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Natural Resources Availability Audit: an Indian Scenerio

R.H Pazare[1] and N.S.Raman[2*]

[1]Research scholar, Rashtrasant Tukadoji Maharaj Nagpur University, Nagpur, India
[2]Principal Scientist and Deputy Director NEERI , Nagpur, India
Corresponding author

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A B S T R A C T

The paper reviews the initial attempts being made in India to establish the practice of Natural Resources Availability Audit which is fast emerging new concept especially in the industries that cause pollution and outlines the concept of Natural Resources Availability Audit, highlighting the notifications issued by the Government of India. Includes a case history to demonstrate how the status of environmental management systems and equipments are investigated vis-a-vis the Indian regulatory requirements and how material, energy, health and safety audits have been conducted to identify avenues for savings in the cost of production.

Introduction

A paradox of modern technological society is that some of our efforts in India towards economic prosperity and increased standard of living could be detrimental to the overall quality of life due to encroachment upon nature beyond its sustenance level or rejection of pollutants to the environment exceeding its assimilative capability. In India, Efforts for environmental protection have often relied on strict regulatory measures with little regard to productivity. Those interested in increasing productivity have, therefore, looked away from environmental management and pollution control. For a developing country like India, lack of industrial development and consequent unmitigated poverty could also cause damage to the environment. If we have to guard our environment without seriously blocking the technological development, there is a need to develop/ adopt environmentally benign strategies and technologies. In this context, Natural Resources Availability Audit provides an effective management tool to care for environment and productivity at the same time. In the context of safeguarding the environment, probably no other issue has drawn so much of attention as Natural Resources Availability Audit.

Evolution of Natural resources availability audit in India

Industrial activities in India, have lead to environmental problems by excessive consumption of resources and release of

deleterious effluents, emissions and residues. Efforts to prevent, abate and control pollution have relied on classical methods for influencing human behavior viz. motivating commitment and introducting competition. Examples of these methods are seen in various laws, regulations and standards; financial incentives, and labelling of environment-friendly products. In India, there are some two hundred and fifty enactments that have a bearing on environment.

As a matter of practice, in India, polluting industrial units are persuaded by pollution-control board to take steps to comply with the prescribed emission standards holding a threat of prosecution in case of default.

With the experience of environmental damage caused by industrial activities, introspection and analysis became increasingly elaborate and various names were given to this process of introspection. Some of the names given earlier on the basis of scope are quality control survey; environmental review; environmental diagnostic study; and health, safety and Natural Resources Availability Audit. In the global context, the United Nations has issued a set of recommendations for industry information disclosure, but these are yet to be implemented even in the developed world. May be this is an area where India could give a lead.

Recognizing the importance of Natural Resources Availability Audit, procedures for Natural Resources Availability Audit was first notified under the Environment (Protection) Act 1986, by the Ministry of Environment and Forests (vide their notification No. GSR 329 (E) dated March 13, 1992), the industrial units are required to furnish Natural Resources Availability Audit reports. By an amendment (vide their notification No.GSR 386 (E) dated April 22, 1993), the term for the document has been revised from "Natural Resources Availability Audit Report" to "Environmental Statement". Environmental Statement has to be submitted by every industry, operation or process requiring consent under section 25 of water (Prevention and Control of Pollution) Act of 1974 or under Section 21 of the Air (Prevention and Control of Pollution) Act of 1981 or both or authorization under the Hazardous Wastes (Management and Handling) Rules of 1989 issued under Environment (Protection) Act of 1986. The Statement has to be submitted to the concerned state pollution control board for the period ending March 31 in the prescribed format by September 30 every year beginning from 1993.

The aim of Environmental Statement of an Natural Resources Availability Audit is to facilitate supervision and, at the same time, gain information on the measures to be taken by an industrial unit as regards compliance with the company's internal policies and with the Indian regulations in force. The Environmental Statement enable industrial units to take a comprehensive look at their industrial operations and facilities, understanding material flows and focus on areas where waste reduction and consequently saving in input costs, if possible.

Natural resources availability audit approach

A typical optimization approach characterizes the process of Natural Resources Availability Audit. The objectives comprise prevent or reduce waste generation, maximise raw material conversion and improve in-plant practices, evolve possible alternatives for raw-material

substitution or process change, examine whether recycle-reuse-recovery is possible, reduction in consumption of energy and improvement in health and safety conditions.

