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FERTILIZER MANUFACTURE AND EEC ENVIRONMENTAL ACTIVITIES

G. BIBERACHER - BASF, Germany F.R. ; F.V. SAMEC - SCGP, France ;
K.D. SHAH - ICI, United Kingdom.

Summary

The European Fertilizer Industry is showing its concern for the environment in various ways. With respect to manufacturing environment, EEC action programmes and regulatory activities, three examples of EFMA action are given.

Within the frame of directive 84 360 (air pollution of industrial plants) EFMA contributed to the Best Available Technology (BAT) project studies regarding new ammonia and nitric acid plants. Pollution limitation proposals have been made : 200-450 mg/m^3 as NO_2 for NOx for ammonia primary reformers and 411 mg/m^3 as NO_2 for NOx in the case of tail gas effluent of nitric acid plants.

EFMA is involved heavily in a study now underway on water pollution of fertilizer manufacturing facilities. This study is being carried out by a consulting company for the Directorate General XI (Environment).

Cadmium "pollution problems" due to phosphate fertilizers have been the object of different studies showing the low relative (10 %) contribution of fertilizers to the overall cadmium pollution. These studies point out that phosphate fertilizers bring, on the average, only 1 microgramme of cadmium per year to 1 kg of european agricultural topsoil and that approximately 500 years would be needed to double the amounts now present. Also noted is lack of ecotoxicological and epidemiological studies.

I INTRODUCTION

This year it is the 20th anniversary of Earth Day and some are already calling the coming nineties the Decade of the Environment. To our industry this means additional challenges ; we are not only concerned with producing the best possible products to maintain and enhance agricultural output on a global basis, but also with growing emphasis for the protection of the environment in relation to effective manufacturing processes and application of fertilizers.

The European Economic Community, EEC, was formed in 1957 by the Treaty of Rome as an economic union with emphasis on free trade. Over the last two decades, the activities of the EEC have considerably extended into the fields of safety, environment and community welfare. Also the organisation of the EEC has expanded significantly. Figure 1 shows how the main Institutions are linked. The responsibility for making proposals for legislation lies with the Commission. Reporting to the Commission, so called Directorates General, are responsible for various domains like Industry (DG III), Agriculture (DG VI), Environment (DG XI). Proposal details are worked out by special committees and service departments at the Commission, with appropriate consultations with industry. A proposal, after adoption by the Commission, is passed on to the European Council and in turn to the European Parliament. Once a Directive has been adopted by the Council, Member States have to implement it through national legislation within a specified period.

Although the Treaty of Rome made no reference to the environment, a number of Directives have been adopted in the last 10-15 years aimed at solving the pollution problems. Many of these Directives are of a general type, ie not specific to any particular group of products or industry. In broad terms their purpose has been to legislate, to produce action plans, to initiate studies which would provide data for taking appropriate future action or to take appropriate precautionary measures. Those which have bearing on the fertilizer industry, are summarised in table 1 but this list is by no means complete.

The Single European Act passed in 1987 includes a provision on the environment. It stipulates a number of objectives, which include preservation, protection and improvement of the quality of the environment.

It is a general trend in policy making to take into account consumer demand for environmentally safe products. This in general is coupled with a policy of increasing the liability of producers for the "damaging" effect of their products.

This paper deals with three selected EEC activities which relate to the manufacture of fertilizers. It does not deal with those which relate to the use of fertilizers although such pending environmental legislation will have significant impact on the application of fertilizers, and consequently cause difficulties for the fertilizer manufacturing industry. Topics discussed below include product impact on soil and manufacture, impact on air and water.

II THE BAT-PROJECT OF THE EEC

Background

The abbreviation BAT means Best Available Technology, in the context of the EEC. More precisely it is called Best Available Technology Not Entailing Excessive Cost (BATNEEC). This project has been aimed at air pollution problems from industrial processes and suitable measures for their prevention or reduction. It takes its roots mainly in the Action Programme spelled out in 1983. The most important directive is EEC Directive 84/360 which lays down requirements for prior authorisation for a wide range of industrial processes in order to achieve BAT standards. Member states are directed to exchange information concerning best technical processes and equipment so that steps can be taken to ensure a harmonious implementation of the Directive in all Member States. Applications for authorisation will be deemed to meet BAT criterion if the performance of the proposed plant, in terms of emissions to the atmosphere, is guaranteed to be equivalent or better than that of the designated BAT.

