in most places. The same applies to collection and scrubbing of waste gases. The most important remaining problem is diffuse emissions from casting and from processing of the cast metal. Owing to the high vapour pressure, manganese production is especially vulnerable, but greater pressure to solve these problems must be expected for other metals as well. It is a challenge to the industry to find production processes or cleaning technology that will make such an improvement possible without unreasonable investment. The pressure for improvement will be greatest in regions where the air quality criteria are exceeded or are close to being exceeded.

SO_2

Emissions of SO_2 are relevant mainly in the case of manufacturers that sinter ore or use slag-free smelting processes.

The air quality criteria for SO_2 are associated both with long-range transmitted acid rain or snow, and the local level of pollution. The ability of the natural environment to absorb acid precipitation is also relevant. Many industrial areas are currently exposed to too much SO_2.

International agreements have been signed for reductions of SO_2. Norway, for example, is committed to reducing the country's emissions of SO_2 to 34,000 tonnes by the end of the year 2000. This is a reduction of 76% relative to the emissions in 1980. Emissions from the ferroalloy industry amount to appr. 10,000 tonnes per year. Most Norwegian ferrosilicon and silicon metal manufacturers will have to renew their discharge permits this year, and in this connection a requirement for cleaning of the emissions, to remove SO_2, may be considered.

A few years ago, an estimate was made by the Norwegian ferroalloy producers of what the cleaning would cost. Most ferrosilicon plants are located near to the sea, making it possible to use sea water scrubbers. This is probably the cheapest cleaning process of all, and nor does it cause precipitation of solid substances that make it necessary to introduce other forms of cleaning. It has been estimated that investment in a sea water-based cleaning plant at the coast would cost 4 -5 million USD, providing that the existing filter plants could still be used. If not, the investment costs would be much higher, perhaps as much as 15 - 20 million USD. The annual operating and capital costs are estimated to 1 - 2 USD per kg SO_2.

An important question in such an estimate is whether the same effect can be achieved more cheaply in other areas.

NO_x

NO_x is another pollutant that has a considerable effect on local acidification. In addition, the reaction between NO_x and volatile organic compounds, e.g. methane, causes formation of ozone in the lower atmosphere (tropospheric ozone), which is also harmful to vegetation. In general, the industry's emissions of NO_x are relatively moderate. The emissions come mainly from combustion engines in cars and ships. Relatively few studies have been carried out on the ferroalloy industry's contribution to emissions of NO_x, but the measurements that have been made indicate that they are more or less equal to the emissions of SO_2. The relationship will be studied in more detail. In this connection, emissions both from furnaces and from converters are of interest.

Other air pollution

The manufacture of metals in contact with carbon and chlorine leads to formation of chloro-organic compounds, including dioxins and furanes. In Norway, few measurements have been made of dioxins emitted from metallurgical industry.

Relatively high emissions of dioxins have been demonstrated from sinter plants and pelletising plants for iron ore. Emissions of dioxins up to 3-10 ng/m^3 have been demonstrated at sinter plants for iron ore in Sweden, Germany and the Netherlands, and we do not know if such emissions are also generated during sintering of manganese and chromium ores. This will be investigated.

It has also been shown that manganese ore can be a source of emissions of mercury, and possible countermeasures are currently being considered.

We still know too little about micro pollutants, and the ferroalloy industry will be requested to make a more detailed investigation of what micro pollutants the industry discharges.

Discharges to water

Water pollution is especially relevant for closed furnaces, where water is used to clean the waste gases, i.e. during manganese and ferrochrome production. In this connection, satisfactory cleaning technology is available, and discharges of PAH and heavy metals have now been reduced to a very low level.

The most important remaining problem is leaching of pollutants from old, uncontrolled deposit sites for sludge, dust and other waste from production. Some countries have made a good start on estimating the problem and taking steps to clean-up the sites. Other ways of solving the problem are to seal the site or to move the deposits to another place where the seepage water can be collected and analyzed, and if necessary cleaned. In line with the principles for management of waste it should be relevant to consider whether some of the waste can gradually be recycled profitably, as it becomes more expensive to deposit it because of the stricter requirements imposed for deposit sites.

Environmental management systems

General

Many companies see both economic and market-related advantages in becoming more environmentally conscious and in lying a step ahead of the requirements imposed by the authorities. Therefore, on the initiative of industry and various public institutions, a number of programmes have been started with a view to systematic quality assurance in management and production, and through measures to discover and effect improvements.

The systems are to a large degree built up as quality assurance systems, but are angled towards use of resources, emissions and minimization of waste. We shall take a closer look at two of these systems.