Natural Resources Availability Audit is being conducted in India under three phases:

1. Pre-Audit activities.
   - Selection and constitution of a team familiar with process and environmental aspects.
   - Development of an audit plan
2. On-site Activities.
   - Sampling and monitoring.
   - Documentation of all observations.
   - Discussions with the plant personnel

3. Post-Audit activities
   - Preparation of draft Natural Resources Availability Audit report
   - Preparation of an Environmental Statement
   - To prepare an action plan for implementing the suggested measures

The overall audit approach is shown in Fig. 1.

Benefits of natural resources availability audit

Some recognized benefits of Natural Resources Availability Audit practice in India are:

a) Provides assurance of compliance with Environmental Standards & regulations
b) Facilitates in Development of Sound Environmental Management Systems and improvement in environmental performance
c) Increases management and employees awareness of environmental issues,
d) Increases sharing of information
e) Reduces potential liability

Being a multi-disciplinary subject, Natural Resources Availability Audit is not easily comprehended by a person trained in any one subject. In India, as on date, a group of 2-5 members drawn among technicians, engineers, academicians based on type of industry are conducting Natural Resources Availability Audit. Special efforts are necessary in India to harmonise the perspectives which the industrial managements, the regulatory and government agencies and the public have for Natural Resources Availability Audit.

Case history

Introduction

A key to success of an Natural Resources Availability Audit in India is management commitment and support. A case history presented here-in is endorsed by the management and viewed by the line personnel as a viable tool to ensure that their operations are functioning in accordance with the environmental regulations. Pulp plants in India are diversifying into progressively more capital intensive and energy intensive areas which are degrading the quality of environment. Considering the future energy and environmental scenarios, the impact, the pulp plant has on environmental quality and occupational health and safety of workers; Natural Resources Availability Audit was conducted in-detail.

Industry Description

In pulp plant, hard wood is washed with water and chipped off in chipper which is screened to 2-3 cm length and 2-3 mm thickness. It is stored in silos for processing. Calcium carbonate powder of fine mesh is made into a slurry with water and circulated

in a packed tower. Sulphur-di-oxide gas is passed into the tower where calcium carbonate slurry is being circulated. The wood chips from storage silos are charged into digester and then the cooking liquor is pumped into the digester, where the chips are cooked with steam at a temperature of 140°C for 7-8 hours. Under this condition, sulphur-di-oxide reacts with lignin and forms soluble compounds. The cooked pulp is discharged into blow tanks and washed to remove about 90% of spent liquor. Washed pulp is taken for screening to remove uncooked wood chips. Then the pulp is bleached and fed to thickener to concentrate the pulp and collect in pulp chest, from where it is converted into sheets in sheeting machine.

The wood pulp, is steeped in 18% caustic soda solution and the excess caustic soda is pressed out mechanically. The resulting product, called Alkali cellulose, is disintegrated into fine crumbs mechanically and aged in small tanks for a period of about 24 hours. The tanks are mechanically lifted to the top floor of the factory and dumped into the Xanthating machine where it is treated with carbon-di-sulphate liquid. The resulting Xanthate is dissolved in dilute caustic soda solution. This solution, called Viscose flows by gravity to the mixing machines situated beneath them where it is mixed very well to get a homogeneous solution. It is then pumped to the ripening room where the viscose is filtered thrice, the air bubbles are removed from the solution and pumped to spinning.

In case of staple fibre, the solution passes through spinnerettes made of gold and platinum having 23000 holes. As soon as the solution comes in contact with dilute sulphuric acid mixed with sodium sulphate and zinc sulphate the cellulose in the viscose is regenerated and comes out in the form of yarn.

In case of Rayon, the viscose flowing through spinnerettes made of gold and platinum having 28, 40 and 36 holes comes in contact with spin bath containing sulphuric acid, sodium sulphate and zinc sulphate and the cellulose is regenerated from viscose, comes out in the form of yarn. Simplified process flowsheet is shown in Fig. 2. Yearly production statistics and main raw materials consumed are depicted in Table 1 and 2. Organization chart of the industry is shown in Fig 3.

Material Audit
Methodology

Keeping in view the process activities envisaged, it was decided to conduct studies on pulp process units and utilities as pulp plant is the major source of pollution and the heart of the entire plant. Available information on different process units involved in the manufacture of pulp was collected along with data on the manufacture of rayon, Viscose Staple Fibre, sulphuric acid and carbon-di-sulphide. Material balance diagram was developed.