In 1988 the Commission took the initiative in this respect by establishing working groups of experts to designate BAT pertaining to the following manufacturing processes :

Ammonia
Nitric Acid
Sulfuric Acid
Cement
Benzene in Refineries and Coking Plants
Garbage Incineration
Selected Heavy Metals

The first two items reflect the high priority given to the fertilizer industry by the EEC.

Members States sent delegates to these groups and a number of EFMA experts took part in the studies, alongside government experts. Independent institutes (CITEPA of France, ENVICON of Germany, ERL of UK) took care of coordination and preparation of the final Technical Notes for submission to the DG XI by early 1990.

It appears logical that an extension of this approach to other technologies may follow and the EEC will probably decide upon this in near future.

The Scope of the Studies

General Aspects

The format of the studies follows more or less a similar pattern. In a Part A, General Aspects are handled. The chapter "Introduction" comprises remarks on the importance of the product in the EEC, definition of processes to be included, justification for exemptions etc. In addition, hint on capacities and comment on typical emission may be given. Of a special interest may be the contribution of pollutants to the total EEC-wide emissions.

Another chapter, "Legal Provisions of Member States for Authorisation", describes the existing national regulations. These show a wide variation from country to country and therefore a harmonisation appears reasonable.

The next chapter gives an account of processes and installations including ancillary equipment, starting materials, features of various processing routes, storage and handling of final products. This chapter in part A covering the existing processes can be a relatively comprehensive one, since a number of routes to ammonia and particularly nitric acid, using quite different technologies, are in existence.

The final chapters in Part A dealing whith the actual situation describe the nature of pollutants emitted by all process steps. This includes actual emission limit values as far as required in the member countries.

Best Available Technology

The part B of the studies starts also with a brief introductory chapter, followed by other chapters on BAT for various routes. The description of steam reforming and partial oxidation processes in the ammonia paper covers in detail various stages, emphasizing all measures to minimise pollution.

The nitric acid study has got a different orientation since the consideration of modern technologies has been carried out already in Part A : in Part B a summarised account is given on actions in the upstream process to improve the exhaust gas quality. However, the important abatement techniques downstream, on the exhaust gases, are described in more detail.

The chapter on the storage and handling takes into account the fact that, ammonia and nitric acid, are regarded as dangerous substances in EEC legislation on chemicals and also in international transport codes. The relevant comments on ammonia are longer than those of the nitric acid study reflecting the more hazardous nature of ammonia.

Two more points of consideration relate to plant performance and emissions under transient conditions (start up, break down etc.) or cross media aspects of the pollutants (example : technique for removal of gaseous pollutant which creates solid or liquid waste).

In a separate chapter, monitoring techniques as well as sampling and statistical treatment of the results are discussed.

Demands upon Emissions

The studies end with important comments on emission values in compliance with BAT. Since these values may become specified standards at least for new plants in the future, this part is of great interest, particularly to the industry.

The ammonia paper specifies the following figures for steam reforming plants :

Primary Reformer :

NOx (calculated as NO_2)	200-450 mg/m^3 (related to 3 % O_2)
SO_2	0,1 - 2 mg/m^3
CO	< 10 mg/m^3

Some indications on minor emissions, including diffuse and non continuous ones, are given.

Partial oxidation processes in Europe are sparse. The major emissions occur in the auxiliary boiler and in the steam superheater. The emission values in the latter are like those from the primary reformer above. The pollutants released from the auxiliary boiler have got higher concentrations.

The nitric acid paper refers to the main pollutant NOx. For new plants and normal operation the proposed emission value is :

200 ppmV NOx (corresponding to 411 mg/m^3, expressed as NO_2)

For transient conditions, a general limit cannot be proposed.It depends on the details in plant design and performance. With respect to the revamping of existing plants, examples are given for requirements on emissions in various countries. These have been set in a range of 220 ppm (D) up to 1 000 ppm (UK). Attention is also paid to the colour of the plume. The study recommends that it should be "substantially colourless" since, in terms of physics, absolutely colourless is not possible.

