Chapter 1

INTRODUCTION

Development of the fertiliser industry is very important to improve agricultural productivity and enhance food production to feed the increasing population. Growth of fertiliser industry, however, causes serious environmental problems. Environmental considerations, therefore, assume importance in respect of fertiliser and several other industries.

The process involved in the production of fertilisers generates effluents and the emissions contribute to environmental degradation such as greenhouse effect, stratospheric ozone depletion, acid rain and acidification, eutrophication, soil degradation, technological hazards, chemical mists etc., with potential damage to human race. Thus, on the one hand we have the dire necessity to increase fertiliser production for maintaining food security while on the other hand the consequential environmental issues are to be tackled effectively to avoid damages. Environmental management assumes paramount importance in this perspective to address the numerous issues relating to pollution control, safety etc., and to minimize the degradation of the environment on account of developmental activities.

Objectives of the Study

The objectives of this study are:

1. to identify key issues in environmental protection in the production of fertilisers,
2. to assess the extent to which the national and international norms/guidelines regarding pollution control and environmental management in fertiliser plants are implemented in the fertiliser industry in India,

3. to identify the reasons for the non-compliance, if any, to those norms and guidelines by the fertiliser firms in India,

4. to understand the problems encountered in Environmental Management in Indian fertiliser plants, and

5. to suggest, on the basis of the above, guidelines for an environmental policy that will foster development of fertiliser industry in the country without degrading the environment.

**Importance of the Study**

The growth of the fertiliser industry in the country all these years has been guided by the necessity of increasing production. This has led to serious environmental degradation of water resources, soil and air around these plants. Worldwide the focus of pollution control in the chemical industry has shifted from end of pipe treatment to avoiding pollution, clean technology and sustainable development. Hence, there is a necessity that environmental considerations shall play a substantive role in the future development of the industry. Despite the importance and urgency of the problem, no comprehensive work has so far been done in India on the whole issue with a view to develop a national level policy guidelines for the industry from the environmental angle. This study is an attempt to fill up the above gap by addressing the issues from the engineering and management angles.
Scope and Methodology

This study has been confined to the large scale sector of the Indian fertiliser industry.

The core of the study is based on detailed primary data collected from a representative sample of the fertiliser firms.

There are 29 major fertiliser manufacturing firms in India, of which 10 are in the public sector, 17 in the private sector and 2 in the co-operative sector. Twelve firms produce both nitrogenous and phosphatic fertilisers, 12 produce only nitrogenous fertilisers and 5 only phosphatic fertilisers. These firms have 72 operating plants in total, of which 54 are nitrogenous and 18 phosphatic plants. The entire requirement for potassium is met by imports.

Of the 54 nitrogenous and 18 phosphatic fertiliser plants, a sample of 15 plants from six firms has been taken for the detailed study based on vintage and technology, the most important factor with regard to pollution control and environmental management. The firms selected are Rashtriya Chemicals and Fertilisers Ltd., Mumbai; Fertilisers And Chemicals Travancore Ltd., Cochin; and Madras Fertilisers Ltd., Chennai from the public sector; Indo Gulf Fertiliser Corporation Ltd., Jagadishpur and Tata Chemicals Ltd., Babrala, from the private sector and Krishak Bharati Co-operative Ltd., Hazira, from the co-operative sector.

The Best Available Techniques (BAT) of European Fertiliser Manufacturers’ Association (EFMA) is used for comparing the environmental performance of Indian plants under study.
Primary data pertaining to the study was collected from the sample using a questionnaire and through personal discussions with the concerned executives. A series of discussions and interviews on the various issues under study were conducted among a group of experienced people from different plants coming under Indian fertiliser industry. The viewpoints on relevant environmental issues from industry operators abroad and practicing professionals in fertiliser sector are obtained through an opinion poll using a specially designed questionnaire. The sources of secondary data were journals, publications on safety and environmental issues, information available from manufacturing companies through print versions or on the web, seminar presentations and such documentations, industry association databases and so on.

Literature Survey

There have been some studies on certain environmental aspects of fertiliser production as noted below. The ‘Fertiliser Manual’ published by United Nations Development Programme (UNDP), 1980 and later revised and updated in 1998, trace the history of fertilisers, major fertiliser processes and contain a chapter on Pollution Control and Environmental Factors highlighting the effluents and emissions from these units and discuss the trends in pollution control approaches being adopted.

The ‘Fertiliser Handbook’ published by The Fertiliser Institute (USA, 1982) intended to underscore the importance of fertilisers, its manufacture and cover the environmental aspects in general.

*Technology and Manufacture of Ammonia* by Samuel Strelzoff examines practically every unit operation of ammonia production from various feedstock and
contains necessary information, data and methodology for optimised design and operation of large capacity plants.

*Catalyst Handbook* edited by Martyn V. Twigg contains details about the various catalysts employed in ammonia manufacturing and contained useful information on catalyst development and manufacture, plant design and operation. Conversion and yield heavily depend on the efficiency of the catalytic reactions and it also help to proceed intended reactions to completion and avoid unwanted side reactions contributing to environmental problems.