ECO Management and Audit Scheme (EMAS)

EMAS is a voluntary environmental management and audit system that has now been introduced in the EU. Norway participates through the EEA cooperation. The idea is to establish a system whereby market forces are exploited to accelerate the efforts to protect the environment. Compliance with the requirements of the authorities is a basic criterion for participation, but the participating companies make sure that they lie ahead of these requirements.

The three fundamental principles of EMAS are shown in fig. 5.

The fundamental principles of EMAS

- The companies shall prepare and implement an environmental policy, environmental programmes and environmental management systems.
- The effect of these measures shall be assessed systematically, objectively and regularly.
- The general public shall be informed about the efforts to protect the environment.
  This information shall include:
  - A description of the company and its activities
  - An evaluation of important environmental problems
  - Numerical overview of use of raw materials and energy, and of emissions and quantities of waste.
  - A summary of the environmental policy, the environmental programme and the environmental management system.

Fig. 5

Norway was the first country to establish a public register of companies that comply with EMAS's environmental requirements. The Norwegian authorities will authorize environmental auditors, who will verify that the individual company is complying with defined environmental requirements, and approve the company. The environmental reports will be available to customers and suppliers, just like other official documents. The system will help to improve the competitiveness of the companies that are registered. The environmental approval can be used when advertising the company, but not when advertising its products.

In the industrialized countries, company managers are showing increasing concern for the environment, but we still find examples of uncritical use of an environmental profile in connection with marketing. EMAS will help to make sure that theory is put into practice.

The most important elements of EMAS are shown in fig. 6.

The elements of EMAS

- Status of, and measures to counteract, pollution
- Energy management and energy economizing
- Raw materials
- Reduction, re-use and disposal of waste
- Noise-abatement
- Optimization of production processes
- Product development
- Conditions at suppliers
- Prevention of environmental accidents
- Preparedness to meet environmental accidents
- Education/training and information

Fig. 6

Industry's environmental efforts should be based on international standards. We already have BS 7750, and in the future ISO 14000 on environment and environmental management will be an important tool in this connection, just like ISO 9000 has been for quality assurance.

The Norwegian system of internal control

Norway was the first country to make it obligatory for industrial companies to introduce a system of internal control. The system is based on more or less the same principles as EMAS. It places the emphasis on elements presented in fig.7:

The Norwegian system of internal control

- Environmental goals and plans of action
- An overview of the organisation and division of responsibility
- An overview of relevant laws and regulations
- Internal procedures
- Non-conformances and corrective actions
- Documentation
- Internal system audits

Fig. 7

The system has been found to function well. The gradual introduction of compulsory and voluntary systems by the different companies is expected to alter the type of public follow-up and control. The supervision will become more goal-oriented, with the emphasis on verification.

Life cycle analyses (LCA)

Life cycle analyses are becoming a useful aid during industry's development of products and processes. The benefits of LCA are mentioned in fig. 8.

Benefits of LCA

- Documentation of the environmental impacts of the product system
- Comparison of different products and processes in an environmental context. This may be useful in product development, when choosing process or supplier, and when deciding the site of the industry.
- Identification of problem areas in order to direct the efforts to protect the environment

Fig. 8

So far, the analyses have been used for existing products, and to compare a company's own products with competitive products on the market. Changing the assumptions also changes the conclusion, so one of the problems so far has been that the client usually gets the answer he wants. Another problem is what weight to give to the various types of environmental problems in relation to each other.

To reduce these weaknesses, a common Nordic manual is being prepared for life cycle analyses, and this will be followed by international standards.

Cleaner Technology Programmes

One way of systematically reviewing the company's potential to reduce the amounts of waste and of discharges to air and water is to undertake clean production assessments. These assessments often draw attention to simple things that receive insufficient priority in day-to-day operations. The method is being used in many countries, with good results. The analyses often point to measures that can be introduced quickly, with only small investments. In Norway the method has been introduced in almost 400 companies, with financial support from the authorities. Many of the measures are economically profitable.

Conclusions

Companies that show an active attitude towards environmental problems will be the winners in today's and tomorrow's marketplace.

In principle, companies have two options. They can either choose a minimum strategy, where they merely adjust to the requirements imposed by the authorities, or they can choose to adopt an active attitude, where the environmental problems are turned into potentials for the company. In many cases it is economically profitable to "think environment", because saved resources mean saved costs, and also because the market is starting to demand environmentally friendly products. Moreover, taxes will be directed to an increasing degree at pollution and disturbance of the environment, and use of resources.

The environmental goals cannot be realized unless everyone takes their responsibility for the environment seriously. Although the authorities can help, it is industry itself that must do the job. A lot depends on attitudes, awareness, knowledge and a will to act. It is you who can catch hold of the problems, and find new and creative solutions.