

Environmental Impact Assessment And Its Role For Sustainable Development of Pulp And Paper Industry

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ABSTRACT:-- Present paper highlights various aspects of EIA, Environmental Protection Acts, Environmental apprehensions due to pulp and paper manufacture and their impact on environmental components, scope of EIA for pulp and paper plants and environmental management plan for sustainable development.

INTRODUCTION

Indian paper industry is one of the core industries in India and has been playing important role in the industrial, economic, cultural and social development of country. It is based on forest and agricultural residue raw materials. There are about 340 units in India out of which only 8% are in large sectors accounting for about 45% of total production [1]. Based on raw materials wood based, agro based and waste paper based units are 38%, 36% and 26% respectively. India with 16% of global population accounts for barely one percent of world consumption. With the present total capacity of about 4 million tonnes, the capacity is expected to be about 5 million tonnes by 2000 AD.

Rapid industrialisation and urbanisation has resulted in three dimensional environmental crisis-environmental pollution, ecological decay and resource depletion. Pulp and paper industry is no exception to this and is amongst the top twenty highly polluting industries in India. During various stages of operation wide variety of pollutants [Table 1 and Fig. 1] are discharged to the environment and have serious impact on various component of the environment water, air, land, biological [2-5].

The quantity and the quality of pollutants released in air, water and soil from different units varies considerably and are dependent on size of the

plants, complexity and quality of the products, raw materials and process technology used, age of the plants, general maintenance and house keeping standards in the factory.

During recent years sustaining and assimilating capacity of the biosphere has started showing signs of stress primarily because of the impact of human on environment and warrants for optimum utilisation of resources and minimisation of adverse impact on the environment. Sound environmental management has become major issue during recent years for survival of mankind and sustainable development. India is the first country which has made provision for the protection and improvement of environment in its constitution. Environmental impact assessment (EIA) which identify and predict the impact on various environmental components and has been a significant development in environmental management during recent years. EIA has been made mandatory for getting the environmental clearance for the new projects listed in Schedule I of EIA notification of 1994 issued by Ministry of Environment and Forest, Govt of India, expansion and modernisation of any activity (if pollution load is to increase in existing one or new projects