Three great works on *Ammonia, Nitric Acid, Phosphoric Acid* edited by A.V. Slack provide first hand theoretical and practical information relating to development of technologies for these plants, various process designs currently available, thermodynamic implications, design details and challenges being confronted in operating plants and point to the directions in which new developments are likely to take place.

*Fertiliser Manufacture* by M.E. Pozin presents a detailed account of the various nitrogenous and phosphatic fertilisers commonly in use, their processes of production, environmental impacts and mechanisms adopted in plants for control.

*Phosphates and Phosphoric Acid, Raw Materials, Technology, and Economics of the Wet Process* by P. Becker gives a vivid account of the technology, process and environmental impacts of phosphoric acid production.

*Pollution Control in Fertiliser Production* edited by Charles A. Hodge, Neculai N. Popovici addresses nearly every aspect of pollution control of chemical fertiliser industry—covering current and emerging technologies for raw materials
production, end products, and by-products. The book also explores the most advanced techniques for reducing noxious emissions in the environment and reviews the technologies needed to renovate existing facilities and methods for converting effluents and by-products to useful products.

*Handbook of Pollution Control Processes* edited by Robert Noyes is a concise but thorough overview of state-of-the-art technology for pollution control processes and highlight appropriate technology for decontamination and destruction of pollutants.

*Manufacture of Sulfuric Acid* by Werner W. Duecker and James R. West gives a detailed description of the process and technology involved in the manufacture and the environmental management of plants producing sulphuric acid.

*Air Pollution* by Arthur C. Stern is an excellent treatise on the various sources of air pollution, its mitigation and control. The book also contains various models of dispersion of pollutants in air and suggest design criteria and considerations for plants for effective containment of air pollution.

The European Fertiliser Manufacturers' Association (EFMA), Belgium, in response to the European Union directive on integrated pollution prevention and control, has brought out 8 booklets on *Best Available Techniques (BAT)* covering the processes for production of ammonia, nitric acid, sulphuric acid, phosphoric acid, urea and urea ammonium nitrate, ammonium nitrate and calcium ammonium nitrate and NPK compounded fertilisers by the mixed acid and nitro phosphate routes. These booklets contain industry perceptions and standard practices necessary to operate plants efficiently and safely.
Natural Capitalism: Creating the Next Industrial Revolution by Paul Hawken, Amory Lovins, L. and Hunter Lovins proposes a new approach for environmental management of our production systems by which natural resources could be made more productive and at the same time environmental concerns are minimized yielding benefits both for today's stakeholders as well as future generations and has a particular relevance to the fertiliser industry.

Major Hazard Control: A Practical Manual, published by the International Labour Organization, Geneva, contains techniques and methodologies for assessment and control of industrial hazards. It also outlines procedures for inspection hazardous installations, accident investigation, site selection etc.

The Mond Index, published by Imperial Chemical Industries PLC, UK, provides explanation and examples of a set of procedures developed for rapid hazard assessment of chemical process plants.

The Fire and Explosion Index-Hazard Classification Guide published by The Dow Chemical Co., UK, is a useful guide for assessing the damage potential of any operation in which flammable, combustible or reactive material is stored, handled or processed.

The Central Labour Institute, India has brought out a publication, Guidelines on Inspection of Major Accident Hazard Installations, to guide inspectors of factories in carrying out inspection of major accident hazard installations, emphasising methods for identifying areas in the plant that can give rise to a serious accident and risk to safety of personnel both onsite and offsite.
Loss Prevention in the Process Industries by Frank P. Lees is a versatile work in three volumes covering hazard and risk analysis in the process industries in its entirety and suggest numerous methods risk mitigation and containment within acceptable limits for safe operation of plants.

The Chemical Manufacturers’ Association, USA, has published Process Safety Management—Control of Acute Hazards with a view to review and evaluate the systematic approaches to process safety analysis and help members select process safety methods which are most beneficial to their particular circumstances and develop more effective steps.

The Risk Analysis in Process Industries published by the Institution of Chemical Engineers (IChemE), UK contains methods for quantified risk analysis for promotion of safety in chemical process industries. The above book is the outcome of an international study group set up by the European Federation of Chemical Engineering in 1980.

Technical guidance for Hazard Analysis and Hazardous Materials Emergency Planning Guide are two important documents published by the US Environmental Protection Agency (EPA) contain techniques and methodologies for hazard analysis and contingency planning for mitigation of the harmful impacts of accidental releases etc., for planners.

Major Industrial Hazards—their Appraisal and Control by John Withers, is a planners guide intended for practitioners in the industry and for regulatory authorities. The book provides an introductory appreciation of the key elements, which need to be taken into account while attempting risk assessment of major installations.
Environmental Engineers' Hand Book by Bela G. Liptak, and F.N. David Liu in three volumes is a complete source book for designing pollution control and environmental management systems for all kinds of chemical plants and processes.


Environmental Management, Law and Administration by Paras Diwan and Parag Diwan is a comprehensive work on the legal implications of the various facets of environmental law, administration and issues pertaining to environmental management.

