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(भारत सरकार का संगठन)
पर्यावरण एवं वन मंत्रालय
Central Pollution Control Board
(A Govt. of India Organisation)
Ministry of Environment & Forests
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Chairman

FOREWORD

Units processing Cashew seeds are concentrated in a few coastal states of India. Even though there is cashew seed cultivated in the country, most of the product demand is met by importing raw cashew seeds from South Africa. The processed cashew kernels are domestically marketed and also exported to the Gulf and the European countries. There are about 1500 units, scattered in Nagercoil (Tamilnadu), Cheerla & Palasa (Andhra Pradesh), Kollam, Pathanamthitta & Trivandrum (Kerala), Mangalore (Karnataka) and in Goa.

The units are mostly in small scale and cottage sector without any effective pollution abatement system. Though the pollution load from individual unit is relatively small but the magnitude of pollution problem from the cluster of units becomes very high. Therefore, it became necessary to study the entire cashew nut processing industry sector in India to suggest techno-economically feasible solutions, keeping in view also that the units are mostly in small scale and cottage sector. With this objective the Central Pollution Control Board (CPCB) took up this study with the help of the Dr. Ambedkar Institute of Productivity-National Productivity Council (AIP-NPC) Chennai. The Study has now been completed and based on its findings, the techno-economically viable pollution control technologies, the standards for gaseous emissions, wastewater discharge and noise pollution have been innovated. The proposed standards have also been recommended by the Peer & Core Committee of the CPCB for consideration by the Ministry of Environment & Forest for notification under Environment (Protection) Act, 1986.

I am thankful to my colleagues Dr. A.B. Akolkar, Additional Director, Shri R.C. Saxena, Sr. Env. Engineer, and Ms. Alka Srivastava, Sr. Research Fellow for bringing out this comprehensive document under the guidance of Dr. B.Sengupta, Member Secretary.

I hope that this document will be useful to the Cashew Seed Processing Units, Regulatory Agencies, and all the concerned with the Environmental Management.

(J. M. Mauskar)
Chairman

27 July, 2007

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C O N T E N T S

8.0 Environmental Standards approved by the Peer & Core Committee of Central Board

FIGURES

ANNEXURES

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1.0 Background

Cashew nut processing industries are one of the promising sectors producing valuable commodity exported to Gulf, European and Western countries. The industry is categorised as small scale/cottage units and there are about 300 units scattered in Nagercoil district, Tamilnadu, about 270 units in Kollam district, Kerala and about 130 units at Palasa-Kasibugga, Andhra Pradesh. There are also concentration of these industries in Cheerla - Andhra Pradesh, Mangalore - Karnataka and few units in Goa. The capital investment on the units is varying between 6.0 lakhs – 15.0 lakhs. Even though there is cashew nut (seeds) cultivation in the country, most of the production demand is met by importing Cashew Nut from South Africa by the units in Tamilnadu and Kerala.

There are two commonly followed methods of cashew nut processing, viz. Roasting process and Steam (roasting) Cooking process. In cooking process vegetable oil is extracted from the cashew shell of the seeds, which has market in paint and adhesive industry. Due to lack of skilled man-power for cutting process of cooked nut and difference in taste of nut, most of the industries are following roasting process.

In the cashew nut roasting process, thick black smoke is released from the rotating roasting drum through the stack. The smoke, when it reaches the ground, has irritating odour and is public nuisance in the neighborhood. Borma heater is also a source of air pollution. Wastewater is generated from the quenching operation of the roasted cashew nut discharged. Cooking process also discharges wastewater from the steam cooker and emits air pollutants by Baby Boiler for steam generation and Borma heater.

Since these industries are small and cottage category units and no conventional and techno-economically cost effective pollution abatement systems are in operation elsewhere, it has become necessary to study the entire cashew nut processing industry sector in India to suggest techno-economically feasible environmental standards. Even though the pollution load from individual unit is relatively low, the magnitude of pollution problem from the cluster of units is very high. Keeping in view of the small scale category of the industry, it is necessary to study the industry in detail before establishing environmental standards.

2.0 Details of Work Carried out

- Survey of the Cashew nut industries in Andhra Pradesh, Kerala, Tamilnadu and Goa and collect the information of process and equipment variations

- Study of field data and identification of model units two in Andhra Pradesh, two in Kerala and two in Tamilnadu for further study

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- Analytical assessment of pollution parameters at the above model units and

S.No	State	No. of Units (Cooking /Roasting)	Processing Capacity, Minimum/Maximum Kg/day
1	Andhra Pradesh Palasa Other than Palasa Cheerala	 109 (- /109) 66 (27/39) 100 (90/10)	 400 - 1000 400 – 2000 400 - 1000
2	Goa	15 (15/ -)	200 – 700
3	Karnataka Udipi Mangalore Other places	 84 42 15 Cooking Process	 300 - 3000
4	Tamilnadu Nagercoil and Kanyakumari districs	300 (270/30)	300 - 1000
5	Kerala	100 (90/10)	300 - 1000

- evolution of pollution prevention / waste minimization measures

- Assessment of Air Pollution and Waste Water treatment requirements and preparation of basic design drawings

- Data analysis and recommendations for National Environmental Standards for cashew nut industries

Requests were made to respective State Pollution Control Boards and Pollution Control Committees to provide the information on number of cashew nut industries and operating practices in their respective States and Union Territories. As a part of the Comprehensive Industrial Document Standards for Cashew nut industries, visits were made to number of cashew nut units at Nagercoil (Tamilnadu), Kollam (Kerala) and Palasa (Andhra Pradesh) to understand the process and equipment variations. A comprehensive questionnaire was used in collecting the data from the industries. Since there are very few units in Goa and those units are also operating the same process with similar equipment as that of Tamilnadu and Kerala, no visits were made to the States of Goa and Karnataka. However the information of the units were collected from respective State Pollution Control Boards.

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Based on the preliminary visits to industries and the information collected from different cashew nut units, the following six representative units were selected as model units for detailed study of various environmental pollution parameters by conducting the field monitoring studies:

A) Nagercoil (Tamilnadu)

1) M/s Indian Resins & Polymers, Thengemputhoor – Cooking Process
   i) Steam Boiler Emissions
   ii) Cooker water discharge

2) M/s Chennai Cashew Co, Edaikodu – Roasting Process
   i) Roasting Drum Emissions
   ii) Borma Heater Emissions
   iii) Quench water discharge

B) Kollam (Kerala)

3) M/s Sun Food Corporation, Kureepally – Cooking Process
   i) Steam Boiler Emissions
   ii) Borma Heater Emissions
   iii) Cooker water discharge

4) M/s Sun Food Corporation, Kureepally – Roasting Process
   i) Roasting Drum Emissions
   ii) Quench water discharge

C) Palasa – Kasibugga (Andhra Pradesh)

5) M/s Vijayalakshmi Cashew Co, - Cooking Process
   i) Steam Boiler Emissions
   ii) Cooker water discharge

6) M/s Bhagyalakshmi Cashew Co – Roasting Process
   i) Roasting Drum Emissions
   ii) Borma Heater Emissions
   iii) Quench water discharge

7) Palasa – Kasibugga – General Ambient Air Quality Analysis

3.0 Process Description and Sources of Environmental Pollution

The cashew nut processing is highly manpower intensive, generally carried out during 0600 hrs - 1800 hrs only during the day time. The major steps in cashew nut processing are (Fig –1)

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Roasting Process

- Roasting
- Shelling
- Borma
- Peeling
- Grading & Packing

Cooking Process

* Cooking
* Cutting
* CNSL extraction
* Borma
* Peeling
* Grading & Packing

Most commonly used equipment and operation practices of cashew nut processing units following roasting and cooking are described here. However, the deviations and exceptions are discussed in the following chapters for respective units.

3.1 Roasting Process

3.1.1 Roasting drum

The roasting of cashew seeds is carried out in a manually rotating open drum of ϕ 600 mm and 2.5m length, with an inclination of axis (15^{o} – 20^{o}) to facilitate the flow of the material from inlet to outlet by rotation of the drum and gravity. The drum is placed in a 'dog-house' Initially the drum is heated externally by firing about 25 to 30 kg of roasted cashew shell for about 15 to 20 minutes. Once the drum is heated up, the cashew nuts are fed manually through an elevated hopper into the inlet of the hot drum. The drum is rotated manually, so that the cashew nuts are moved from inlet to outlet of the drum. Due to the high temperature of the drum, the Cashew Nut Shell Liquid (CNSL) in the cashew nut (calorific value 6000 kCal/kg) catches fire spontaneously and the nuts are roasted through the entire length of the drum without any supporting fuel. The hot gases from the inlet of the drum are discharge into atmosphere by a natural draft stack of about 15 – 18m height. The cashew nuts, in burning state, are discharged at the outlet of the drum and quenched immediately with spray of water to prevent further roasting. The water consumption by quenching process is in the range of 14 – 21 litre/ 100 kg of nut roasted. The ash generated from the drum initial firing with roasted shell is sprinkled on the wet nuts to prevent sticking. The quench water is collected in a oil trap and discharged on ground as wastewater. The water vapour and fumes generated while quenching are discharged by independent short vents connected to the dog-house. In some units, these vents are also connected to the main chimney.

The cooled nuts are sent for shelling. The manual feeding of the cashew nut and the rotation of the drum are so synchronised that about 6 to 7 bags (Each bag weighs about 80kg of cashew nut) of cashew nut are roasted in an hour. The units in Nagercoil carrying out the roasting operation in two batches of 1 hr each

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where as the roasting operation is carried out in one batch for about 2 – 3 hrs in the units at Kerala as well as at Palasa (Andhra Pradesh).