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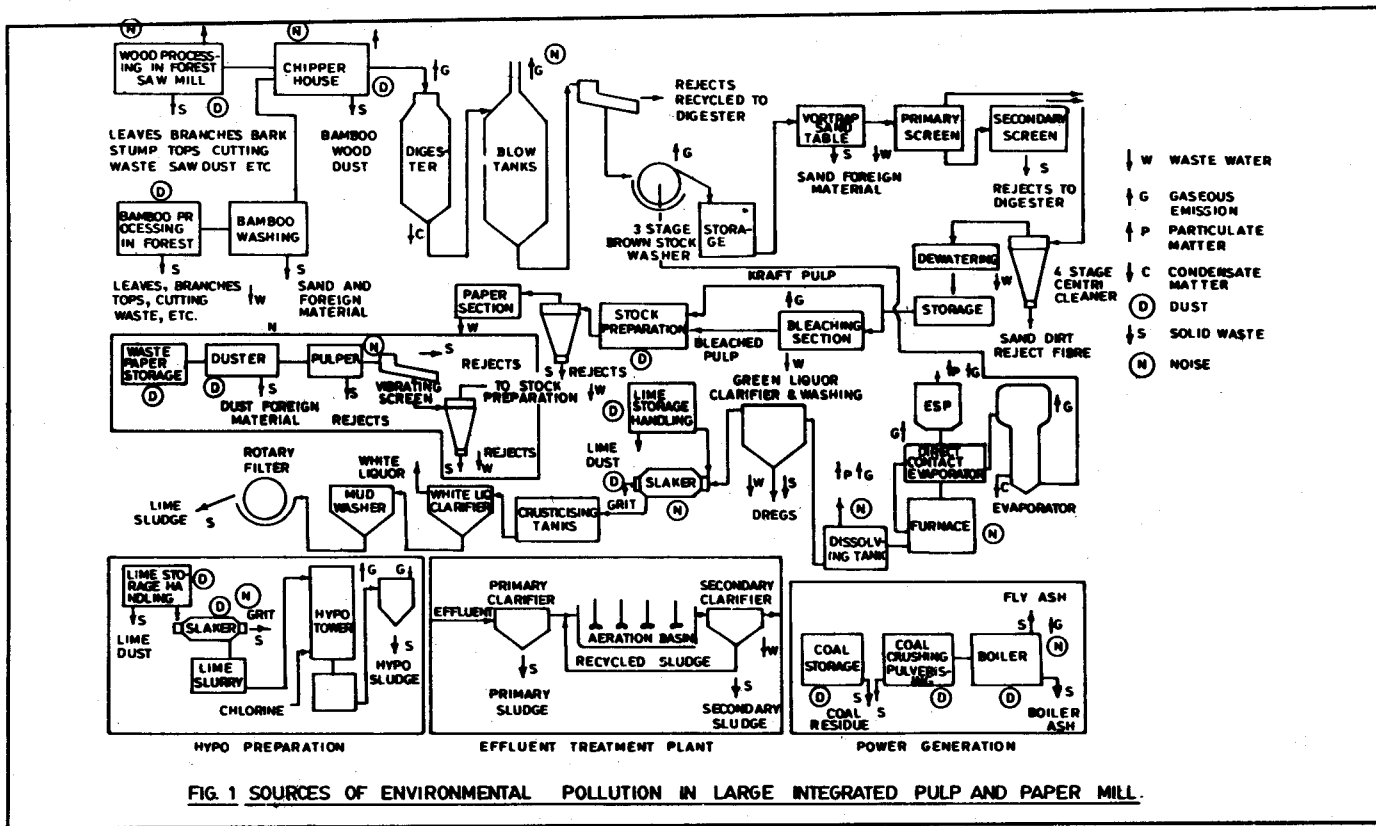


Table-1.

Major Pollutants and Solid Wastes from Pulp and Paper Industry

General	Specific	Pollutants	Typical generation / emission
Water Pollutant	Resin acids: abietic, dehydroabietic isopimaric, palustic, pimaric, sandaracopimaric and neoabietic. Unsaturated fatty acid: oleic, linoleic, linolenic and palmitoleic acid: Chlorinated resin acid: mono and dichlorodehydroabietic acid, dichlorostearic acid: Diterpene alcohols: pimarol, isopimarol, abienol etc., Juvabioncs; Lignin and lignin degradation products: Fugitive toxicants: sodium sulphite, hydrogen sulphide, chlorinated Phenolic compounds: 2, 4-dichloro phenol, 2, 4, 6-trichlorophenol, 2, 4, 5-trichlorophenol, trichloroguaiacol, pentachlorophenol, Tetrachloroguaiacol, di-and trichloro catechol Chlorinated vanillins, chlorinated syringols, chlorinated syringaldehydes. Genotoxic compounds: 1, 3 dichloroacetone, 3-chloro-4-di chloromethyl - 5 - hydroxy-2 5-H-furanone, chloroacetones, Dyes and pigments		Large integrated mills: per tonne of paper COD: 150-210, BOD: 30-50 Total solids: 100-200 Agro based Paper mill: COD: 500-1200 BOD: 90-300 Total Solid: 100-250 Waste paper based mills: Waste water M ³ /tonne Large Mills : 200-350 agro based : 200-350 Waste paper based : 70-150 Colour kg per tonne of paper: Bleached kraft :150 Bleached thermo mechanical : 60 Bleached sulfite : 60
Gaseous Pollutants	Hydrogen sulfide, methyl mercaptant, dimethyl sulfide, SOx, NOx, chlorine, chlorine dioxide, CO.		Recovery furnace: Dust: 450-1000 mg/M ³ ; SO ₂ : 10 mg/Nm ³ ; H ₂ S: 32 mg/Nm ³ ; Mercaptan: 20-30mg/Nm ³ Total reduced sulphur: 600g/Tonne
Particulate	Wood, bamboo and straw dust, lime, salt cake, acid and alkali mist, fly ash etc.		
Solid Wastes	Forest and agricultural residues, pith, chipper house dust, fly ash and bottom ash, screen and centricleaner rejects, hypo sludge, lime sludge, effluent plant sludge etc., brine mud		Forest residues about 40-50% Bark: 8-15%; Bamboo & wood dust 3-5% kg per tonne of paper Rejects; 35-40 Lime sludge: 450-650, Grit from causticising section: 30-45; Coal ash:70-100 Hypo sludge:60-80; ETP sludge 180-200; Total waste: 1200-2500 Brine mud: 30-40 kg per tonne of NaOH (Hg: 8-9 mg gm of mud Total loss of Hg: 390 mg/tonne of caustic.