On the basis of the developed material balance scenario, it was shown that the present loss of wood in chipper section (1 to 2%) may be reduced to 0.5 to 0.75% by regularising the waste collection systems.

Energy Audit
Methodology

Basic data regarding operational features and working of various process units, overall energy consumption, its cost and production figures for the last 3 years was collected. These figures, when compared gave a trend of energy consumption and its cost per unit production over the year. When sufficient data was built-up, existing records of consumption was reviewed and

measurements were taken wherever necessary using portable instruments.

"Pie-diagram of energy consumption" was prepared to indicate the share of various forms of energy in the total energy consumption of the plant.

Energy conservation potentials drawn on the basis of this Natural Resources Availability Audit for electrical and thermal energy is shown in Table 3.

Water Audit Methodology

Water audit studies aimed at evaluation of raw water intake facilities, performance evaluation of existing water treatment plants, water consumption in different processes and development of water balance scenario highlighting water conservation measures.

Table 4 depicts the water conservation potential drawn based on the studies.

Environmental Quality Audit Methodology

1. Ambient Air Quality monitoring was carried as a part of Natural Resources Availability Audit studies to assess the status of existing air quality within the industrial complex
2. In order to quantify the stack emissions as a part of audit studies, stack monitoring was carried out at steam boiler, liquor preparation section of pulp plant, VSF, Rayon, H_2SO_4, and CS_2 plants
3. Monitoring of sectional and combined wastewater discharges were carried out during audit studies. Performance evaluation of Effluent Treatment Plant was undertaken
4. Workzone monitoring was carried out to know exposure concentrations during audit studies.
5. Noise levels were measured as a part of audit studies after identifying critical noisy zones
6. Existing facilities for handling/ disposal of solid/ hazardous wastes were critically examined

Table 5 depicts the outcome of Environmental Quality Audit Studies.

Health & Safety Audit Methodology

Preliminary information (through Questionnaire, Protocols) on health/ safety aspects was collected. Occupational health data & accident scenario were gathered through audit exercises, pre-audit meetings and inspection. As a part of Health and Safety audit, damage distances were evaluated using 'EFFECTS'_ software and suggestions were drawn for improvement in these aspects.
Table 6 depicts the outcome of health/safety audit studies.

Audit Implementation

The suggested measures during the Natural Resources Availability Audit programme are being implemented by the industry in a phased manner. The industry is already recording savings in the implemented suggestions.

1. Water audit studies have indicated that it is possible to save an amount of Rs. 0.97 lakh per annum
2. Major conservation opportunities exist in the field of wastewater treatment which yields a saving to the extent of Rs. 52.00 lakhs per annum
3. Energy conservation opportunities exist in major areas like TG sets, substation,

Rayon & VSF spin bath and acid plant waste heat boiler and it is possible to save an amount of Rs. 72.47 lakhs per annum by adopting suggested energy conservation measures

Table.1 Yearly Production Statistics

Sr No.	Category	April 89 to March 90	April 90 to March 91	April 91 to March 92	April 92 to March 93
1	Rayon yarn	5,109	4,706	4,663	4,909
2	Wood pulp	42,715	45,015	46,025	51,103
3	Viscose staple	13,123	14,628	14,339	19,220
4	Sulphuric acid	26,257	30,594	44,681	35,632
5	Carbon di sulphide	3,787	4,566	4,047	5,592
6	Sodium Sulphate	7,469	5,427	6,120	7,922

NOTE: ALL FIGURES ARE IN METRIC TONS AND ON DRY WEIGHT BASIS

Table.2 Main Raw Materials Consumption

Category	1990-91	1991-92	1992-93
Pulp wood	1, 41,521	1, 48,064	1, 642, 50
Sulphur	23,099	26,538	26,582
Liquid Chlorine	1,610	1,469	1,972
Caustic soda	15,941	15,247	20,312
Limestone	9,260	8,916	9,493
Charcoal	2,074	1,851	3,204