The Report of the International Study Group on Risk Analysis, published by the Institution of Chemical Engineers, UK (1985) reviews the techniques employed when carrying out risk analysis for the promotion of safety in process industries for useful application in fertiliser industries.

A World Bank technical paper Techniques for Assessing Industrial Hazards, developed by Technica Ltd., UK, provide guidelines for identifying potential hazards of new and existing plants or processes in chemical and energy industries and for assessment of the consequence of the release of toxic flammable and explosive materials to the atmosphere. Most of the fertiliser raw materials are petroleum products that are highly inflammable and storage and handling of these products carry a high-risk potential.
The International Fertiliser Development Centre (IFDC), Alabama, USA, along with European Fertiliser Manufacturers Association (EFMA), the International Fertiliser Industry Association (IFA), The Fertiliser Institute (TFI), the United Nations Environment Programme (UNEP) and the United Nations Industrial Development Organization (UNIDO) has organized a series of workshops to examine the impact of fertiliser production and use on the environment, which include:

1. Environmental Impact of Ammonia and Urea Production Units (India, 1991)
2. Phosphate Fertilisers and the Environment (USA, 1992)
3. Nitric Acid Based Fertilisers and the Environment (Belgium, 1993)
4. Environmental Challenges of Fertiliser Production—an Examination of Progress and Pitfalls (USA, 1997) and

These workshops, in view of the significant progress that has been made in achieving an increased level of environmental stewardship within the fertiliser industry and the special dynamics of the industry discussed the issues encountered in responding to existing and emerging environmental challenges among a wide representation of fertiliser manufacturers, engineering and scientific community, managers and policy planners and evolved remedies for the problems confronted in large-scale production processes.

The UNEP technical report on *Mineral Fertiliser Production and the Environment* (1998) provided guidelines on how environmental objectives might be
achieved in the production of fertilisers by means of integrated industrial and environmental policies.

An inter-regional meeting on safety in the design and operation of ammonia plants under the joint auspices of United Nations Industrial Development Organization (UNIDO) and the Fertiliser Association of India (FAI) was also organized in India during 1976.

The Fertiliser Association of India (FAI) organized a group discussion on 'Emergency Preparedness and Disaster Management in Fertiliser Industry' (1995) to create overall awareness on the risk emanating from fertiliser plants and improve the state of preparedness to deal with emergency situations.

An Innovative High Risk/High Priority Anhydrous Ammonia Study: Tampa Bay (1995) was organized by the US Environment Protection Agency to enquire into the safety of ammonia installations catering to fertiliser plants in the Florida coast.

FAI has developed and published a comprehensive Safety Manual (1996) for fertiliser plants in India.

'Environmental Management' a noted work by G.N. Pandey which covers pollution control in fertiliser industry also is intended to educate planners as well as executives working in the industry especially for developing a feel for the necessity of integrating environmental protection with development for balanced environmental management.

Reliability and Risk Assessment by J.D. Andrews and T.R. Moss gives a comprehensive description of the main probabilistic methods employed in reliability and risk assessment focusing on process plant operations.

The above studies cover different aspects relating to safety and environmental issues of fertiliser plant operation in general and in certain cases specific to certain units only. A comprehensive study analyzing the various issues in environmental management and covering the whole of the industry was not attempted so far. This study is expected to cover the gap.

Limitations of the Study

The study is confined to the environmental management issues pertaining to the production of mineral fertilisers. It does not cover the implications of its use in the
environment. The extent of the study is limited to the current practices prevailing in
the industry and systems available at hand in the various units for meeting the quality
and quantity regulations of the pollution control authorities. The study does not cover
the impact of projects under implementation and future plans for better environmental
control in the units. It is also assumed that installed pollution control facilities are
always diligently operated. Further the study covered only the large-scale sector of
the industry

Organisation of the Thesis

The research report is laid out in nine chapters. The introductory chapter
describes the objectives of the study and its importance, the methodology and the
limitations of the study.

The second chapter is devoted to establishing the intricate relationship
between population, food security and fertiliser requirement to boost agricultural
production.

The third chapter briefly reviews the growth and development of the fertiliser
industry in India and highlights the environmental challenges being confronted.

The fourth chapter gives an outline of the fertiliser manufacturing processes
currently in vogue in the country and the environmental problems arising out of these
processes by way of emissions, effluents, solid waste etc., and reviews methods being
adopted to control their adverse impacts.

The fifth chapter deals with the current practices and developments in
environmental management and control strategies being adopted internationally in
fertiliser manufacturing plants worldwide.
The sixth chapter outlines the legal framework of environmental protection as applied to fertiliser units.

The seventh chapter describes the importance of environmental management systems being adopted by several units, such as ISO 14000, Environmental Impact Assessment and Environmental Audits in Indian fertiliser plants.

The eighth chapter examines the environmental performance of the selected units vis-à-vis the best available practices, conformity with statutory stipulations and international standards.

The last chapter suggests, based on findings of the above analysis, elements of an environmental policy, to support the growth and development of fertiliser production in the country and enhance our food production with out large-scale environmental problems.