3.1.2 Shelling

Shelling is the breaking operation of the quenched and cooled cashew nuts, carried out manually). The cashew kernel from the processed nut is collected for further processing. About 22 – 25 kg of kernels are collected from 80 kg (1 bag) of cashew nut (Fig 2). The roasted cashew shell resulting from the shelling process has calorific value of 4600 kCal/kg and is used as fuel within the process and also sold as fuel in the market. The firing of roasted cashew shell generates more particulate matter (soot) due to the presence of 10 - 15 % of CNSL remaining in the shell.

3.1.3 Borma

The kernel coming from the shelling section (Roasting Process) as well as Cutting Section (Cooking Process) contains a brown cover, known as 'testa', over it. To remove testa over the kernel and also control the moisture content in the kernels, they are Exposed to prolonged and controlled heating with hot air at 80 - 90 ^{o}C for about 9 hrs to 10 hrs in a chamber. About 5 – 8% of moisture is removed from the kernels in the process. This process is known as "Borma". The hot air is generated by indirect heating of atmospheric air over hot surface in a "Oven". The hot air form a loop between the Oven and the chamber.

The Borma Ovens are fired with cashew shell (from Roasting Process) or de-oiled cashew cake (from Cooking Process) for about 4 – 6 hrs depending on the quantity of kernels to be dried. The flue gases from the oven are discharged by a natural draft stack of about 13 – 15m high. In some units in Kerala, the Borma operation is also carried out by electric heaters.

3.1.4 Peeling, Grading & Packing

The brown cover (Testa) over the Borma processed kernels from the oven are easily peeled out manually. About 1kg of testa is generated from 1 bag of cashew nut processed. The testa has market value as vegetable tanning agent in leather industries. The kernels are also graded manually according to the size and shape. The product cashew kernels are packed according to their quality in tins and polythene packets with industrial carbon dioxide and nitrogen mixed gases. The gases are handled in cylinders and there are no associated pollution problems, but for gas cylinders handling and safety**.**

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FIG – 1: CASHEW NUT PROCESSING & DISCHARGES TO ENVIRONMENT

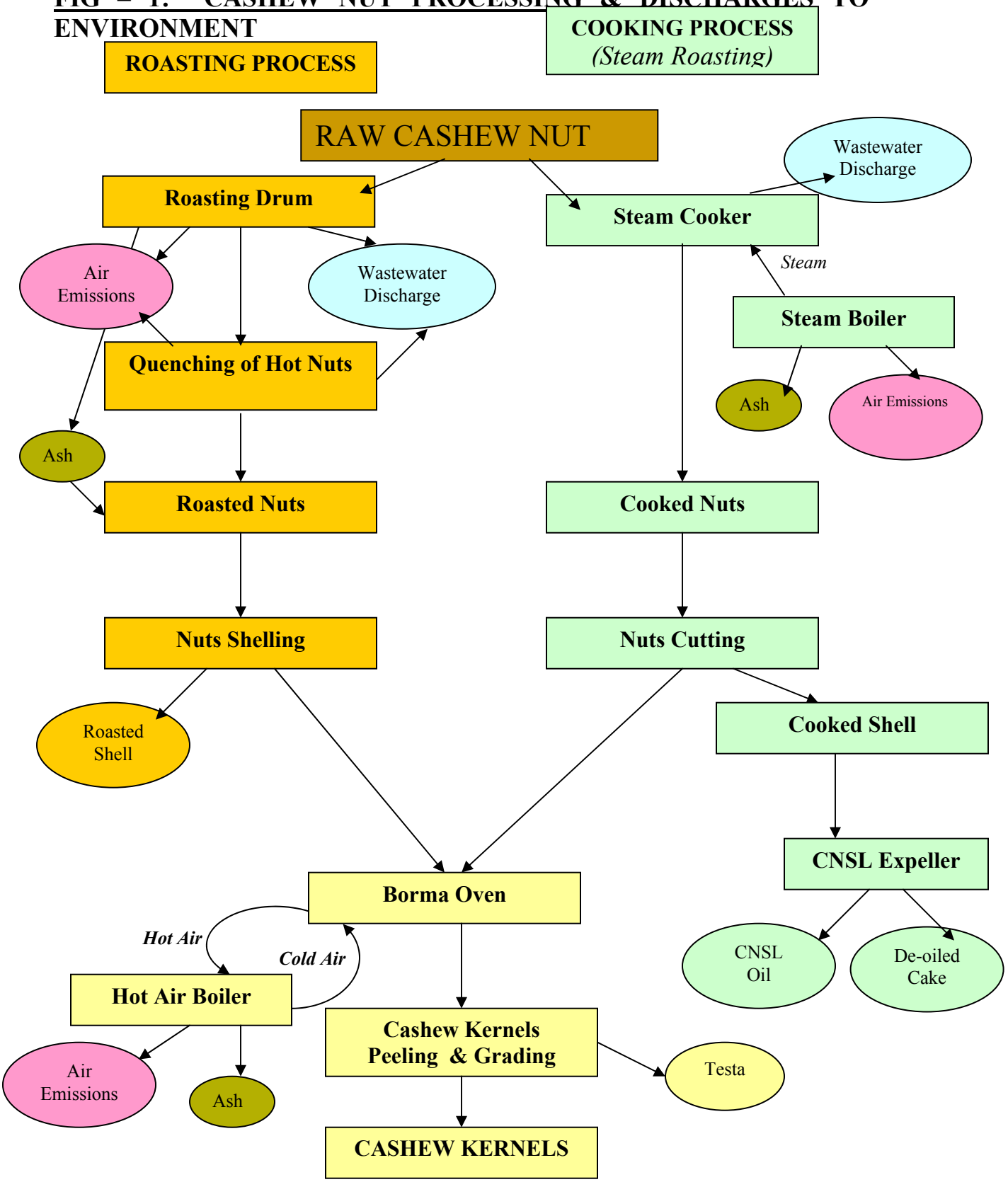

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Fig – 2: Cashew Nut Roasting Process Yield

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3.2 Cooking (Steam Roasting) Process

The steam roasting process, commonly known as “cooking process” consists of a baby boiler followed by a steam cooker where the cashew nuts are cooked with steam.

3.2.1 Baby Boiler

The baby boiler is a hand stoked fire tube boiler, which produces steam at 7.0 – 8.5 kg/cm^2. The roasted cashew shell or de-oiled cake are fed manually (about 2 to 3 kg fuel once in 15 to 20 minutes) at the bottom of the boiler. The combustion air is drawn through the grate by natural draft stack at the top of the boiler. The flue gases from the boiler are discharged into atmosphere through the stack 12 – 15m high. The flue gas emissions from the boiler are the source of air pollution.

3.2.2 Cashew Nut Cooker

A cylindrical steam cooker with provision of cashew nut feeding at the top and discharging of cooked nuts from the side near bottom, has a capacity of holding 4 bags (80 kg each) of cashew nut in a batch. Once the cashew nut is loaded, steam from a boiler is introduced into cooker at a pressure of 7.0 – 8.5 kg/cm^2. The cashew nuts in the cooker are steam cooked and when all the nuts are sufficiently cooked, the excess steam starts releasing near the bottom outlet. The steam is injected into the cooker till the steam starts escaping form the outlet mouth of the cooker. This process takes about 10 – 20 minutes time. Then the steam injection into the cooker is stopped and the condensed water at the bottom of the cooker is discharged in to a container and disposed on ground through septic tank . In cashew nut cooking process in Kerala have different process in steam injection quantity. The steam is injected for about 15 minutes even after the steam starts escaping from the outlet mouth of the cooker. This method consumes more steam.

The cooker condensate water is the source of water pollution. The cooked cashew nut are removed from the bottom of the cooker and spread on the floor for cooling. The cooled nuts are sent for cutting section to cut open and collect the kernel. The total batch time is about 40 –45 minutes. Usually, the units are provided with a baby boiler and minimum two cookers, while one cooker is in cooking operation, the other cooker is in unloading and loading operation. Normally the cooking operation is carried out for 2 – 4hrs in a day, cooking 5 to 10 batches of nuts, depending on the production capacity of the units.

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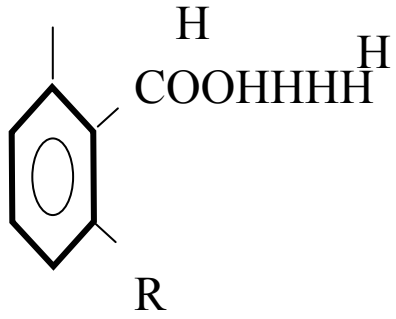
3.2.3 Cutting Section

The cooked cashew nuts are spread over the floor for drying and cooling, minimum 8 – 10 hrs. The dried and cooled nuts are cut open in cutting machines manually and the cashew kernel is collected. This section operates for about 8 hrs in a day. The collected kernels undergo Borma operation (see 3.1.3) followed by peeling, grading and packing as described in 3.1.4. About 47 kg of cashew shell is generated from 80 kg (1 bag) of cashew nut in cooking process and the separated cashew shell resulting from this section is sent for Oil expeller unit for extracting valuable Cashew Nut Shell Liquid (CNSL).