NOTE : ALL FIGURES ARE IN METRIC TONS AND ON DRY WEIGHT BASIS

Table.3 Energy Conservation Potential

Sr. No	Details of Recommendations	Savings in Steam		Savings in Electricity		Cost of Implemen-tation Rs. Lakhs	. Simple Payback Period Yrs
		Tons of Steam/yr	Rs. in Lakhs per year	Lakh kWh per year	Rs.in Lakhs per year		
	Electrical Systems						
1	Achieving optimum loading on distribution transformers at outdoor substation	-	-	0.135	0.27	NIL	Immediate
2	Achieving optimum loading on Effluent Treatment substation transformer	-	-	0.119	0.238	NIL	Immediate
3	Providing capacitor banks of capacity 2 MVAR on 22 KV side at the main out door substation % savings in maximum demand	-	-	-	12.29	25	Immediate
4	Operating TG sets at an optimum power factor to increase active power generation and to improve efficiency of TG sets Electric Drives and Lighting	-	-	72.93	12.29	-	-
5	Replacement of oversized motors with optimum size ones in agitators, exhaust blowers, pumps and driers	-	-	0.912	1.82	5.43	3

	fans						
6	Providing PF controller Electronic Energy Saver) for slurry presses	-	-	0.096	0.192	0.72	3.8
7	Switching off fluorescent lamps during 8 Am - 5 PM in Rayon spinning and Rayon spindle expansion	-	-	0.87	1.74	NIL	Immediate
8	Rational use of quality inspection table fluorescent lamps Marginal Immediate Boiler, Steam and Process Aspects	-	-	0.19	0.38	Marginal	Immediate
9	Sensible heat recovery from boiler continuous blow down	315	1.16	-	-	1.0	0.9
10	Heat recovery from hot flue gases evolving during charcoal calcining	270	0.90	-	-	4.0	4.5
11	Heat recovery from hot ammonia refrigerant gas in CS2 plant	375	1.35	-	-	4.0	3.0
12	Energy savings in controlling CS2 plant cooling tower fan	-	-	0.097	0.0194	0.20	1.0
13	Improving thermal insulation of viscose staple fibre dryers 1,2,3	583	2.34	-	-	4.2	1.7
14	Recovering steam condesate from VSF 1,2, & 3 dryers and sending to boiler plant	36.3	0.362	-	-	0.25	1.7
15	Heat recovery from Rayon VSF1 spin bath concentrator steam condensate	3675	14.7	-	-	15.0	1.0
16	Improving thermal insulation of three Rayon tunnel dryer second zone	636	2.55	-	-	3.0	1.2
17	Recovering rayon plant tunnel dryer steam condensate	25	0.10	-	-	Marginal	Immediate
18	Derating rayon plan twin lobeblower or providing air receiver	-	-	0.343	0.685	0.70	1.0
19	Raising steam generating pressurein acid plant waste heat boiler(generated electricity cost Rs. 0.60/ unit)	-	-	22.19	13.30	25.0	1.9
20	Sensible heat recovery from evaporator foul condensate Compressed Air	2252	9.0	-	-	10.0	1.1
	Compressed air						
21	Drawing fresh cold air from outside compressor house through ducts	-	-	0.11	0.22	0.25	1.1
22	Cleaning of intercoolers in Khosla 2 instrument air compressor in power plant	-	-	0.16	0.32	0.10	0.3
23	Heat recovery from Khosla compressor 4 used for sulphur burners in pulp plant	68.0	0.27	-	-	0.27	1.0
	Total	8235.5	32.73	98.41	39.74	99.12	-

Table.4 Water Conservation Potential

Sr. No.	Measures	Estimated Investment (Rupees)	Savings per annum (Rupees)	Payback period (Month)
1.	Water reuse in Chipper House	20,000	97,200	2.5

(Basis: Piping installation cost Rs. 20,000
Raw Water pumping cost = Rs. 0.90/m3, Reduction in water requirement = 360 m3/d
Number of working days per annum = 300

Table.5 Outcome of Environmental Quality Audit

Sr. No.	Measure	Estimated Investment	Savings per annum (Rupees)	Payback Period (Years)
1.	By providing pre clarifier for pulp plant effluent before sending the same to ETP (Basis : Pulp accumulation rate = 10 tons/day; Number of working days = 300/year; Pulp cost = Rs.250/t)	10,00,000	7,30,000	1.5
2.	Reduction in cleaning frequency of equalisation tank (Basis : Cost of cleaning per year = Rs. 1,50,000)	Nil	1,25,000	-
3.	Discontinuation of air blowers in equalisation tank and stoppage of 7 aerators in aerated lagoons (Basis : 50 HP aerators Power cost = Rs.1.90/KW	Nil	43,45,000	-

