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An overview of environmental issues and protection measures in Indian non-ferrous plants

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ABSTRACT

In the industrial scenario of the country, non-ferrous industry plays a predominant role producing variety of metals and alloys for application in chemical, petrochemical, structural, power and engineering sectors. Base metal industries have witnessed remarkable changes in the past two decades besides registering considerable growth. But, most of these base metal industrial developments are generally associated with environmental degradation viz., by way of discharge of wastes into air, natural water bodies or subsoil. Release of harmful gases and suspended particulate matters (SPM) into air leads to ecological imbalance, resulting in destruction of natural life cycle of flora and fauna and many other associated harmful effects. Environmental degradation has become one of the most pressing problems facing India today. Tackling the pollution problem needs innovative and effective approach and industries should be encouraged to adopt non-polluting technologies rather than seeking to regulate the discharged toxic effluents. This critical review includes environmental impacts due to base metal production, approaches to environmental improvement and finally examines various options to prevent pollution in base metal industries.

Keywords : Environmental issues, Non-ferrous plants, Non-polluting technologies, Base metal industries.

INTRODUCTION

Indian economy has been subjected to wide range of structural reforms over the past few years. The primary objectives of this process is to take the country forward and place it in the front ranks of the rapidly growing Asia Pacific Region. Non-ferrous industry has a record-growth in the last five years. Investment in the non-ferrous sector has been growing after liberalisation of

economy. Privatisation is now permitted in virtually all industries with reduction and simplification of tax structure. The new EXIM 1997-2002 has been further relaxed cutting duties and tariffs.

The growth of non-ferrous industry has contributed to the problems of environmental degradation in both developed and developing countries. The ultimate impact is felt in the health and well-being of man, woman, children and ultimately the total ecology comprising the animal, acquatic life, insects and plants. Although somewhat delayed, fortunately, man has reacted with foresight in many locations and has reversed the degradation process with the installation of control systems. Still we have a long way to go. Non-ferrous sector is facing increasing pressure to eliminate or atleast reduce waste and pollution.

The awareness of impact of pollution has set in the minds of industrialists that they will have to be utterly transparent in their dealings with both the Government and society at large while aiming at clean or safe environment. Knowledge of environmental phenomena, their anticipation, understanding and prognosis have increased tremendously with simultaneous advances in computer technology.

ENVIRONMENTAL POLLUTION IN NON-FERROUS INDUSTRY

Aluminium Production

In the production technology of aluminium metal, the principle ore bauxite is digested with caustic solution by the Bayer's process. The important steps involved in Bayer's process are digestion, separation of red mud, precipitation of alumina trihydrate from sodium aluminate solution and calcination of precipitated particles to get alumina. Aluminium metal is produced by electrochemical reduction of alumina dissolved in fused bath inside carbon lined cells using HALL-HEROULT process.

Environmental impacts due to aluminium production industry is shown in Table 1 while the primary aluminium production data is shown in Table 2.

Environmental Management

'Indian aluminium plant' environmental protection measures involve pollution monitoring and control and also integrated development of forest and ecology. To maintain the ecological balance, most of the aluminium companies have drawn up special afforestation programmes. Numerous varieties of forest species are planted. The mined areas are reshaped to blend with surrounding

landscape. Water basins are provided to control run off and soil erosion from mined areas.

Table 1 : Environmental impact in aluminium metal production

Location	Impact
Mining	Surface run off, tailings, tail dump, dust problems in excavation and transportation
Crushing and grinding	Fugitive emissions, solid and liquid effluents
Leaching section	Liquid effluents and solid effluents (alkali and noxious substances).
Alumina calciner	Dust and gases
Cell house	Dust, gases (CO, CO_2, HF, SO_2, water vapour, hydrocarbon fumes and fluorides)
Paste plant	Coke dust, coal dust, gases and hydrocarbon fumes.
Melting plant	Dust, Gases and flux fumes
Boiler	Coal dust and gases
Ancillary operations	Dust from old pots, butts and material handling

*Standard from fluoride and SPM

Calciner 250 mg/Nm^3

Smelter 1 kg of fluoride per ton of aluminium, 150 mg/Nm^3 SPM.

Table 2 : Primary aluminium production

Company	Capacity (T/Year) (Fig. in lakhs)	Production 1996-97 (T/Year) (Fig. in lakhs)	Anticipated capacity Expansion by 2000 AD (T/y) (Fig. in lakhs)
HINDALCO	2.1	1.66	2.40
INDAL	1.77	0.37	1.00
BALCO	1.00	0.92	1.00
NALCO	2.18	2.03	3.45
MALCO	0.25	0.24	0.75
TOTAL	6.70	5.22	8.60

*Source : MMR - May 1997.