3.2.4 CNSL – Oil Expeller

Cashew nut shell oil (CNSL) contains “Anacardic Acid” a substitute phenol as described below:

Aromatic 2 Carboxy –
3 Alkyl Phenol (90%)
pH = 6 (Weak Acid)
Volatile Matter < 2%



CNSL is used as resin in brake linings, industrial belts, in lacquers and paints, antifungal agent etc. The complete combustion of CNSL in cashew nut or cashew shell results in carbon dioxide and water vapor. The CNSL expeller has a crusher where the cooked cashew shell is crushed and the oil is extracted About 7 kg of CNSL is extracted from 47 kg of cooked shell (Fig – 3). The oil is filtered further to separate the mud and sediments, which are sold in the market. The oil extracted shell is known as “De-oiled cake” which has market value as fuel (calorific value 4400 kCal/kg). In some units, the de-oiled cake is further under go solvent extraction to collect the last traces of oil and sediments are used as fertilizer. Except oil spillages and improper house-keeping, there are no sources of pollution in this section

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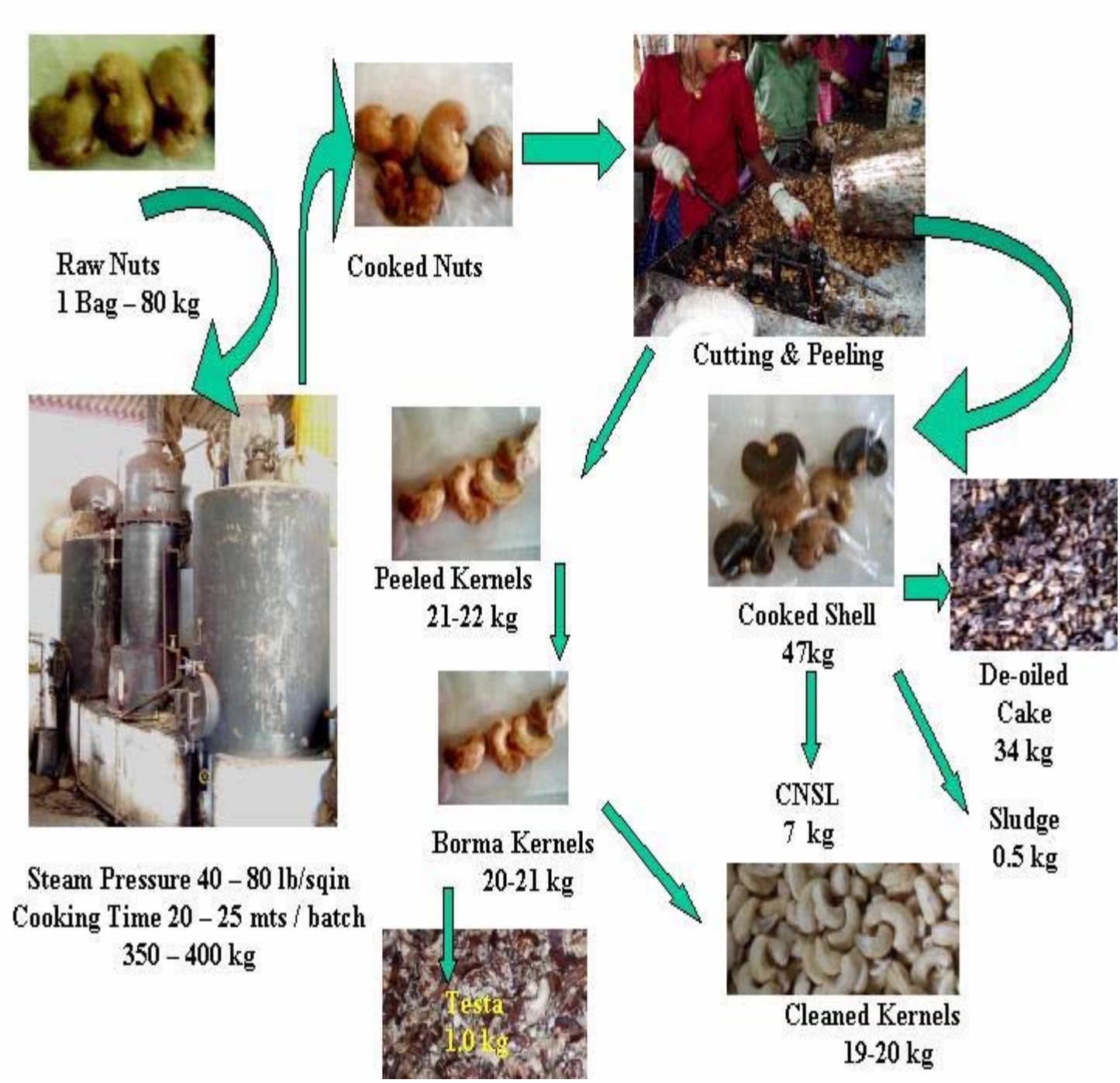

Fig – 3: Cashew Nut Cooking Process Yield

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4.0 Monitoring Methodology

The sampling and analysis of respective the environmental pollution parameters were conducted by following the standard methods, procedures and guidelines prescribed by Central Pollution Control Board, New Delhi (Emission Regulations – III, CPCB Publication 1985)

4.1 Air Pollution

4.1.1 Stack Emission Monitoring

Stack sampling ports were fabricated in the stacks at representative cashew nut units where the flow parameters are stabilized using minimum 5D criteria. In some units, exiting port holes were used (which are already in use by respective State Pollution Control Boards) due to approach constraints. However velocity measurements were repeated during the period of sampling to ensure that there was not change with time. The velocities at requisite traverse points were measured by using standard pitot tube and micro manometer. The average velocity across the stack cross-section was calculated. The temperature of the gases was measured with Cr-Al thermocouple. The flue gas analysis in terms of CO_2, CO, O_2 and NOx were conducted by a direct reading flue gas analyzer by MRU, German make approved by Technische Übervachung Vereinigung (TÜV), Germany, instead of Orsat's apparatus which is cumbersome and time consuming. The instrument has electrochemical cells, which can analyse the respective gas components instantaneously and report the readings in percentage or ppm as case may be. An average of 10 minutes continuous measurement were taken and such measurements were repeated 2 to 3 times during the period of sampling and the average value is reported.

Stack sampling train made by Strölein, Germany was used for particulate and gaseous sampling .The particulate matter concentrations were measured by thimble holder method under iso-kinetic sampling conditions. The sulfur dioxide concentrations in the flue gases were measured by IPA – wet chemistry method.

The phenolic compounds in the flue gases were measured by chloroform extraction method. Gas samples were absorbed in 0.1N NaOH. The absorbed air samples were reacted with 4-aminoantipyrine in presence of potassium ferri cyanide to form antipyrine dye which was extracted with chloroform. The absorbance was measured with UV spectrophotometer at 460 nm. Same analytical procedure was followed for the analysis of wastewater samples from cooker, quenching process. The minimum phenolic compounds measured in air and water samples were 0.02 mg/Nm^3 and 0.05 mg/litre respectively. (Standard

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Methods for Examination Air and Wastewater Samples published by Americal Public Health Association, Washington DC, 1995)

4.1.2 Ambient Air Quality Monitoring

The units in Kerala and Tamilnadu are bit isolated units surrounded by well developed green cover. No deposits of dust or impact by the cashew nut unit were observed on trees and surrounding areas.

The units in Palasa (Andhra Pradesh) are developed as a cluster surrounded by residential houses. Once all the units start operation simultaneously, there is visible build up of smoke in the atmospheric.air It was felt necessary to conduct ambient air quality monitoring in Palasa – Kasibugga town to study the impact of the emission on the ambient air. Ambient air quality monitoring was analysed by installing RPM sampler of Envirotech, New Delhi make. The sampler was located on the terrace of residences in the midst of cashew nut units and measured the SPM concentration during the working and non working period of cashew nut units .

4.2 Wastewater Discharges

Since the cashew nut cooking process is a batch process, the quantity of the water discharge from the cooker per batch was collected and measured in litter per batch. The wastewater discharge from quenching of cashew nut in roasting process were collected for specific time using stop watch and the discharge rate was calculated in litter/hr. Since the cashew nut process was limited only for few hours in a day, the total wastewater generation load per 100kg of cashew nut cooked was calculated.

Ground water samples in and around the cashew nut processing units were also collected and analysed to study the influence of waste water discharges by the units on the ground. All the wastewater samples were analysed for pH, TSS, TDS, o&g, BOD, COD and Phenolic compounds (represented as phenols). The actual domestic water consumption by the units was assessed with the help of the information by the respective unit management.

4.3 Noise Pollution

Noise levels in dBA in roasting drum area, shelling section, baby boiler and cooking section, Borma operation and peeling and grading sections of the units were measured using a noise meter made by Brül and Kajer, Denmark.

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5.0 Field Data Analysis & Observations

The monitoring data of various parameters and different units are tabulated in Field Monitoring Data Tables 1 to 16 under Annexure - I.

5.1 Cashew Nut Roasting Units

5.1.1 Air Pollution – Roasting Drum Stack Emissions

Three cashew nut roasting units were studied and the feeding rate 7 to 8 bags of cashew nut in an hour. The initial drum heating is by 25 to 30 kg of roasted cashew shell for about 15 to 20 minutes, is almost same in all the roasting units. The cashew nut roasting process is carried out either in two batches of one hour each or in continuously for 2 hours in one batch depending on the labor availability for shelling and peeling.

The quenching of hot roasted nut at the discharge end of the drum releases water vapor continuously through out the roasting operation. The emissions from initial drum heating and quenching operations are discharged through two short vents of 5 – 8m height. The draft created by these short vents is not sufficient resulting fugitive emissions in the work area . In some units these vents are also connected to the main stack, where little improvement was observed so far fugitive emissions are concerned.

Generally the dog-house with roasting drum is located in a covered shed with open sides, providing well ventilated work area. On contrary, in Palasa cluster, the entire roasting operation is carried out inside a closed room, curtailing the dispersion of the fume generation from the dog-house. The work environment is suffocating with build up of the smoke from initial firing of the drum and also with the water vapour from quenching operation.

The natural draft by the stack is varying between 2 – 3 mmWc (Tables – 1 to 3). The process gases emissions from the roasting drum were varying between 1500 Nm^3/hr to 2500 Nm^3/hr and the gas temperatures were varying between 135 ^oC to 360 ^oC. However large volume of dilution air reduces the temperature of the gases causing reduction in combustion of the process gases and increase in soot formation.