encompassing all developmental, infrastructural and chemical projects.

Some of the environmental implications of pulp and paper mill manufacture activities are-large scale deforestation, use of huge natural resources like water coal, lime stone etc., discharge of coloured and toxic pollutants in water stream; emission of maladorous sulphur compounds; discharge of huge quantity of solid wastes like lime sludge, fly ash and bottom ash, chipper house dust, forest residues, screening and cycle clean rejects; noise pollution. Present paper highlights various aspects of EIA, Environmental Protection Acts, Environmental apprehensions due to pulp and paper manufacture and their impact on environmental components, scope of EIA for pulp and paper plants and environmental management plan for sustainable development.

ENVIRONMENTAL PROTECTION ACTS, RULE AND STANDARDS IN INDIA

In response to United Nations Conference held at Stockholm in June, 1972 for the preservation of natural resources of earth and protection and improvement of human environment, several acts, rules, regulations, conventions, practices and

standards has been enforced in India [Table-2] and now it is constitutional obligation of all the citizen of India to protect and improve natural environment including forest, lakes, rivers and wild life and to have compassion for living creatures. Some of these rules includes Water (Prevention and Control of pollution) Act 1974, Air (Prevention and Control of pollution) Act 1981, Environmental (protection) Act, 1986 and various amendments. Emission and effluent standards prescribed for pulp and paper industry and caustic chlorine plant which is integral part of many large units is given in Table-3 [6]. The Central Pollution Board has also set ambient air quality standards which must be met by the industries [Table-4]. Ambient air noise standard is given in Table-5 [6].

SUSTAINABLE DEVELOPMENT

UN Conference on Human Environment at Stockholm in June 1972 has been a significant land mark in the sphere of environmental conscientiousness the world over. Environment and development are not exclusive of one another but are complementary and interdependent. The concept of sustainable development which is closely related to carrying capacity of ecosystem has two primary principles [6]-

Table-2.

Environmental Protection Acts, Rules and Various Ammendments

The Water (Prevention and Control of Pollution) Act, 1974 and its ammendment up to 1988.
The Water (Prevention and Control of Pollution) Rules, 1975.
The Water (Prevention and control of pollution) (Procedures for Transaction of Business) Rules, 1975.
The Water (Prevention and control of pollution) Cess Act, 1977 as ammended by Amendment Act, 1991.
The Water (Prevention and control of pollution) cess rule, 1978.
The Air (Prevention and Control of Pollution) Act, 1981, as ammended by Amendment Act, 1987.
The Air (Prevention and Control of Pollution) Rules, 1982.
The Air (Prevention and Control of Pollution) (Union Territorries) Rules, 1983.
The Environmental (Protection) Act, 1986.
The Environmental Protection Rules, 1986.
Environmental Impact Assessment of Development Projects
Hazardous Wastes (Management and Handling) Rules, 1989.
Manufacture storage and Import of Hazardous Chemical Rules, 1989.
Manufacture, Use, Import, Export and Storage of Hazardous Micro-Organisms Genetically Engineered Organisms or Cells rules,1989.
Scheme of Labelling of environment Friendly Products (ECO-MARKS)
The Public Liability Insurance Act, 1991.
The Public Liability Insurance Rules, 1991.

Table-3.