In the aluminium refinery, bag house, dust collectors etc., are provided in the storing and transport areas to control fugitive emissions. E.S.Ps are provided to extract dust from calciner. Red mud ponds are provided with linings to prevent seepage of soda water. The smelter gases are collected through hoods provided over the entire periphery of the cells. Tar vapours, CO and other volatile constituents are burnt inside the burners specially provided over the cells before the gases are taken to gas cleaning plant. Dust and tarry substances are removed by ESP and finally passed through soda scrubbers. HF and SO_2 are tapped as NaF and Na_2SO_4. Finally, flue gases are released through tall chimney. Process and sewerage waste water are handled in treatment plants [1].

Copper Production

During the technology of copper metal production, the copper concentrate is smelted in flash furnace with oxygen enriched air. To produce matte, the molten matte is converted in Pierce Smith copper converter into blister copper. The blister copper is fire refined in anode furnace and finally electro-refined. Environmental impacts during copper production are shown in Table 3 whilst Table 4 includes Indian primary copper production data.

Table 3 : Environmental impact in copper production

Operation	Impact
Mining	Tailing water, tail dumps result in water pollution. Dust and gases during blasting, transportation results in air pollution. Landscape disruption occurs.
Crushing, grinding and transportation	Fugitive emission, solid and liquid effluents, tailings
Beneficiation	Solid and liquid effluents, tailings result in water pollution
Roaster/smelter	Dust, gases, spills, solid slag
Converter	Dust, gases, solid slag
Anode furnace	Dust, gases, solid slag
Electrolytic refining	Water pollution due to effluents containing dissolved metals
Slag treatment furnace	Dust, gases and fluxes

*Standard for SPM 150 mg/NM^3.

Off gases must be used for H_2SO_4 production. No release of SO_2/SO_3 permitted.

Table 4 : Primary copper production

Company	Capacity (T/year) (Fig. in lakhs)	Production 1996-97 (T/year) (Fig. in lakhs)	Anticipated capactiy Expansion by 2000 AD (T/y) (Fig. in lakhs)
HCL (Khetri & Ghatsila)	0.50	0.47	0.88
Private Sector			
STERLITE	0.60	–	0.60
INDOGULF	1.50	–	1.50
SWIL	0.50	–	0.50
METDIST	1.50	–	1.50

Source : MMR - August 1997.

Environmental Management

Environmental concerns with copper production and its use rarely focus on metal. In fact, copper is an essential element for life. Real environmental concern about copper production has centered on emission of SO_2 and easily vapourised trace metals such as arsenic, cadmium and mercury from smelters. The waste gases from smelting furnace are scrubbed and cooled in peabody tower. Acid mist from cooled gas is removed in ESP. The resulting gas is dried in H_2SO_4 and converted to sulphuric acid. M/s Sterlite Industries Limited [2] have provided control system in the converters, anode and rotary holding furnaces. ISA smelt furnaces have separate fans, duct work, scrubber and stack. Fugitive gases emitted from converter are controlled by hygiene ventilation system. The company claims to have provided for the first time in India a specially designed lime scrubber to absorb SO_2.

Zinc Production

In the production technology of zinc metal, the zinc concentrate is roasted in flash roaster/fluidbed roaster to convert zinc sulphide to zinc oxide. The calcined zinc oxide is leached with sulphuric acid to get zinc sulphate which is subjected to purification prior to final electrolysis. Environmental impact due to zinc production is shown in Table 5 while primary zinc metal production data are shown in Table 6.

Table 5 : Environmental impact in zinc production

Location	Impact
Mining	Tailing water, tail dumps creates water pollution; dust and gases during blasting, transporation of ores results in air pollution.
Crushing, grinding	Fugitive emission, solid and liquid effluents, tailings
Beneficiation	Solid and liquid effluents, tailings result in water pollution
Roaster	Dust, gases, acid mist, fine zinc dust
Leaching plant	Water pollution due to solid and liquid effluents
Electrolytic cell house	Water pollution due to solid and liquid effluents, acid mist.
Melting	Dust and gases, fine dust of heavy metals.

*Standard for SPM 150 mg/NM^3.

Table 6 : Primary zinc production

Company	Capacity (T/year) (Fig. in lakhs)	Production 1996-97 (T/year) (Fig. in lakhs)	Anticipated capactiy Expansion by 2000 AD (T/y) (Fig. in lakhs)
HZL, (Dabari, Vizag)	0.80	0.78	0.90
HZL Zn-Pb sector, Chanderya	0.70	0.60	0.80
Binani Zinc	0.30	0.26	0.60
Others	0.50	0.34	0.656
Total	2.30	1.98	2.86

*Source : MMR - May 1997.