The pollutant emission load in kg/hr for different pollution parameters are calculated and the range of variations are as follows:

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Roasting Drum Stack Emissions

Flow Rate of Gases NM^3/hr	Temp ^oC	SO_2	NOx	OH^-	PM	CO2 %
1500 - 2500	135 - 360	10 – 36 (0.02 – 0.07)	27 – 131 (0.05 – 0.17)	2.9 – 5.3 (0.005 – 0.01)	665 – 1468 (1.3 – 2.6)	1.5 - 4.0

Note: Avg concentrations are in mg/Nm3 and values in parenthesis are kg/hr

5.1.2 Ambient Air Quality at Palasa - Kasibugga

Unlike Tamilnadu and Kerala, where the cashew nut roasting units are scattered, about 130 units are concentrated as cluster amidst of residences in Palasa – Kasibugga area. All the units start roasting operation simultaneously at 6:00 AM and continue for 2 to 3hrs depending on the production demand. Between 6:00 AM – 9:00 AM the stacks of all the units emits black smoke into atmosphere. Once the roasting operation is completed for the day, the operation is started once again at 6:00 AM on the following day. Sunday is a weekly holiday and no operation is carried out on that day. The roasting operation in Palasa is carried out from April to December every year. There are no operations carried out from January to March, due to lean period.

To assess the ambient air quality during the working and non-working period of the units, ambient air quality samples for SPM were collected for 4 hrs each during the respective periods (Table – 4). The average concentration of SPM during non-working period was about 145 $\mu g/m^3$ and the roasting period the value is as high as 587 $\mu g/m^3$. The 8hr average SPM concentration during the day time is calculated as 250 – 366 $\mu g/m^3$.

5.1.3 Roasted Nut Quenching - Wastewater Discharge

The hot roasted nuts, in burning condition are discharged at the end of the drum and the flame is put-off by water spray. The water consumption by the spray nozzles at different units was varying between 60 – 120 liter/hr. It was observed that about 25% to 30% of water sprayed was evaporated or carried away along with the quenched nuts and the remaining water is discharged into drain. About 14 to 21 liter/ 100 kg of cashew nut cooked of quench water discharge was measured in the quench water drain.

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The quench water samples from three roasting units were analysed for different parameters (Tables – 5 to 7) and range of variation is as follows:

Quench process wastewater discharge

Flow Rate Liter/100 kg of cashew nut roasted	PH	TSS	TDS	O & G	BOD	COD	OH-
14 -21	7.2 – 8.2	1175 – 2115 (0.12 – 0.255)	2240 – 4284 (0.19 – 0.29)	1400 – 2068 (0.13 – 0.25)	5200 – 10,424 (0.16 – 0.625)	4,790 – 27,600 (1.2 – 2.2)	5.2 – 7.0 (0.0005 – 0.0007)

Note: Avg concentrations are in mg/liter and the values in parenthesis are kg/batch

5.2 Cashew Nut Cooking Units

5.2.1 Baby Boiler Stack Emissions

The steam required by the cookers is generated in a vertical fire tube boiler (7kg/cm^2 and 50kg/hr) .Roasted cashew shell or de-oiled cake is fed manually with shovels at the fire grate of the boiler. The hot combustion gases travel vertically by natural draft created by the stack at the top of the boiler. The steam boilers at three cooking units were studied. Stack sampling ports were fabricated in the stack and flue gas samples were analyzed for various parameters. Even though the fuel fired has no influence on the cooking process, to analyze the emission for different fuel firing, the boiler emissions at two units were studied additionally with de-oiled firing (Tables – 8 to12). The emission parameters were in the following ranges:

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Baby Boiler Stack Emissions:

Fuel Fired	Flow Rate of Gases NM^3/hr	Temp ^oC	SO_2	NOx	OH^-	PM	CO2 %
Roasted Shell	181 - 182	340 - 367	21 – 30 (0.004 – 0.005)	227 – 593 (0.04 – 0.11)	3.2 - 4.3 (< 0.001)	992 – 1270 (0.18 – 0.23)	4.2-5.7
De – Oiled Cake	193 – 495	340 – 720	12 – 29 0.003 – 0.006)	124 – 645 (0.03 – 0.1)	0.24 – 0.6 (<0.001)	382 – 535 (0.08 – 0.1)	13 - 15

Note: Avg concentrations are in mg/Nm^3 and values in parenthesis are kg/hr

5.2.2 Cooker – Wastewater Discharge

5.1.2

The cooker waster samples from three different units were collected and analysed for respective parameters (Tables – 5 to 7). There are different practices with the quantity of steam injection into the cooker. In some units the steam is injected into the cooker till the steam ejection appears at the outlet of the cooker. This method gives little condensate measure to be 0.8 – 1.9 litre / 100 kg of cashew nut cooked. Whereas in some units the steam is injected continuously for about 10 – 15 minutes even after the steam ejection appear at the outlet of the cooker. In such cooker the steam condensate quantity measured to be about 2.4 – 5.0 litre/ 100 kg of cashew nut cooked.

The wastewater parameters measured and the range of variations are as follows:

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Cooker – Wastewater Discharge

Waste Water Qty Litre/100kg of cashew nut cooked	PH	TSS	TDS	O & G	BOD	COD	OH^-
0.8 – 5.0	5.3 – 7.3	350 – 720 (0.001 – 0.006)	6028 – 13,416 (0.03 – 0.16)	24 – 52 (0.00002 – 0.00006) 0.03 *	2800 – 5000 (0.014 – 0.046)	6080 – 18,000 (0.045 – 0.098)	4.2 – 10.2 (0.00003 – 0.00009)

Note: Avg concentrations are in mg/liter and the values in parenthesis are kg/batch

5.3 Ground Water Quality around Roasting and Cooking Units

Since the cashew nut processing units are discharging waste water on ground for years together, to assess the present status of ground water in and around the cashew nut units in Tamilnadu and Kerala states ground water samples were collected and analysed for drinking water parameters. It is observed that the ground water quality is good and not yet contaminated by the discharges by the cashew nut processing units.

5.4'Borma' Oven - Flue Gas Emissions

The hot air oven is fired with Roasted shell or Deoiled caked, where the flue gases transfer the heat to the air flow over the fire tubes. The flue gases are drawn from the oven by natural draft stack. The emissions from three Borma ovens at three different units were studied. All the three ovens were fired with roasted cashew shell. The Borma oven firing continues for 4 to 6 hrs in day depending on the moisture content in the cashew kernels. The range of emission parameters as given below.

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'Borma' Oven - Flue Gas Emissions:

Flow Rate of Gases NM3/hr	Temp °C	SO_2	NOx	OH-	PM	CO2 %
186 - 996	190 – 352	10 – 48 (0.001 – 0.05)	55 – 146 (0.01 – 0.09)	0.4 – 0.8 (< 0.001)	363 – 587 (0.1 - 0.36)	1.0 – 2.7

Note: Avg concentrations are in mg/Nm^3 and values in parenthesis are kg/hr

However the Electric Borma Ovens, which are used by some of the small capacity units are pollution free

5.5 Noise Levels Monitoring

The noise levels in the roasting opeation, Borma operation, Cooking Operation, Shelling / cutting and peeling sections were measured. The range of variations are as follows:

Noise Levels (dBA)at different sections

Roasting Drum	Shelling	Cooking Operation	Cutting	Borma Operation	Peeling & Grading
81 - 85	80 - 83	78.7 – 81.0	80 - 82	73 - 75	68 - 70

5.6 Solid Waste Management

Each bag of cashew nut (80 kg) processed either by roasting or cooking process generates about 47 – 50 kg of roasted shell or de-oiled cake. None of the units have need to store these wastes as they have been used as fuel immediately or sold in the market. The 'testa' generated from the peeling section has continuous market demand where it is used as vegetable tanning agent in tanneries. The CNSL and the oil mud generated from the oil expeller units have export market in resin and paint industry. The ash generated from the initial drum heating is used in sprinkling over the roasted and quenched nut to prevent sticking. However the bottom ash from the Borma air heater and the steam boiler in the cooking process is land filled within the unit premises.

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6.0 Pollution Prevention and Abatement

6.1 Data Review

The pollution emission load (kg/hr) by cashew nut processing, both by roasting and cooking processes, is very low even though the concentrations of particulate matter emissions and wastewater discharges viz., BOD, COD, TDS are high.

6.1.1 The roasting and cooking processes are operating only for a small part of the day (maximum 2 to 4 hrs in a day) emitting pollutants. For the remaining part of the day, the industry is not discharging any trade effluent or air emissions in to environment.

6.1.2 The sulfur dioxide emission load is satisfied by the present stack height by the respective processes resulting in necessary dispersion. The nitrogen oxide emission concentrations are relatively low.

6.1.3 More than 2.0 kg/hr (3 kg/T of raw cashew processed) particulate emission (soot) concentrations were observed when improper combustion prevails due to high cashew nut input and low gas temperatures. The unburnts and soot formation is causing high particulate matter in emissions.

6.1.4 Phenolic compounds, reported as phenols C_6H_5OH, are less than 5 mg/Nm^3 in air emissions and less than 10 mg/ litre in wastewater batches.

6.1.5 There is no visible impact of the industry on the ambient air except at Palasa cluster (Andhra Pradesh).

6.2 Roasting Process

6.2.1 Dog-House Fume Extraction - Increase in Stack Height

The initial firing of the drum in the dog-house is for about 15 to 20 minutes with 35 to 50 kg of roasted shell. Even though there is a short vent connected to dog-house over the drum, the draft is not sufficient enough to extract the smoke. The quench water vapour generation is continuous throughout the roasting process and the connected short vent is not creating sufficient draft to extract all the fumes. In some units these vents are connected to main stack, to improve the situation. However the resultant draft improvement is not appreciable.