Minas for Small Pulp and Paper Industry		
Parameter	Discharged on to surface water	Disposal on land
pH	5.5-9.0	5.5-9.0
Suspended Solids, mg l ⁻¹	100	100
BOD, mg l ⁻¹	30	100
Sodium absorption Ratio		

MINAS for Large Integrated Pulp and Paper Industry	
Parameter	Concentration
pH	7.5-8.5
Suspended Solids, mg l ⁻¹	50
BOD, Mg l ⁻¹	30
COD, mg l ⁻¹	350
Total organic chloride per tonne of product	2.0

EPA EMISSION STANDARD
 Particulate matter 250 mg/Nm³ : H₂S 10Nm³
 FLOW (Total waste water discharged)

Capacity below 24,000 tonnes per annum
 Agro based : 200 cu.m/T (150 cu.m/T for established after 1992)
 Waste paper : 75 cu.m/T (50 cu.m/T for established after 1992) based
 Capacity above 24000 tonnes/annum
 Total waste water discharged 200 cu.m/T (175 cu.m/T for established after 1992)

MINAS for Caustic chlorine Plant

Parameter	Concentration
pH	5.5-9.0
Mercury in the final effluent, mg l ⁻¹	0.01
Mercury bearing waste water generation	10 kilo lit/tonne of caustic produced

EPA Emission Standards	Maximum permissible limit
Mercury from hydrogen gas holder	0.2 mg/Nm ³
Chlorine from Hypo tower	15 mg/Nm ³
HCl vapour and mist from HCl Plant	35 mg/Nm ³

- (i) Symbiotic relation between consumer human race and producer natural system
- (ii) Compatibility between ecology and economy

For sustainable development the development activities to meet the human needs must proceed with acceptable environment limits and is closely related to carrying capacity of the environment. Four essential requirement for sustainable development are environmental harmony, economic efficiency, endogenous choices and equity, social justice [7].

Table-4.

National Ambient Air Quality Standards, 1994

Pollutant	Time weighted average	Concentration in ambient air		
		Industrial area	Residential, rural & mixed use area	Sensitive area
Sulphur dioxide (SO ₂)	Annual Average*	80	60	15
	24 hours	120	80	30
Oxides of Nitrogen (as NO ₂)	Annual Average*	80	60	15
	24 hours	120	80	30
Suspended particulate matter (SPM)	Annual Average*	360	140	70
	24 hours	500	200	100
Respirable particulate matter [size less than 10 um (RPM)]	Annual Average*	120	60	50
	24 hours	150	100	75
Lead (Pb)	Annual Average*	1.0	0.75	0.50
	24 hours	1.5	1.00	0.75
Carbon Monoxide (CO)	8 hours**	5.0	2.0	1.00
	1 hour	10.5	4.0	2.00

* Annual arithmetic mean of minimum 104 measurements in a year taken twice a week 24 hours at uniform interval.

** 24 hourly/8 hourly values should be met 98% of the time in a year. However, 2% of the time, it may exceed but not on two consecutive days.

NOTE:

1. National Ambient Air Quality Standards: The levels of air quality necessary with an adequate margin of safety to protect the public health, vegetation and property.
2. Whenever and wherever two consecutive values exceeds the limit specified above for the respective category, it would be considered adequate reason to institute regular/continuous monitoring and further investigation.
3. The above standards shall be reviewed after five years from the date of notification.

EIA AND ITS ROLE FOR SUSTAINABLE DEVELOPMENT

EIA is an activity designed to identify and predict the impact on the bio-geophysical environment and man's health and well being of legislative proposal, policies, programme, projects and operation procedures and to interpret and communicate information about its impact [8]. Thus EIA can be used as decision making tool for monitoring changes in the environment because of the human activities and provide future sound environmental management

Table-5.