Note :

1. Ambient Air Quality Monitoring indicated that concentration of SPM, SO2, NOx were below the prescribed limits suggested by CPCB for industrial/mixed zones.
2. Work-zone monitoring results show that at all places concentrations were within the limits prescribed by TNPCB
3. Noise levels measured within the factory premises were within the ambient noise standards prescribed by CPCB and sound pressure levels were within the safe values prescribed based on occupational health criteria
4. Hazardous wastes generated are within the regulatory quantities as per Hazardus wastes (Management of Handling) Rules of 1989.

Table.6 Outcome of Health/Safety Audit

Sr.No.	Suggestions
1	Safety function be reinforced to give special emphasis on occupational health aspects
2	Safety organisation is adequate to meet the requirements of Factories Act. But analysis and investigation of work-area toxics to be undertaken
3	Chemical storages are as per GOI rules, 1989
4	Chlorine leakage in bleaching section to be checked thoroughly
5	Proper guidance in "Material handling" is a must to avoid accidents in wood yard and Chipper Section
6	Communication system to be strengthened between management and employees.

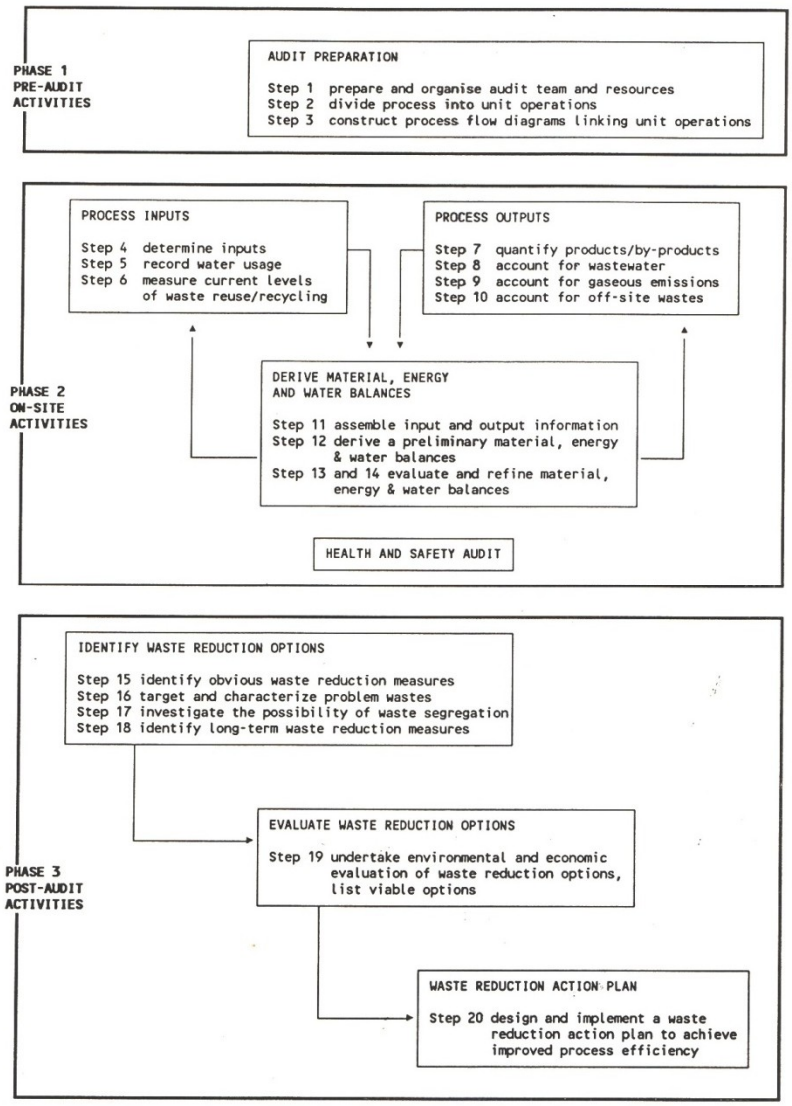

FIG 1 . : METHODOLOGY FOR ENVIRONMENT AUDIT APPROACH

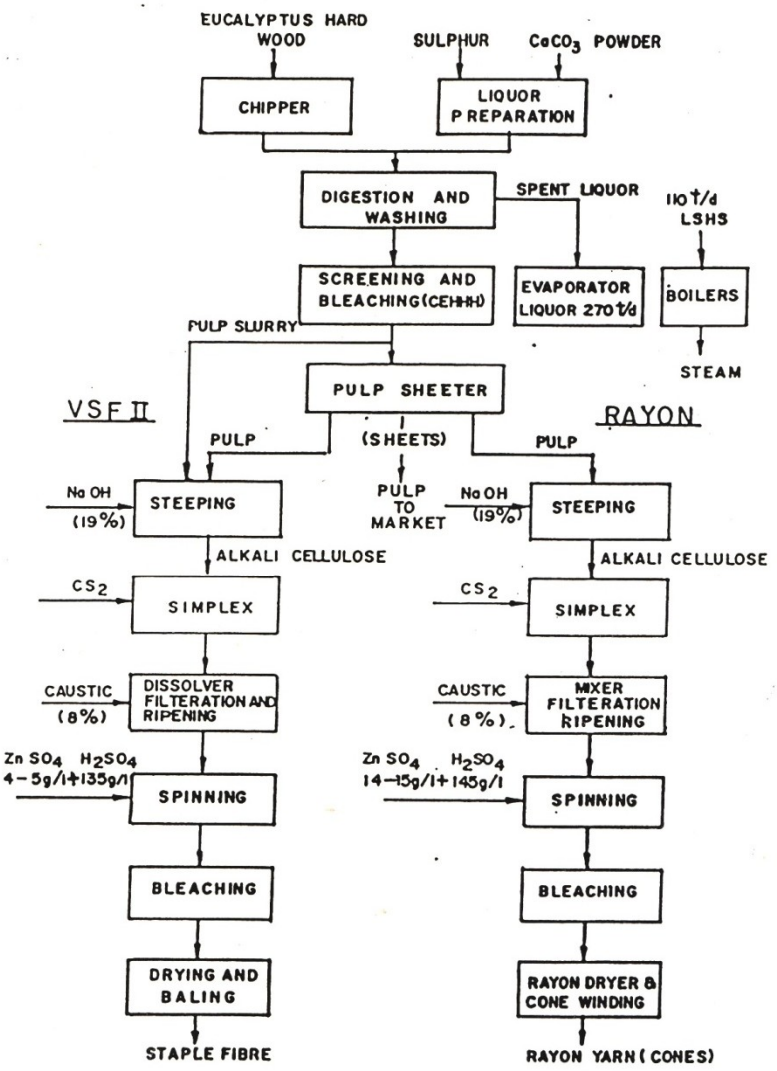

FIG. 2 : SIMPLIFIED FLOW SHEET

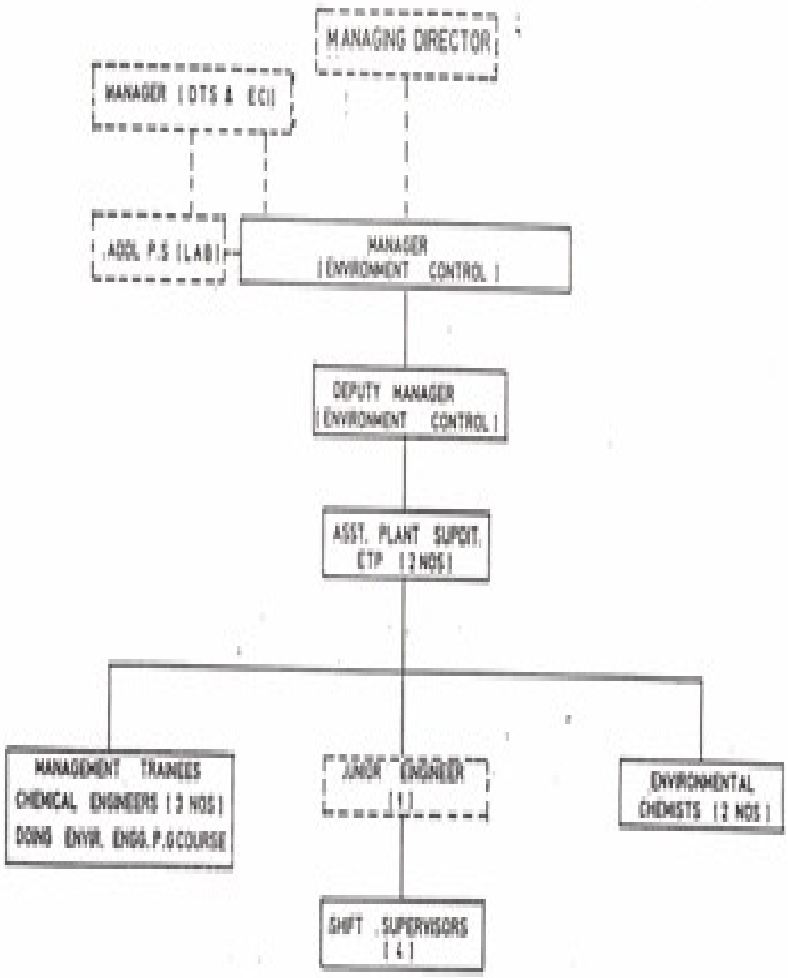

FIG. 3 ORGANISATION CHART (ENVIRONMENT CONTROL DIVISION)

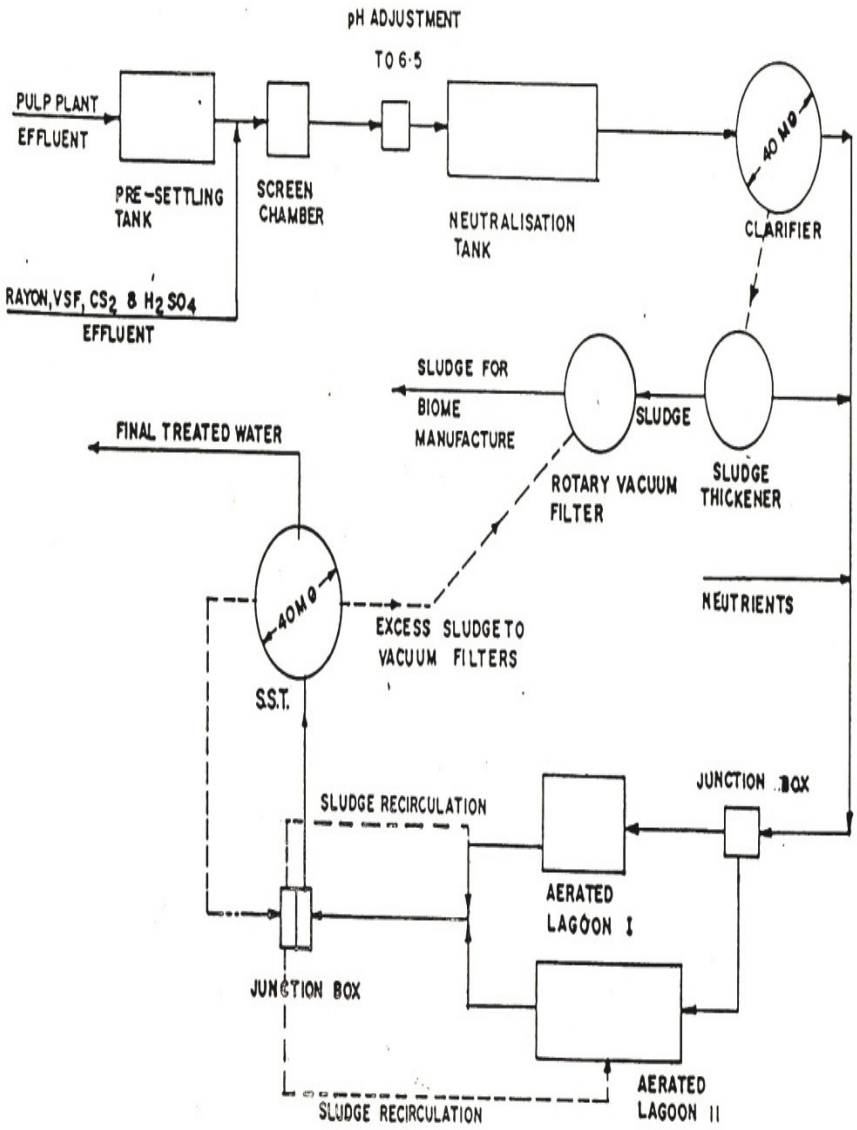

FIG. 4. SUGGESTED FLOWSHEET OF EFFLUENT TREATMENT PLANT

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