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Since the available natural draft is only in the range of 2 – 3 mmWc with the existing 15m high stack, it is necessary to increase the stack height to 20m (similar to that of units in Kerala), which can supplement the draft (Annexure – II) available to the drum and result in better dispersion. However, to improve the dog-house fume extraction, the short vents are connected to the Venturi Scrubber together with the emissions from roasting operation.

6.2.2 Process Optimisation

There are variation in raw cashew nut manual feeding rate in to roasting drum, which is influencing the flue gas temperature (135 ^{o}C - 360 ^{o}C), natural draft (2 – 3 mmWc) and particulate emission rate from 665 to 1500 mg/Nm^{3} due to incomplete combustion of flue gas and soot formation. It was observed that whenever the temperature of the gases is less than 180 ^{o}C and there is no visible flame at the feeding end of the drum, causing soot formation in the gases causing high dust emissions through chimney. The skilled personnel engaged for cashew nut feeding and the rotation of the drum are more concerned about the roasting process and not about the proper combustion of the gases at the feeding end of the drum. It is required to optimize and practice the feeding rate there by ensuring enough combustion of the gases, by maintaining the continuous flame at the feeding end of the drum. This will result in relatively lower dust emissions.

6.2.3 Air Pollution Control

In all the roasting units about 7 to 8 bags (80 kg each) of cashew nut are roasted in an hour. Depending on the man-power availability, number of hours of operation from unit to unit is varying. In general, roasting process is carried out for 2 hrs either continuously or with a break. The flue gas emissions are creating irritating odour to the neighborhood. The emissions from the roasting drum are treated in a Venturi Scrubber with a dust collection efficiency of 90 – 95%. as shown in the Fig - 4. The water discharge from the scrubber is collected in a settling tank and the clear water is recirculated to the scrubber by the pump throughout the batch period of 2 – 4 hrs in a day. Depending on the sludge collected at the battom of the tank, once 2 to 3 days the sludge is pumped to sludge drying beds.

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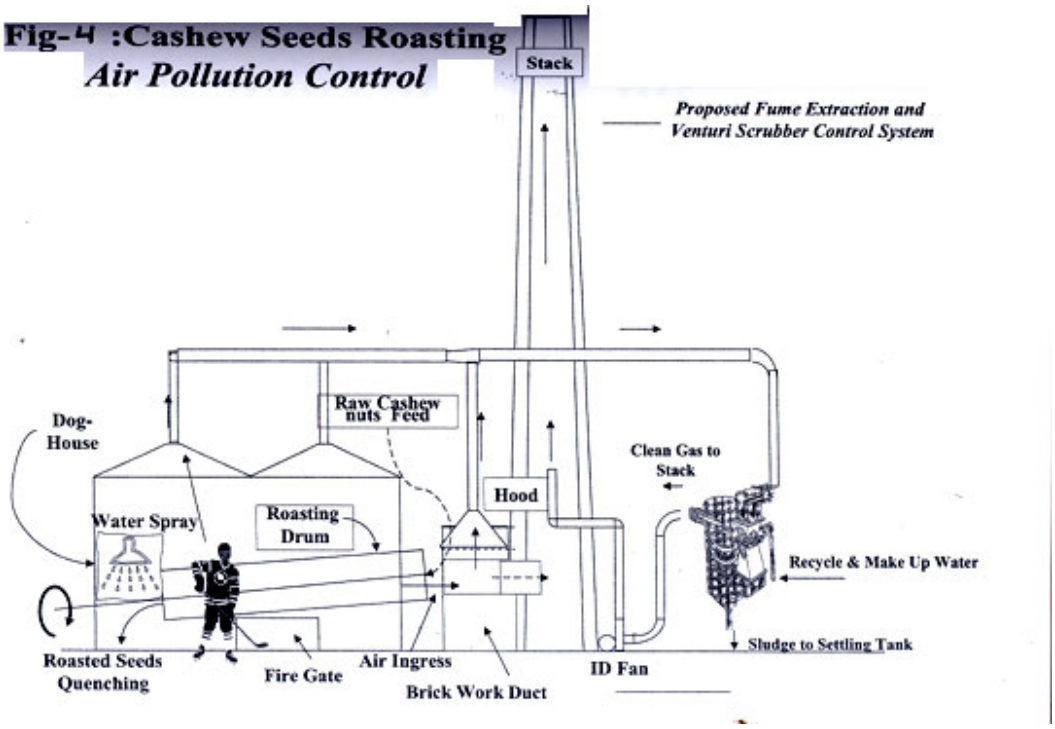
Fig-4 :Cashew Seeds Roasting
Air Pollution Control
Stack
Proposed Fume Extraction and
Venturi Scrubber Control System
Raw Cashew
nuts Feed
Dog-
House
Clean Gas to
Stack
Hood
Water Spray
Roasting
Drum
Recycle & Make Up Water
Sludge to Settling Tank
Roasted Seeds
Quenching
Fire Gate
Air Ingress
Brick Work Duct
ID Fan

- -

Venturi Scrubber Specifications

Application	**Roasting Drum operation emissions**
Air handling Capacity	5,000 ACMH
Air Pollution Control System	Ventury cum packed Bed Scrubber.
Centrifugal Exhauster	9.0 HP 1440 rpm
Motor Capacity	12.5 HP
Cost, Rs	2.25 Lakhs

This arrangement can reduce the particulate matter emission less than 0.2 kg/hr, resulting in maximum ground level concentration of less than 10 $\mu g/m^3$ (Annexure –III) at a distance of about 250m from the plant during the roasting operation.

6.2.4 Alternate Processes

6.2.4.1 Steam (Roasting) Cooking Process

The cashew nut processing by cooking (steam roasting) process, which is relatively less pollution intensive and an alternative process to roasting process has to be considered to avoid implementation of expensive air pollution control measures. In addition valuable CNSL can be recovered as by product.

6.2.4.2 Bio-Gasifier

The cooking process has a fire tube boiler for steam generation. The Borma Oven is also a fire tube boiler to hot air generation. In both the cases either roasted shell or de-oiled cake are used as fuel. Alternatively, the heat can be generated by biogas, produced by a bio-gasifier using roasted shell or deoiled cake as fuel. The bio-gasifier converts cashew shell (both roasted and de-oiled) into bio-gas which is a clean fuel and leaves no smoke upon combustion.

M/s Associated Engineering Works, Tanuku (Andhra Pradesh) are the suppliers of such biogasifiers with the following specifications (A copy of the information from the supplier is enclosed at Annexure – IV.)

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Fuel Consumption	:	100-125 kg/hr (Roasted shell or De-oiled cake
Heat output	:	2,50,000 kCal/hr (100 kw)
Floor space required	:	10ft x 10 ft x 15ft (height)
Cost of gasifier	:	Rs. 7.0 lakhs

About 5 kg of cashew nut shell, costing Rs 10/- max., generates bio-gas giving heat equal to that of 1 liter of Diesel oil, costing Rs 30/-, which is not only economical but also leaves no atmospheric pollution. The biogas can be used in

- Steam boiler in cooking process
- Initial firing of the drum in roasting process
- Borma boiler (indirect heat)

6.3 Effluent Treatment Alternatives

The following effluent characteristics from cashew nut roasting cooking processes are considered for effluent treatment alternatives

The design wastewater flow will be 200 litre/day (max) The wastewater will be collected in a terminal collection cum buffer tank. At 5000 mg/l, the BOD load is 1000 grams/day. Being a reclamation project, the entire wastewater has to be collected in a central place and treated to meet the good quality BOD norm of < 20 mg/l. The wastewater will be treated to render the following treated effluent quality:

- pH 6.5 to 8.5
- BOD, mg/l < 20 (3 days at 27oC)
- Turbidity, NTU < 3

Alternate -1 : SBR System

A typical SBR (Sequential Batch Reactor) system will consist of:

- Collection-cum-aeration-cum-settling tank
- Sand Bed Filter system for decanted water filtration
- Sludge drying bed for excess sludge

EQUIPMENT/FACILITY	Mini SBR System
Buffer Tank with pre-aeration	6.5 cum, below ground level, SBR concept

- -

Raw Effluent transfer pumps	Eliminated by SBR operational feature
Aeration Tank	SBR of 6.5 cum size with 7 Nos dome diffusers
Sedimentation tank	SBR itself renders Solid/Liquid separation provision
Sludge re-circulation pumps	Not required for SBR system
Treated water and sludge withdrawal pumps	1 No treated water transfer pump On/OFF operated and 1 No sludge withdrawal pump ON/OFF operated
Mini Blower	2 Nos (1W +1SB) each of 1.5 HP rating
Dome Type diffusers	9 Nos (2 as reserve)
Treated water holding tank	Not required, if disposal planned
PSF & ACF	Organic removals are maximum done using F/M ratio < 0.1 and for filtration "Sand Bed Filter" incorporated.
Process Controls	Timer control for pumps and simplified Operational Instructions for SBR mode of operation
Sludge drying beds	2 Nos based on net sludge production

EQUIPMENT/FACILITY	Mini SBR System
Plant Aesthetics	All units below ground level in a compact size and only 2 pumps and 2 blowers involved. Pump operates ON/OFF, while one blower continuously

The operational sequence will be:

- Continue to receive the process wastewater for seven days, while aeration is on
- On 7th day, stop the blower and allow the sedimentation for 1 hr.
- Switch on the transfer pump (pre-set at a depth) and regulate the withdrawal @ 2 cum/hr for 45 minutes via 2 Nos Sand Bed Filter system (1W + 1SB). This will drop the level equivalent to 1400 litres, 7 days feed rate.
- Once in a month, also carryout settled sludge withdrawal @ 2 cum/hr for 20 minutes. The sludge will be sent via 2 Nos Sludge Drying Bed of 0.4m X 0.4 m X 0.8 m (1W +1SB)
- Switch on the blower and repeat the above steps.