Ambient Air Noise Standards

Inserted as Schedule-III to the Environment (Protection) Rules, 1986 vide Notification No. GSR 1063(E) dated 26.12.1989 in the Gazette of India

Area code	Category of area	Limits in dB (A) Leg	
		Day time	Night time
A.	Industrial Area	75	70
B.	Commercial Area	65	55
C.	Residential Area	55	45
D.	Silence Zone	50	40

Exposure Time Hrs/day	Limit dB(A) Leg
8	90
4	93
2	96
1	99
1/2	102
1/4	105
1/8	108
1/16	111
1/32	114
(2 min. or less)	

plans, disaster management plan, forest management plan, green belt design [8]. Rapid EIA involves assessment based on one season (3 months) while comprehensive EIA involves assessment based on three seasons (9 months) monitoring for base line data collection.

EIA PARAMETERS AND METHODOLOGY

Some of the basic steps in EIA involves base line study, scoping or impact identification, impact measurement, impact analysis, mitigating measure, monitoring of the scheme, disaster management plan. The various methods used in EIA are Adhoc Method; Overlays; Cheklists; Martrix; Network; Integrated method-combination of matrices, net work, analysis models and a computer aided systematic approach. Some of the salient features of these methods is given in Table-6 [8-13].

ENVIRONMENTAL IMPACT ASSESSMENT OF PULP AND PAPER MANUFACTURE

Scoping (impact identification) and base line studies are the activities taken at early stages of

Table-6.

Summary of the Environmental Impact Assessment Methodology

Method	Description
Ad hoc Methods	First step involves consideration of environmental area and identification of the nature of the impact upon it, such as no effect, problematic, short- or long term, and reversible or irreversible.
Overlay Method	This method rely on a set of maps of a project areas environmental characteristics (physical, social, ecological, aesthatic etc.)
Impact Checklists Method	This involves combining a list of potential impact areas that need to be considered in the environmental impact assessment process with an assessment of the individual impacts.
Leopold matrix Method	This basically incorporate a list of project activities or actions with a checklist of environmental conditions or characteristics that might be affected. Combining these lists as horizontal and vertical axes for a matrix allows as horizontal and vertical axes for matrix allows the identification of cause-effect relationships between specific activities and impacts.
Battelle Environmental Evaluation system	In this method human concern are separated into four main categories-ecology, physical/chemical, ion system aesthetics, human interest/social and each categories contains a number of components that have been selected specifically. For each component index of environmental quality is developed, normalised to a scale ranging from 0 to 1, using a value function method. Each impact indicator is then given as the difference in environmental quality between the stages with and without action.
Net work Method	This start with a list of project activities or action and then generate cause-condition-effect net-works (i.e. chains of events).
Integrated method	This uses a combination of matrices, net work, analytical models and a computer aided systematic approach.
Probabilistic Method	This method uses mathematical models of the environmental phenomenon. Numerical odds are assigned to every possible out come or combination of out comes. On the basis of such assigned odds prediction statement are made about the future behavior of the phenomenon studies, even
Habitate evaluation system (HES)	HES system is applicable to water resources and involves six basic steps (i) Defining habital type or extent (ii) Deriving habitual quality index scores (iii) Deriving habital unit values (iv) Projecting HUVS for future with and without project conditions (v) Using HUVS to asses impact of project alternatives (vi) Determining mitigation requirement.

EIA. Pulp and paper making process is a combination of four major steps, namely,

Raw material preparation	- Debarking and chipping
Pulping	- Separation of fibres
Stock preparation	- Imparting suitable properties for making paper
Paper making	- Conversion of pulp from stock preparation into a sheet of paper
Chemical recovery	- Concentration of spent liquor, burning and causticising of liquor

Various process technologies involved in pulping processes are kraft pulping, soda or lime pulping, sulfite pulping, NSSC, mechanical - pulping - stone ground, thermo-mechanical, cold soda refiner mechanical pulping, and refiner mechanical pulping.