The above values for new plants have been judged to not entail excessive cost when the plant is designed according to the technique as described in the studies.

III STUDY ON WATER POLLUTION

As the BATNEEC programme of studies dealing with air pollution was coming to an end, a start was made on a new initiative to study the water pollution problem. In the second quarter of 1989, the Commission of the European Communities, through the Directorate General Environment (DG XI), commissioned BKH Consulting Engineers, a Dutch company, to carry out a study on water pollution caused by the fertilizer industry and other industries causing nutrient discharges. In the industrial sectors, the study is covering:

1) production of phosphate fertilizers (super phosphates, phosphoric acid),

2) production of nitrogen fertilizers (excluding nitrogen, hydrogen and ammonia production),

3) production and/or formulation of compound fertilizers (NPK) and,

4) production of phosphate-containing detergents.

The study is required to give a descriptive analysis of the following aspects of each of the above sectors in the EEC Member States ;

- location and products of factories,

- production processes and quantities, pollution loads and environmental impacts,

- existing measures to prevent or reduce waste water discharges and waste water treatment systems,

- standards for effluent discharge and surface water quality,

- required measures to reach these standards,

- costs of these measures.

The pollutants to be covered by the study include N (in ammoniacal and nitrate forms) and P_2O_5 as the nutrients and other related chemicals such as F, Cd, gypsum and other solids. EFMA, through its Technical Committee, had discussions with BKH Consulting Engineers on this issue and has agreed to assist BKH by doing a survey and gathering data from its members on the pollution aspects. Care is being taken with the collecting and presentation of the data to take account of recent or imminent plant closures on overall discharges. However, as the industry is getting more and more streamlined with inevitable further plant closures, it is quite likely that the pollution figures may represent an overestimation. On the other hand however, since our survey is based on EFMA members only, the resulting figures will slightly underestimate the real discharges due to non inclusion of small manufacturers who are not members of the EFMA organisation.

BKH expect to complete the study towards the end of this year or beginning of 1991.

IV THE TECHNICAL ASPECTS OF CADMIUM IN FERTILIZERS

Cadmium is a widely spread element, at comparatively low levels of concentration, and does not seem to have special physiological properties like copper or zinc which would make it indispensable to human life. On the other hand it has been linked to some physiological disorders.

Due to the assumption that such a ubiquitous element would migrate to humans and possibly have some noxious effects, this member of the so called "heavy metals" family has been included in black list substances for possible future controls. In april 87, the Commission presented a Cadmium Action Programme which has been translated by the Council into a resolution to "combat environmental pollution by cadmium". This means cadmium from all sources.

It is well known that cadmium is present in commercially available rock phosphates in varying amounts, ranging from negligible level in Kola apatite to 80-90 ppm in some African phosphates. Even higher concentrations have been found in rocks from Idaho (U.S.A.), and elsewhere. Thus fertilizer, manufactured by present processes from these rock phosphates, will inevitably contain cadmium.

From the onset of the Cadmium Action Programme, we knew that fertilizers would be involved in one way or another. So EFMA action has centered on obtaining reliable data on cadmium pathways and balances in fertilizer processing. The task of the Environmental Subcommittee of the Technical Committee of EFMA has been to gather information on the quantities of cadmium involved and on possible industrial counter measures.

The enclosed table 2 shows that the total amount of cadmium brought into EEC agricultural topsoil through fertilizers was about 266 tonnes/year. This is equivalent to about 1 microgramme per kg of topsoil per year based on the estimated fertilizable area of 106 millions ha. The current mean amount already present in soil is 0.5 milligramme/kg. A simple calculation will show that, on mean basis, it would take about 500 years to double the amount of cadmium now present in soil assuming no other movement of cadmium is taking place. For specific cases, the type of rock used and therefore its cadmium level and the type of fertilizer (high or low phosphate) applied, would affect this period.

Even though these figures seem to give plenty of time before any action might be needed, it would be prudent, and also there is political pressure, to look for ways of controlling cadmium in fertilizers. So, an extensive search has been carried out to see what methods, if any, were available.