The investment cost of SBR will be Rs 4.5 Lakhs, (Annexure-VI)

Alternate -2 : Rotating Biological Contactor System:

- -

In this system, except holding tank, all other items are pre-engineered. The system will consist of:

- Buffer tank, integral part of packaged plant
- Feed pump of Water Wheel type connected to the RBC Drive itself
- Disk area 50 sqm, with adjoining lamellar separator
- Sludge disposal timer operated pump

The pre-engineered package RBC Technology is more compact and will eliminate most of the pumping operations in SBR. The investment cost of RBC will be Rs 4 - 5 Lakhs, (Annexure-VI)

6.4 Cashew Nut Roasting Units Cluster – Palasa - Kasibugga

The cashew nut roasting units are located as a cluster in the town Palasa – Kasibugga (Andhra Pradesh). The units are about 3 decades old and the town was developed subsequently. Presently it is a well-populated town and the units are amidst of the town. The units have been advised by local municipality to start the roasting activity at 6:00 AM and finish within three hours before the commencement of public activity and business hours.

The ambient air quality measurements during the roasting time (i.e. 6:00 AM to 9:00 AM) resulted in SPM concentrations in the range of 354 $\mu g/m^3$ to 607$\mu g/m^3$ leaving smoky ambience.

6.4.1 Change to Cooking process

It is suggested that the industries have to be change the roasting process to cooking with due consideration for the following:

- Train the persons in careful handling in cutting process
- Sitting the industries by following the sitting criteria.

6.5 Cashew Nut Industry - New and Relocation - Sitting Criteria

Even though the pollutant emission load in to environment by a single cashew nut unit is low, it has been observed that the total emissions load by number of such units in a cluster causes considerable environmental degradation. To avoid the combined effect by number of units on the environment, the cashew nut

- -

processing industries with roasting/cooking process have to be located with the following criteria

6.5.1 Cashew Seed Processing Industry shall be established at least 1.0 km away from residential area, hospital, schools, public building or a place where flammable substances are stores / processed and similarly such establishments should not be permitted within 1 Km from the existing Cashew Seed Processing Units.

6.5.2 Cashew Seed Processing Industry shall be established 5.0 km away from notified municipal limits of any town/city or airport.

6.5.3 Cashew Seed Processing Industry shall not be constructed within 200 m from the middle of Railway Tracks, National Highway and State Highway and 50 m from the middle of other roads.

6.5.4 In normal circumstances, installation of new cashew seed processing industry shall not be allowed in sensitive areas notified by the State Pollution Control Boards / Pollution Control Committees under the provisions of the National Air Quality Guidelines using coal as fuel.

6.5.5 The distance between two Cashew Seed Processing Industry shall not be less than 500 meter to avoid clustering of Cashew Seed Processing Industry in an area if a new Cashew Seed Processing industry is being installed.

6.6 Cashew Nut Industry – Good Operating Practices

6.6.1 Both cooking and roasting process operations should be carried out under covered shed with open sides. The operations should be well ventilated with cross ventilation to minimize the pollutant concentration build up within work environment, which is the case in units especially at Palasa.

6.6.2 It is required to optimize and practice the cashew nut feeding rate such that there is continuous flame at the end of the drum ensuring adequate combustion of the gases. It will help in reducing incomplete combustion, soot formation and lower dust emissions in the stack.

- -

6.6.3 Biogas may be used in place of roasted shell or deoiled cake. This will reduce the emission and cost.

6.6.4 Green belt of 10 m width should be developed around the periphery of the unit.

6.6.5 Portholes for stack monitoring and platform shall be provided for all stacks

6.6.6 Cap/ Apron / Hand Gloves is to be provided to the workers during cutting / peeling of the roasted / cooked cashew seed to avoid unhygienic conditions. Special Powder should also be provided to the workers to protect their skin from stickiness / burning.

6.6.6 Lightening Arrestor, as per the PWD norms or any other standard design shall be installed to avoid the damage to the stack(s) / chimney(ies) or plant which may be caused due to lightening attack.

7.0 Formulation of Environmental Standards

7.1 Air Pollution Emission Standards

7.1.1 Particulate Matter and Stack Height Guide Lines

7.1.1.1 Roasting Process

Most of the units have 15m high main stack and the emissions from the dog-house are discharged by independent short vents. Even though these vents are connected to the main stack in some units, it has been observed that there is no sufficient natural draft available by the main stack to extract the fumes generated by quenching operation and initial drum firing

The emissions from roasting drum are by natural draft and due to dilution, the % CO2 in the emissions is varying from 3% - 4 % from unit to unit. To regularise the emissions on common dilution platform, the emission volumes are normalised to 12% CO_2 for all the roasting process units. The particulate matter emissions from the roasting process (field monitoring data tables 1 to 3 in Annexure – I) are given as follows:

S.No	Name of the unit	Raw cashew nut processed kg / day	Particulate matter emission, mg/NM3		Remarks
			Actual (CO2%)	At 12% CO2	
1	Indain Polymers & Resins	1120	665 (3.5%)	2280	2 hours of operation
2	Sun Food Corporaton	2000	1468 (4.2%)	4194	4 hours of operation

- -

3	Bhagyalakshmi	640	1357 (1.3%)	12,526	1 hour of operation
Average			**1,163**	**6,333**	

The average particulate emission 6,333 mg/NM^3 at 12%CO_2, equivalent to 1163 mg/NM^3 at actual conditions (CO_2 varying from 1.3% to 4.2%), can be reduced to less than 350 mg/NM^3 (90 – 95% avg dust removal efficiency) by installing Venturi Scrubber dust control system (9 HP Blower). The system is also designed to extract the emissions from the dog-house about 2000 M^3/hr in addition to the extraction of gases from roasting drum, as shown in figure – 4. The technical specification and cost of the system are given in Annexure - V.

The periodic wastewater discharge from Venturi Scrubber is treated together with quench waster discharge.

Roasting process stack emissions limits

Parameter	**Roasting Process Stack**	**Remarks**
Particulate Matter	350 mg/NM^3 at 12% CO_2 with the installation of Venturi Scrubber	1) 2 –4 hrs of operation in a day and about 560 – 640 kg/hr of Cashew Nut processing 2) The emissions from dog-house are also extracted and treated by the Venturi Scrubber
Minimum Stack Height, m	20m	From Ground Level

7.1.1.2 Cooking Process and Borma Operation

Even though these processes are batch type, the steam or hot air required for the process is generated continuously for 4 to 6 hrs in a day by firing cashew nut roasted shell or deoiled cake. Since both the air heater in Borma operation and the steam boiler in cooking process are manually fired with natural draft stack with similar firing practices, the particulate emissions with roasted shell and de-oiled cake fired in cooker steam boiler and Borma air heater are given in the field monitoring data tables 8 to 15 (Annexure – I) which are normalized to 12% CO_2 as follows:

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Process	PM emission with Roasted Shell firing mg/NM3 at		PM emission with De-oiled cake firing mg/NM3 at	
	Actual (CO2%)	12% CO2	Actual	12% CO2
Steam Boiler in cooking process	1270 (4.2%) 992 (5.7%)	3269 2088	535 (14.3%) 382 (12.9%) 397 (15.0%)	449 355 318
Air Heater in Borma operation	587 (2.0%) 363 (0.6%) 405 (6.7%)	3522 7260 725	-	-
Average emission factor	723	3373	438	374

The stack heights of these processes are varying from industry to industry from 12m to 15m. A stack height of 15m is commonly proposed for these operations for better dispersion of pollution emissions.

The above average particulate emission factors for the Steam Boiler in cooking process and Air Heater in Borma operation are taken as emission standards for the processes as given below:

Baby Boiler and Borma Oven emission limits

Parameter	Cooking Process – Steam Boiler		Borma Oven Heater	
	Roasted Shell	Deoiled Cake	Roasted Shell	De-oiled Cake
Particulate Matter	350 mg/M^3 at 12% CO2	350 mg/NM^3 at 12% CO2	350 mg/NM^3 at 12% CO2	350mg/NM^3 at 12% CO2
Minimum Stack Height, m	15m from ground level or 2m above the height of the nearest building, which ever is higher		15m from ground level or 2m above the height of the nearest building, which ever is higher	

- -

Since the fuel firing is intermittent and batch type, it is not practicable to implement any srubber. The emissions reduction from 3373 mg/NM3 to 350 mg/NM3 at 12% CO2 with out any control system is not practicable. Hence, it is recommended that the Cooking Boiler and Borma operations have to use *only deoiled cake* for firing instead of roasted shell and an emission standard of 350 mg/NM3 at 12% CO2 is achievable with good firing practices. Alternatively, to meet the emission standard converting roasted shell in to fuel gas in a biogasifier is suggested as a long term measure**.**

7.1.1 Sulphur Dioxide, Nitrogen Oxides and Phenolic Compounds

The sulfur Dioxide and Nitrogen Oxide emissions from the air pollution sources in the cashew nut industry are less than 0.1 kg/hr and for phenolic compounds it is less than 0.01 kg/hr. The emission load of these parameters are very low and there are no proven technologies for control at such lower magnitudes. Further more the suggested stack heights are more than adequate for better dispersion of these pollutants into atmosphere. Hence no separate emission standards are proposed for these parameters.