Environmental apprehensions from various activities of pulp and paper manufacture are

1. Deforestation due to use of forest raw material which has resulted direct impact on forest eco system, climate condition, soil conservation.
2. Deterioration in air quality due to emission of malodorous- odorous sulfur compounds like mercaptan, dimethyl sulfide, dimethyl di sulfide, hydrogen sulfide; sulfur dioxide, chlorine, particulates, NO_x, SO_x, alkali fumes, particulates.
3. Deterioration in the water quality due to presence of high BOD, COD, colour, suspended and dissolved solid, toxic compounds-chlorinated lignins, chlorinated phenols, mercury and heavy metals.
4. Environmental deterioration due to noise pollution at various stages like chipping digester blow, boiler blowdowns, smelter dissolving, turbine, compressors, lime stone, coal handling plant etc. Noisem level may vary from 70-120 dBA at various section.
5. Adverse impact on biological environment due to various toxic pollutants discharged to water stream.
6. Adverse impact on the land environment due

to various solid wastes like lime sludge, fly ash, bottom ash, ETP sludge, centricleaner rejects, hypo sludge, brine sludge, mercury bearing sludge, waste paper plant. Total solid waste generation may be around 1.5-2.5 Tonnes per tonne of paper.

7. Socio cultural disruption due to influx of labour force, migration from outside, movement of heavy machinery, additional traffic etc.

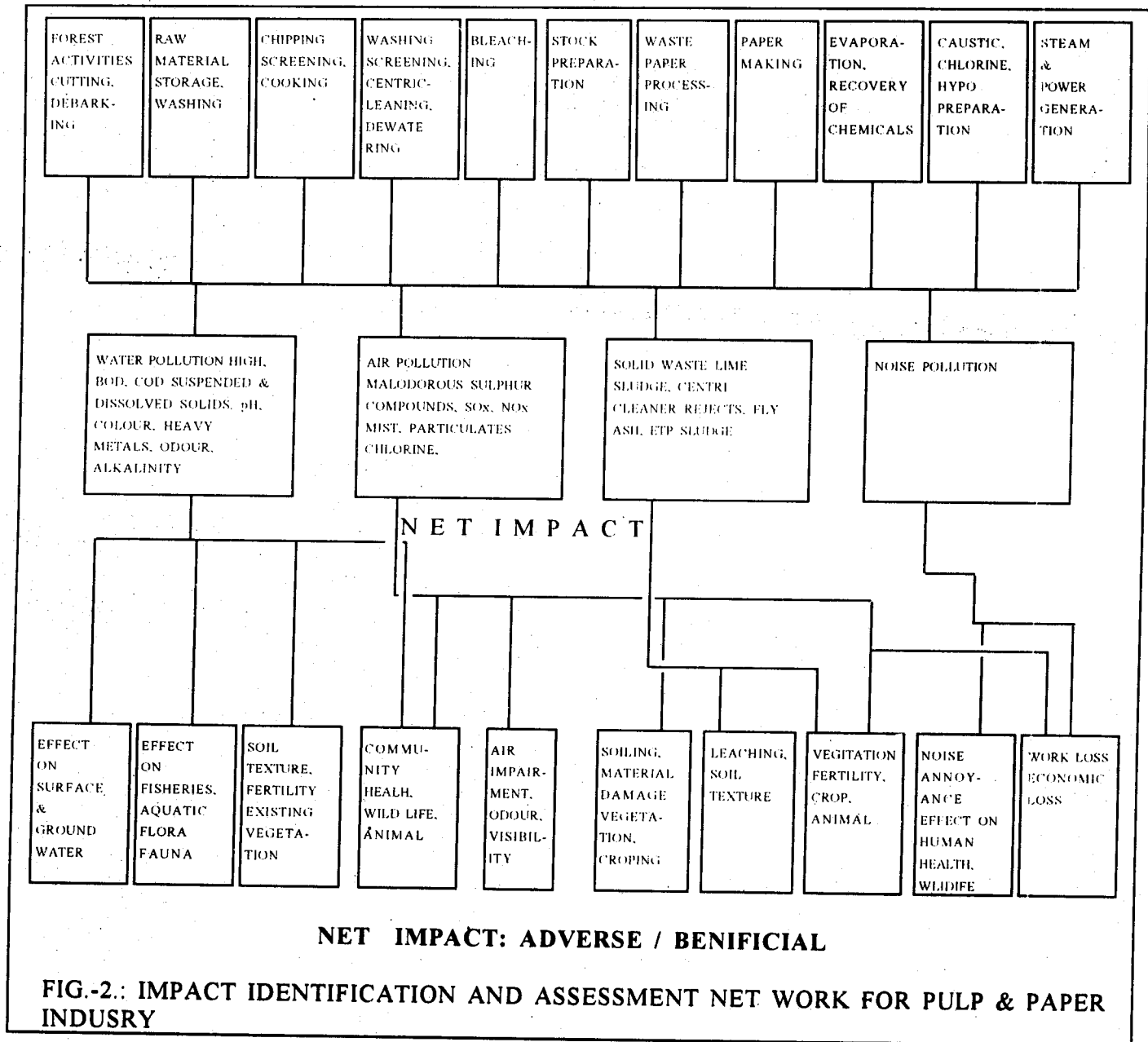
Basic resources which are likely to be affected due to location/expansion/modernisation of the pulp and paper manufacture activities are