Environmental Management

Indian zinc plants have already implemented environmental management systems which include provision of cyclone, ESP, scrubber etc., in their plants. They are also taking steps to plant varieties of trees and plants in and around the plant site (green belt). Most of the zinc plants carry out stack and ambient air quality (A.A.Q.) monitoring on regular basis to asses the nature, quality and quantity of pollutants emitted by the source and also to evaluate the performance

of pollution control equipments and compare with national emission standards.

Lead Production

In the production technology of lead metal, the concentrate is roasted on a sintering machine and the roasted material is smelted to get lead bullion which is further purified by drossing.

Environmental impact during lead production is shown in Table 7 while primary lead production data is shown in Table 8.

Table 7 : Environmental impact in lead production

Location	Impact
Material handling section	Fugitive emission and gases
Sintering	Dust, metallic fumes, gases and water vapour
Smelting	Dust, gases
Drossing	Dust, gases, flux fumes
Refining	Dust, gases, flux fumes

*Standard for SPM 150 mg/NM^3.

Table 8 : Primary lead production

Company	Capacity (T/year) (Fig.in lakhs)	Production 1996-97 (T/year) (Fig. in lakhs)	Anticipated capacity Expansion by 2000 AD (T/year) (Fig. in lakhs)
HZL (Zn-Lead smelter-Vizag and Chanderya)	0.57	0.288	0.80
HZL (Lead-smelter, Tundoo, Bihar)	0.10		
Others	0.58	0.412	0.70
Total	1.25	0.7	1.50

* Source : MMR - May 1997.

Environmental Management

Indian primary lead industries have considered environmental protection as one of the key elements in their corporate management and have implemented various control measures to contain pollution by providing cyclone, ESP, bag

filter etc., in various locations of the plant. There are a number of backyard secondary lead producers in the country who process battery scrap for lead recovery. They operate even in residential areas and pollute the environment. They need a close watch and should be made to adopt control measures and relocate their operations. It is reported that M/s India Lead Ltd., have installed pollution control equipment such as settler, cyclone, bag filter, wet scrubber to meet the regulatory requirements [3].

Environmental effect of various pollutants is shown in Table 9 while standards for A.A.Q., is shown in Table 10.

Table 9 : Effect of pollutants

Nature of Pollutant	Effects
Oxides of sulphur, SO_x	a) Irritant, affecting mucous membranes b) Causes severe bronchospasmas at low levels of SO_3 c) SO_2 levels at 400-500 ppm dangerous for short term exposure
Carbon monoxide	a) Tendency to combine with haemoglobin of the blood forming carboxy haemoglobin (COH_b) thus reducing oxygen supply to body tissues b) Affects central nervous system, responsible for hearth attacks and high mortality rates
Oxides of nitrogen, NO_x	a) Causes occupational diseases b) Eye and nasal irritation occurs after exposure of 15 ppm of NO_2 and pulmonary discomfort after brief exposure to 25 ppm.
Ozone, (O_3)	Irritates the respiratory tract
Hydrogen sulphides and Mercaptans	Causes fatigue
Fluorides	Fluorine gives cumulative poisoning effect under conditioning of prolonged exposure and in sub acute concentration
Lead	Released into atmosphere from automobile, causes gastrointestinal damage, liver and kidney damage, abnormalities in pregnancy and affects mental development of children

Source : Intl. Conf. Vol. on "Management of Pollution in Foundries" April 1990, p. 21.

Table 10 : Ambient air quality standards (CPCB)

Area category	Concentration in micrograms per cubic meter			
	SPM	SO_2	CO	NO_x
A. Industrial and mixed use	500	120	5000	120
B. Residential and Rural	200	80	2000	80
C. Sensitive	100	30	1000	30

Environmental Control Through Environmental Impact Assessment (EIA)

EIA is to identify and evaluate the potential impacts (beneficial and adverse) of the non-ferrous plants on environmental system. EIA assesses the baseline status of air, water, land and socio-economic environmental components with the impact zone during expansion/new operation. Based on the findings of the EIA report, an environmental management plan (EMP) can be prepared and implemented. EIA also determines the magnitude of impacts measured quantitatively or qualitatively and the assesses the significance of these impacts against standards. These standards can be legislative policies or wishes of the general public. Public participation is key element in EIA. It is a part of democratic process where key issues are highlighted through public participation. EIA can also suggest alternative site or technology to be applied in a comprehensive manner [1].