7.2 Wastewater Discharge Standards

The wastewater generation from cashew nut industry is of batch type for 2 to 4 hours in a day. It is too small a quantity 200 lit/day at a BOD of 5000 mg/l, COD of 10000 mg/l and Oil & Grease (Extractable, mostly in the form of phenolics compounds) at 2000 mg/l.. The broad characteristics indicate high strength and of phenolic in nature. Even though the cashew nut units are discharging for years the effluent directly on ground without any treatment, the ground water analysis in and around the units indicated that the ground water quality is still meeting the norms. However keeping in view of the clean environment, the following alternate treatment methods (Annexure-VI) are suggested to comply with the following surface water discharge standards by CPCB, which can be reused for gardening.

Waste Water Discharge Standards		
S.No	**Parameter**	**Limit, mg/lit**
1	BOD (27 ^{o}C and 3 days)	100
2	Oil & Grease	10
3	Suspended Solids	100
4	Phenol	1.0

- -

6	PH	6.5 – 8.5

7.2.1 Alternate – 1: Sequential Batch Reactor (Fig – 5)

A typical SBR (Sequential Batch Reactor) system was evolved deploying 'Process knowledge" and restricting number of "Hardware", as they lead to O & M problems. This system will consist of:

- Collection-cum-aeration-cum-settling tank
- Sand Bed Filter system for decanted water filtration
- Sludge drying bed for excess sludge

The investment cost of SBR will be Rs 4.5 Lakhs, (Annexure-VI)

7.2.2 Alternate – 2: Rotating Biological Disc Treatment (Fig – 5)

In this system, except holding tank, all other items are pre-engineered. The system will consist of:

- Buffer tank, integral part of packaged plant
- Feed pump of Water Wheel type connected to the RBC Drive itself
- Sludge disposal timer operated pump
- Sludge drying bed for excess sludge

The investment cost of RBC will be Rs 4 - 5 Lakhs, (Annexure-VI)

7.3 Solid Waste Disposal Practices

The ash generated during initial drum firing with roasted cashew shell is spread over the roasted and quenched nuts to prevent sticking. The ash generated at the bottom of Borma air heater as well as the Steam Boiler has to be properly land filled with necessary precautions so that there are no secondary air emissions. The cashew shell generated both by roasting process and cooking process, which is presently used as fuel by the industry, has to go through bio gasification route to convert in to less polluting fuel gas as a long-term measure. However directions may be given to the industries that the cashew shell should not be sold to retail users for domestic and commercial firing purposes, due to the obnoxious odor generation by the flue gases.

The 'Testa', which is removed from the surface of the cashew kernel after Borma is also a source of solid waste. In all the cashew nut industries the testa

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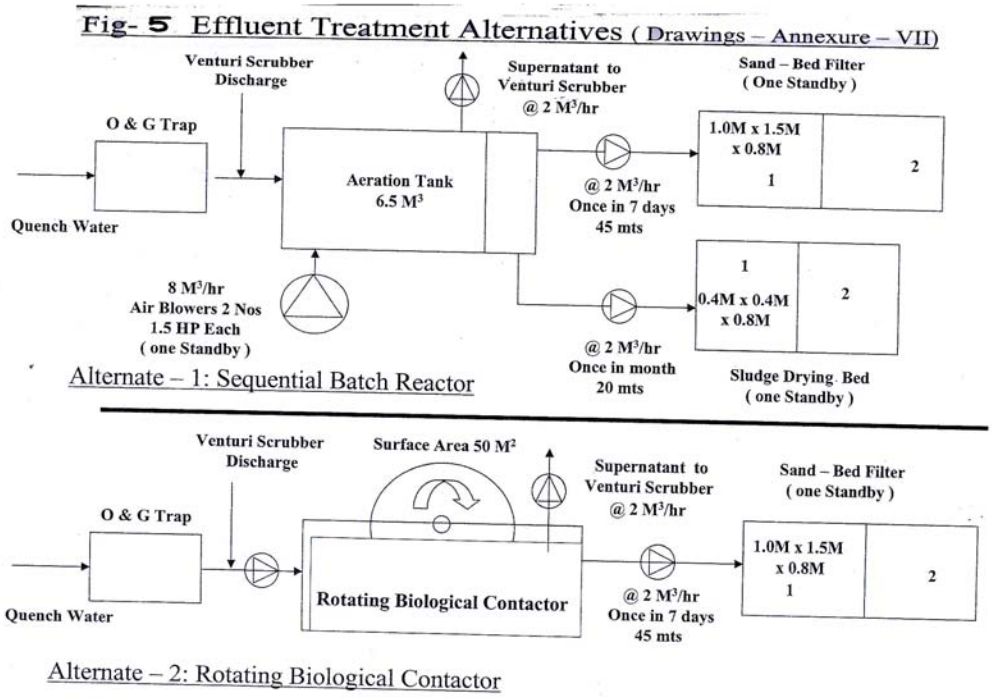
produced has market value, which is used as vegetable tanning agent in tanneries.



7.4 Noise Pollution Standards

The study reveals that noise pollution is not an issue associated with cashew nut processing industry. However, the general ambient noise standard as per EP Act are applicable for cashew industry also.

AMBIENT AIR QUALITY STANDARDS IN RESPECT OF NOISE
Environment (Protection) Rules, 1986

- -

Area Code	Category of Area	Limits in dB (A) Leq	
		Day / Time	*Night / Time*
(A)	**Industrial Area**	**75**	**70**
(B)	**Commercial Area**	**65**	**55**
(C)	**Residential Area**	**55**	**45**
(D)	**Silence Zone**	**50**	**40**

Note:

(i) Day time is reckoned in between 6 a.m and 9 p.m

(ii) Night time is reckoned in between 9 p.m and 6 a.m

(iii) Silence zone is defined as areas upto 100 meters around such premises as hospitals, educational institutions and courts.

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8.0 **Environmental Standards approved by the Peer & Core Committee of Central Board:** The environmental standards for the cashew Seed Industry was discussed in 21st Peer & Core Committee and following are approved:

8.1 Air Pollution Emission Standards

8.1.1 Roasting Process, Cooking Process and Borma Operation

Parameter	**Roasting Process Stack** **(2 –4 hrs of operation and 560 - 640 kg/hr of cashew nut processing)**	**Cooking Process – Steam Boiler (4 –6 hrs of operation)**		**Borma Oven Heater (4 –6 hrs of operation)**	
		Roasted Shell **	**Deoiled Cake**	**Roasted Shell ****	**Deoiled Cake**
Particulate Matter	* 150mg/Nm^3 at 4 % CO_2	150 ** mg/Nm^3 at 4 % CO_2	150 mg/NM^3 at 4 % CO_2	150 ** mg/NM^3 at 4 % CO_2	150 mg/NM^3 at 4 % CO_2
Minimum Stack Height, m	20m from ground level	15m from ground level or 2m above the height of the nearest building, which ever is higher		15m from ground level or 2m above the height of the nearest building, which ever is higher	

* The dog-house emissions are also to be directed together with the roasting drum emissions to wet scrubber to meet the emission standard

** The units have to install bio-gassifier to meet the emission standard specially wherever roasted shell is used for firing. Alternatively the deoiled cake may be used

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8.1.2 Sulphur Dioxide, Nitrogen Oxides and Phenolic Compounds

The suggested stack heights results in better dispersion of these pollutants into atmosphere resulting in minimum possible ground level concentrations. Hence no separate emission standards are proposed for these parameters.

8.2 Wastewater Discharge Standards

The wastewater generation from different sources of cashew nut roasting and cooking process are as follows:

- Quenching operation in roasting process: 200 liters/day (2 – 4 hrs of operation in a day) – after oil & grease trap (or)
- Vessel discharge from 5-10 batches in Cooking Process: 70 - 80 liters/day

In view of such infrequent nature of wastewater generation and BOD of 5000 mg/l, COD of 10000 mg/l and Oil & Grease (Extractable, mostly in the form of phenolics compounds) at 2000 mg/l, the following alternatives are recommended to comply with following waste water discharge standards for disposal on land:

Waste Water Discharge Standards		
S.No	**Parameter**	**Limit, mg/lit**
1	BOD (27 ^{o}C and 3 days)	100
2	Oil & Grease	10
3	Suspended Solids	100
4	Phenol	1.0
6	PH	6.5 – 8.5

- -

8.2.1 Alternate – 1: Sequential Batch Reactor

A typical SBR (Sequential Batch Reactor) system consist of:

- Collection-cum-aeration-cum-settling tank
- Sand Bed Filter system for decanted water filtration
- Sludge drying bed for excess sludge

8.2.2 Alternate – 2: Rotating Biological Disc Treatment

The Rotating Biological Disc system consist of:

- Buffer tank, integral part of packaged plant
- Feed pump of Water Wheel type connected to the RBC Drive itself
- Sludge disposal timer operated pump
- Sludge drying bed for excess sludge

The treated water can be reused for gardening or for similar applications

8.3 Solid Waste Disposal Practices

8.3.1 The use of cashew shell generated especially by roasting process, as fuel, has to go through bio gasification route to convert into less polluting fuel gas as a long-term measure

8.3.2 .The ash generated at the bottom of 'Borma' air heater as well as the Steam Boiler and excess ash from initial firing of the roasting drum, have to be properly land filled with necessary precautions so that there are no secondary air emissions.

8.3.3 The cashew shell or de-oiled cake should not be sold to retail users for domestic and commercial firing purposes due to their obnoxious odour .

8.4 Alternate Raw Cashew Nut Process

The cashew nut processing by cooking (steam roasting) process, which is relatively less pollution intensive and an alternative process to roasting process may be considered. In addition valuable CNSL can be recovered as by product.

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8.5 Noise Pollution Standards

Since noise pollution is not an issue associated with cashew nut processing industry, the general ambient noise standard as per EP Act are applicable for cashew industry also.