- Physical component: Metrology, air quality, surface water, hydrology, ground water, topography and geology, soil, material.
- Ecological Environment: Fresh water ecology, terrestrial, forest, fauna, sanctuary, natural vegetation, species diversity, bacterial population, eutrophication, plant productivity forest cover.
- Human use values: Land use, transportation, water supply, medical facilities, industries and other occupation, fisheries animal, husbandry fisheries, gross economic yield etc.
- Socio-economic & cultural aspects: Impact on economic & cultural aspects, economic yield.

Environmental impact assesment net work involves impact identification and assessment of water environment, air environment, solid waste and its impact on land environment, noise environment, human use value and socio-economic environment. Impact identification and assesment net work for pulp and paper manufacturing activities has been given in Fig.2.

ENVIRONMENTAL MANAGEMENT PLAN IN PULP AND PAPER INDUSTRY

Basic components of the environmental management plan for paper mill include waste minimisation, waste treatment, waste disposal, and attenuation of residuals. Some of the basic steps involved in plan are based on Inplant control measures, external control measures and technological development. Some of the other component of environmental management plan net work include



Green belt design and Forest Management plan, environmental management plan for pulp and paper mills are given in Fig.3.

DISASTER AND HAZARDOUS WASTE MANAGEMENT PLAN

Pulp and paper manufacturing activities handles toxic and hazardous substances like chlorine, chlorine dioxide and mercury handling and storage of these can lead to disaster resulting in heavy toll of human life or loss of productivity. The risk can be minimised by undertaking risk assessment either

by Fault tree analysis or Failure mode and effect analysis and Hazard & operability study. Hazard & operability study is a systematic techniques for identifying hazards and operability problem of the plant and involves identification of the accidental sequence and development of recommendations for design or procedural changes that will prevent occurrence of those severe accidents or reduce their probability of occurrence can reduce the severity of the consequences. Chlorine and chlorine dioxide, sulphur dioxide is used in pulp and paper industry and hazard potential of these and their quantitative