Use of phosphate rock with low cadmium content is the obvious option which has been taken up by a number of manufacturers, supplying fertilizers in countries like Austria, Danemark or Finland which have already implemented statutory national limit values while others like Norway or Germany are considering proposals.

Consequently there have been some slight changes in phosphate rock supply patterns. it is clear however that this trend towards buying of low cadmium phosphate rock cannot go on indefinitely because supply is restricted to well known but scarce limited sources.

The alternative is to remove cadmium and there are two possible options for this : either a treatment of the rock phosphate itself, or a treatment of the phosphoric acid. The state of art today is such that no industrial process can remove all cadmium from any source, be it rock or acid. Rock calcination works partly on certain types of rock and was used for Nauru rock. As for phosphoric acid, there is still no process in use at the industrial scale, although most of the research and pilot plant work has been devoted to this route. We know that some companies are still actively working in this difficult area in order to find a way around the stumbling block of economics. In addition to these individual industrial efforts, EEC funding has been made available for research, for instance in the case of TOGO.

In order to estimate the relative impact of the phosphoric acid treatment route, EFMA has run an EEC wide study on the amounts of finished phosphate fertilizer used going through the stage of phosphoric acid processing (see table 3). In short, a process extracting cadmium from phosphoric acid would achieve approximately a 27% lowering of cadmium going into European soils if used for home production in Europe. A 44% lowering may be possible if all phosphoric acid, including imported, is subjected to extraction. A 68% reduction can be achieved only if, in addition to the above, all imported TSP and DAP are treated. This would be about the same result as that achieved by a rock phosphate treatment carried out at the mine or before processing into fertilizer. The rock treatment route offers nevertheless the advantage that various phosphoric acid and phosphate manufacturing processes, which are now operating in Europe, could continue to function as at present, avoiding complicated process modifications.

All this has been dealt with in various EFMA position papers which have been forwarded to EEC officials. The interesting point here is that EEC, in order to gain its own knowledge, has commissioned various studies by independent consultants,notably Environmental Resources Limited of London (ERL). Their findings show no discrepancies with ours and point to the fact that fertilizer industry is not a main contributor to overall cadmium pollution : less than 10 % of the total as can be seen from table 4. Furthermore, two main points have still not been fully addressed

First, what is the real impact of cadmium present in soil on the human food chain and ultimately on human health? Plants do not have the same cadmium uptake ; also depending on soil pH and organic matter, cadmium uptake by a given plant species varies in great proportions. Furthermore, eating and other habits, may greatly vary the exposure of man to this element.

The second point is that there have been very few, if any, thorough epidemiological studies regarding human toxicity. Some animal studies have been carried out and more are now underway. The results may affect the classification of cadmium in terms of carcinogeneity.

Despite the above uncertainties and the assessment that fertilizers are not a major contributor of cadmium pollution, some countries in Europe have started imposing limits on the cadmium content in fertilizers as precautionary measures.

CONCLUDING REMARKS

Clearly much work is going on in the EEC to combat environmental pollution from various sources including the fertilizer industry. In order to arrive at sound, sensible, practival and cost-effective control measures, reliable data and technical expertise are needed. The organisation of EFMA has been and is cooperating within the EEC and other bodies appointed by it, to help achieve these objectives.

TABLE I

E.E.C. ACTION RELATING TO POLLUTION AND FERTILIZER INDUSTRY

Directive	TITLES	DATE	OBJECTIVES
75-437 75-438	Decisions concerning the convention for the Prevention of marine pollution from land based sources	03.03.75	Community ratification and representation on the Paris Convention
76-464	Directive on pollution by certain dangerous substances discharged into the aquatic environment of EEC	04.05.76	System of authorization for discharge to water. Limit values for List I Quality objectivies for List II
	Resolution concerning the combating water pollution	07.02.83	Establish action priorities for implantation of directive 76-464
86 (280)	Amendment to List I of directive 76-464	12.02.86	
80-68	Directive on the protection of groundwater against pollution by certain dangerous substances	17.12.79	Prevent discharges of List I and restict those of List II substances. Inventory of discharge authorization
83-514	Directive on limit values and quality objectives for Cadmium discharges	26.09.83	Application of 76-464 to Cadmium
84-360	Directive on combating air pollution from industrial plants	28.06.84	BATNEEC. Measures and procedures to prevent and reduce air pollution
85-203	Directive on air quality standards for nitrogen dioxide	07.03.85	Limit and quide values for nitrogen dioxide
87-165	Communication on action programme of environmental pollution by cadmium	21.04.87	