Environmental Control by Environmental Audit (EA)

Recently, EA has been introduced for the first time by the Ministry of Environment and Forests for continuation of NOCs for industries. The subject is still evolving and its importance and modalities are yet to be understood by many organisations. EA is a management tool that is valuable only if it is a part of overall management system. It is a self-assessed system and will cover all relevant information pertaining to base metal production units/departments generating air, water and noise pollution.

Environmental Control by Pollution Prevention

Pollution prevention (PP) means not producing wastes or emission streams. PP could pay substantial dividends by reducing production cost, onsite waste monitoring, treatment cost, raw material cost, energy and water cost, long term environmental liability and insurance cost. It also improves income through sale of reusable waste, improved overall operational efficiency and safety of employees etc. Pollution prevention programme involves three major techniques such as: (i) source reduction; (ii) recycle/reuse; and (iii) treatment. Source re-

duction reduces pollutants before it is generated. Recycle/reuse helps in recovering unusable materials from waste. The final treatment is to reduce volume and toxicity of wastes/pollutants before it is disposed [4].

Environmental Control Using Clean Technology

The clean technology in non-ferrous sector can be adopted for recovery and reuse of large amounts of expansive volatile chemical solvents, metals etc. Clean technology can also be used to process discarded solid or liquid materials into commercial environmentally responsible products. Clean technologies give rise to good economic returns and also improve intrinsic operating performance of a facility while reducing environmental cost.

India should also go in for clean technologies in non-ferrous sector because they are integral to production and safe to workers and eliminate non-product waste outputs to the environment. Some of the environmental options by reducing the pollutants/wastes available in selected non-ferrous sector are enumerated below.

ONTARIO Division of INCO, Canada have reduced SO_2 emissions in their operations to acceptable level by sustained research efforts which led to increased rejection of pyrrhotite, an iron sulphide from the ore during milling with good nickel recovery. INCO has also developed a new copper smelting technology based on oxygen top blowing, nitrogen bottom stirring process to convert semi blister to blister copper with minimum pollution [1]. Yet another example is Ausmelt technology to treat sulphide ore, complex ores etc., which is very much environmental friendly and gives out clean products.

M/s Encycle, Taxas has set up a hydrometallurgical unit to process variety of waste materials obtained from non-ferrous industries to recover lead, copper, zinc etc. This plant has facility to treat liquid wastes, metal bearing wastes, baghouse waste etc., by leaching, purification, cementation, reduction etc. To combat the environmental problem posed by SO_2 emission, M/s Sherritt-Gordon, Canada has developed a two-stage oxidative pressure leaching (800 kpa, 150°C) of zinc sulphide with high recovery of zinc, cadmium etc., and simultaneous production of elemental sulphur. HZL is actively considering to adopt this technology [1].

KIVCET lead process developed in USSR has been commercially tested and offers advantages of flexibility of raw material and low level of lead emission. Also QSL lead process is based on low grade coal or natural gas. The oxidation and reduction are carried out in the same vessel. The process is energy efficient and meet very strict environmental limits, particularly with regard to lead in the work place. Recently, M/s Zinc Corporation (ZINCO) has developed revolu-

tionary Zinco-Warner process for extraction of zinc and other metals from zinc rich ores. The company claims the process to be eco-friendly and the pollution is reduced to bare minimum because the tailings and slag are easier to dispose off acceptably than comparable outputs from existing processes. The process is expected to reduce the cost of production upto one-third of the present day cost and capable of producing zero emissions [5].

Environmental Control Through Treatment Method

Treatment of mine drainage water, mineral processing plant water, non-ferrous plants' waste water etc., has become a necessity for environmental regulation. Treatment methods such as chemical precipitation, ion exchange, solvent extraction, adsorption, bio-technology etc., can be adopted as an environmental control measure [4].

CONCLUSION

Non-ferrous industries will have unprecedented opportunities for record growth, expansion, modernisation and diversification in near future. Globalisation, liberalisation and privatisation of Indian economy have created a favourable industrial climate and opened a bright future for non-ferrous industries. The environment has become a problem of which the broad public has become aware to the point of forming obstacle to certain operations or preventing the opening of new operations. The whole non-ferrous industry which affects the natural environment must redouble its efforts to minimize its impact, reduce its nuisance value and restore sites in all the stages of production.

Environmental procedures and regulations must be realistic and practical. The regulation should support the very role that non-ferrous industry can operate efficiently utilising resources and improving the environment. In order to survive as an eco-friendly industrial society, industrialists should work together with regulators and general public. Non-ferrous units should update their plants to the extent that they meet reasonable environmental limits. Non-ferrous units can interact with research organisations and develop innovative process technologies to utilise waste products and produce usable products without environmental degradation. Our primary mission should be to achieve excellence in all aspects of metal production activities to the maximum benefit of our country and the community in which it operates.

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