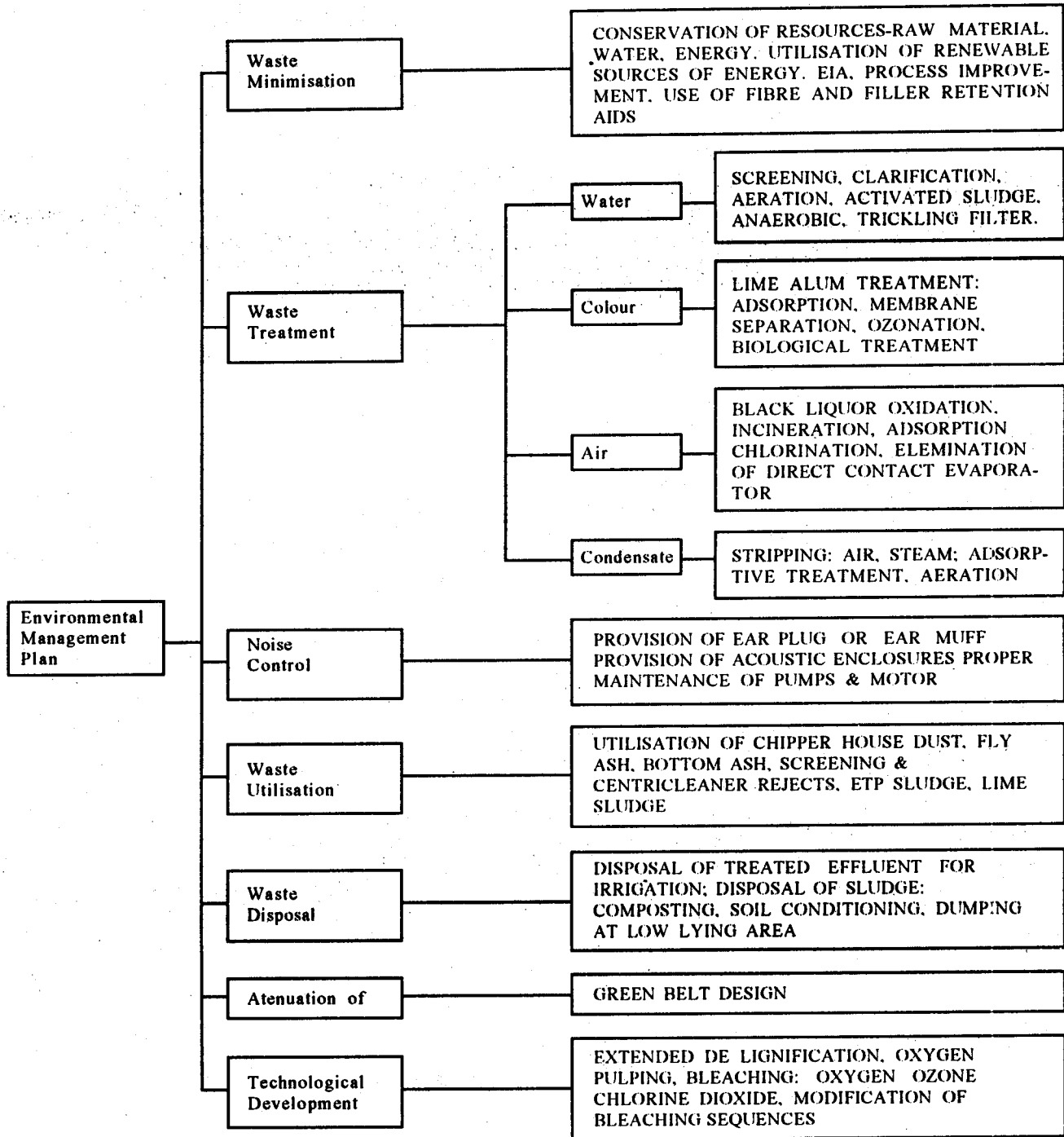


FIG.-3: COMPONENTS AND STRATEGIES FOR ENVIRONMENTAL MANAGEMENT PLAN IN PULP & PAPER INDUSTRY

assessment can be made using any of the above mentioned method.

CONCLUSIONS

Although Indian paper industry shares with other pulp and paper industries in the world the emergence of environmental conscientiousness to have cleaner technologies for better environment and sustainable development, however, still Indian paper industry is far behind the developed countries. Sound environmental management is needed especially in the old plants and plants based on agricultural residue as raw material where chemical recovery is poor or there is no chemical recovery. Indian pulp and paper industry needs cohesive EMP, DMP, FMP, Green belt design to meet the statutory regulation control and standards which has been enforced. EIA will not only help in achieving the goal of sustainable development but will also increase the productivity through conservation of resources and should not be seen just another act of bureaucratic machineries and should be taken as constitutional obligation. Some of the major issues which the pulp and paper industry needs immediate attention are colour removal, utilisation of lime sludge, improvement in the chemical recovery, chemical recovery in agricultural residue based mills, control of malodorous sulfur compound, better forest management plan.

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