TABLE II

CADMIUM IN EUROPEAN FERTILIZERS

COUNTRY	FERTILIZABLE AREA mio ha (*)	P2O5 Consumption (*) 1.000 T/Y			CADMIUM from fert. total T/Y			
		85	86	87	85	86	87	Mean
Belgium	1,45	93,6	91,0	113,0	2,70	2,70	3,30	2,90
Danemark	2,82	109,2	105,6	107,1	4,51	4,55	4,62	4,56
France	28,90	1521	1378	1402	88,0	92,0	74,00	84,67
Germany	12,00	732,0	736,0	683,4	30,50	28,60	24,60	27,90
Greece	3,50	190,5	173,0	163,9	13,40	13,00	12,30	12,90
Holland	2,01	86,1	81,8	90,8	5,07	4,81	5,35	5,08
Ireland	4,85	151,3	133,2	149,6	12,70	11,72	12,60	12,34
Italy	15,00	721,0	761,0	759,0	40,70	42,40	38,80	40,63
Luxembourg	0,05							
Portugal	3,40	61,4	69,6	78,9	8,10	9,05	10,26	9,14
Spain	20,40	424,7	469,8	519,0	33,00	36,47	35,25	34,91
United Kingdom	12,10	469,0	434,0	432,0	32,83	30,38	30,34	31,18
Total E.E.C.	106,48	4560	4433	4499	271,5	275,7	251,4	266,2
Austria	2,66	95,0	90,4	72,1	3,69	3,52	2,80	3,34
Finland	2,26	160,1	160,5	154,3	3,50	1,42	1,00	1,97
Iceland	0,01	7,5	7,0	6,5				
Norway	0,97	56,8	52,1	50,0	1,30	2,00	1,20	1,50
Sweden	2,90	101,3	85,3	78,9	3,19	3,24	2,76	3,06
Switzerland	1,05	43,9	41,8	39,0	1,71	1,63	1,52	1,62
Total (Others)	9,85	464,6	437,1	400,8	13,39	11,81	9,28	11,49
TOTAL	116,33	5024	4870	4900	284,9	287,5	260,7	277,7

* IFA Statistics

TABLE III

CADMIUM REMOVAL SCHEMES
AND
RELATED E.E.C. SOIL IMPUT

Removal of cadmium from listed sources	Expected removal cadmium tonange	Degree of lowering in EEC Cd soil imput
1) Merchant grade phosphoric acid (54 % P205) imports	45	17 %
2) Raw phosphoric acid (30 % P205) domestic	72	27 %
3) Two above combined	117	44 %
4) All phosphoric acid routes domestic and foreign DAP + TSP included	181	68 %
5) Raw phosphate if 90 % efficiency	240	90 %

TABLE IV

MAIN CADMIUM SOURCES
TO THE E.E.C. ENVIRONMENT (1)

Activity	Amount T/year
Natural processes	15
Non ferrous concentrate mining	?
Coal combustion	177
Oil refining and combustion	28
Iron and steel production	386
Copper refining	20
Lead refining	34
Zinc refining	343
Battery manufacture	39
Electroplating manufacture	86
Pigment manufacture	21
Stabilizer manufacture	12
Alloy manufacture	1
Cement manufacture	268
Fertilizer manufacture	126
Alloy use & disposal	?
Battery use & disposal	444
Electroplated products use & disposal	?
Fertilizer use	263
Pigment use & disposal	1061
Stabilizer use & disposal	487
Sewage sludge disposal	121
Solid waste disposal	1053

(1) ERL Report "Evaluation of the Sources of Human and Environmental Contamination by Cadmium".

FIGURE I

E.E.C. INSTITUTIONS