8.6 Cashew Nut Industry - New and Relocation - Sitting Criteria

Even though the pollutant emission load in to environment by a single cashew nut unit is low, it has been observed that the total emissions load by number of such units in a cluster causes considerable environmental degradation. To avoid the combined effect by number of units on the environment, the cashew nut processing industries with roasting/cooking process have to be located with the following criteria

1.0 Cashew Seed Processing Industry shall be established at least 1.0 km away from residential area, hospital, schools, public building or a place where flammable substances are stores / processed and similarly such establishments should not be permitted within 1 Km from the existing Cashew Seed Processing Units.

2.0 Cashew Seed Processing Industry shall be established 5.0 km away from notified municipal limits of any town/city or airport.

3.0 Cashew Seed Processing Industry shall not be constructed within 200 m from the middle of Railway Tracks, National Highway and State Highway and 50 m from the middle of other roads.

4.0 In normal circumstances, installation of new cashew seed processing industry shall not be allowed in sensitive areas notified by the State

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Pollution Control Boards / Pollution Control Committees under the provisions of the National Air Quality Guidelines using coal as fuel.

5.0 The distance between two Cashew Seed Processing Industry shall not be less than 500 meter to avoid clustering of Cashew Seed Processing Industry in an area if a new Cashew Seed Processing industry is being installed.

8.7 Cashew Nut Industry – Good Operating Practices

1.0 Both cooking and roasting process operations should be carried out under covered shed with open sides. The operations should be well ventilated with cross ventilation to minimize the pollutant concentration build up within work environment

2.0 It is required to optimize and practice the cashew nut feeding rate such that there is continuous flame at the end of the drum ensuring adequate combustion of the gases. It will help in reducing incomplete combustion, soot formation and lower dust emissions in the stack.

3.0 Biogas may be used in place of roasted shell. This will reduce the emission and cost.

4.0 Green belt of 10 m width should be developed around the periphery of the unit.

5.0 Portholes for stack monitoring and platform shall be provided for all stacks

6.0 Cap/ Apron / Hand Gloves are to be provided to the worke rs during cutting peeling of the roasted / cooked cashew seed to avoid unhygienic conditions. Special Powder should also be provided to the workers to protect their skin from stickiness / burning.

7.0 Lightening Arrestor, as per the PWD norms or any other standard design shall be installed to avoid the damage to the stack(s) / chimney(ies) or plant which may be caused due to lightening attack.

INDIAN RESINS & POLYMERS – CHENNAI CASHEW PROCESSING, EDAIKODU (TAMILNADU)

Table –1: ROASTING DRUM - STACK EMISSION MONITOIRNG & ANALYSIS DATA

S No	Date and Time	Cashew Processed Kg/hr	Source Details	Fuel Used, Kg/hr	Flow rate Flue gases		Temp ^{o}C	Flue Gas Composition, %			Pollution Parameters Concentration, mg/NM^3 (kg/hr)			
					M^3/ hr	NM^3 /hr 2		CO_2	O_2	CO	OH^-	SO_2	NOx	PM
1	22-9-2004 06:00 – 07:00	560 [1] 6:00 – 7:00 11:00 – 12:00	Roasting Drum Stack	Roasted Shell 15 –20	4130	1944	360	3.5	16.2	0.5	5.26 (0.01)	36 (0.07)	27 (0.05)	665 2280 (12%) (1.3)

(1) 2 Batches in a day one at 6:00AM – 7:00AM and other at 11:00 – 12:00 hrs. Total roasting capacity – 1120 kg cashew nut per day

(2) Flow Rate is measured in Nm^3/Hr that is at the Normal Temperature ($298^{o}K$) and at Normal Pressure(760mmHg)

(3) Roasted shell firing is only for initial heating of the drum. The CNSL in the raw cashew nut shell catches fire and burns in the drum subsequently.

(4) Stack Height & Cross section – 18M & 0.45 x 0.45

(5) Natural Draft – 2.0 – 3.0 mmWc

(6) Noise Levels: At Roasting Drum – 82 dBA, At Shelling Section – 80 dBA

SUN FOOD CORPORATION, KUREEPALLY (KERALA)

Table –2 ROASTING DRUM - STACK EMISSION MONITOIRNG & ANALYSIS DATA

S No	Date and Time	Cashew Nut Processed Kg/hr	Source Details	Fuel Used, Kg/hr	Flow rate Flue gases		Temp ^{o}C	Flue Gas Composition, %			Pollution Parameters Concentration, mg/NM^3 (kg/hr) [kg/T of Nut]			
					M^3/ hr	NM^3 /hr 2		CO_2	O_2	CO	OH^-	SO_2	NOx	PM
1	24-9-2004 06:00 – 07:00	500 [1] 8:00 – 12:00	Roasting Drum Stack	Roasted Shell 15 –20 kg [3]	2600	1273	330	4.2	13.5	0.5	6.5 (0.007)	36 (0.05)	131 (0.17)	1468 4194 (12%) (1.9)

(1)One Batch in a day at 8:00AM – 12:00AM. Total roasting capacity –2000 kg cashew nut per day
(2) Flow Rate is measured in Nm^3/Hr that is at the Normal Temperature ($298^{o}K$) and at Normal Pressure(760mmHg)
(3) Roasted shell firing is only for initial heating of the drum. The CNSL in the raw cashew nut shell catches fire and burns in the drum subsequently.
(4) Stack Height & Cross section – 20M & ϕ 0.45M
(5) Natural Draft – 2.0 – 3.0 mmWc
(6) Noise Levels: At Roasting Drum – 85 dBA, At Shelling Section – 83 dBA

BHAGYALAKSHMI CASHEW CO. PALASA (ANDHRAPRADESH)

Table –3: ROASTING DRUM - STACK EMISSION MONITOIRNG & ANALYSIS DATA

S No	Date and Time	Cashew nut Processed kg/hr	Source Details	Fuel Used, Kg/hr	Flow rate Flue gases		Temp ^{o}C	Flue Gas Composition, %			Pollution Parameters Concentration, mg/NM^3 (kg/hr)			
					M^3/ hr	NM^3/ hr 2		CO_2	O_2	CO	OH^-	SO_2	NOx	PM
1	7-10-2004 07:00 – 09:00	640 [1]	Roasting Drum Stack	Roasted Shell 20 –30 kg [3]	2,650	1,936	135	1.3	19	0.1	2.9 (0.005)	9.7 (0.02)	33 (0.06)	1357 12526 (12%) (2.63)

1) One Batch in a day between 6:00AM – 9:00AM. Total roasting capacity – 640 kg cashew nut in an hour
2) Flow Rate is measured in Nm^3/Hr that is at the Normal Temperature ($298^{o}K$) and at Normal Pressure(760mmHg)
3) Roasted shell firing is only for initial heating of the drum. The CNSL in the raw cashew nut shell catches fire and burns in the drum subsequently.
4) Quench water consumption – 1 liter/minute Quench water flow – 0.7 liter/minute
5) Stack Height & Cross section – 15M 0.85M x 0.85M
6) Natural Draft – 1.0 – 2.0 mmWc
7) Noise Levels: Near Roasting Drum – 81.0 dBA At Shelling section – 82.0 dBA

Table –4 AMBIENT AIR QUALITY MONITORING – PALASA - KASIBUGGA

S No	Date and Time	Location	Cashewnut industry operation	Suspended Particulate Matter Concentration, $\mu g/M^3$			
				> 10 μ 4hrs Avg	RPM < 10 μ 4hrs Avg	SPM 4hrs Avg	SPM 8hrs Avg
1	6-10-2004 07:45AM – 11:45AM	Maruthi Nagar Terrace of a House	In operation (Upwind)	221	133	354	
2	6-10-2004 11:45AM – 15:45PM	"	Not in operation	40	106	146	250
3	7-10-2004 7:15AM – 11:15AM	"	In Operation (Down wind)	27	580	607	
4	7-10-2004 11:15AM – 15:15PM	"	Not in operation	46	99	145	376

1. About 130 cashew nut units continue roasting operation from 6:00 AM - 9:00 AM every day except on Sundays

INDIAN RESINS & POLYMERS, THENGEMPUTHOOR (TAMILNADU)

Table – 5 : WASTE WATER ANALYSIS DATA

S No	Date	Cashew Nut Proces - sed Kg/ Batch	Waste WaterSo urce Details	Waste Water Genera tion Litre/ 100 kg	Pollution Parameters Concentration, mg/litre (kg/Batch)							
					pH	TSS	TDS	O & G	BOD	COD	OH^-	Domestic Water consumpt ion
1	20-9-2004	320	Cooking process Cooker-1 discharge	0.78 Five batches in a day	6.31	650 (0.001)	11,520 (0.029)	24 (0.000 06)	Not measu r-ed	18,000 (0.045)	10.2 (0.0000 3)	3000 liters/ day
2	21-9-2004	560 kg/hr	Roasting process Quench Water sample	14.3 Lit/hr (2hours operat-ion)	8.16	1500 (0.12 kg/hr)	2372 (0.19 kg/hr)	1644 (0.13 kg/hr)	10,424 (0.835 kg/hr)	27,600 (2.2 kg/hr)	7.0 (0.0005 kg/hr)	2000 liters/ day
3	22-9-2004	320	Cooking process Cooker-2 discharge	1.13 Five batches in a day	6.36	680 (0.0024)	13,416 (0.048)	52 (0.000 2)	3863 (0.014)	13,200 (0.0484)	4.2 (0.0000 3)	3000 liters/ day

SUN FOOD CORPORATION, KUREEPALLY (KERALA)

Table – 6 : WASTE WATER ANALYSIS DATA

S No	Date	Cashew Processed Kg/ Batch	Waste Water Source Details	Waste Water Lit/ 100 kg of Nut	Pollution Parameters Concentration, mg/litre (kg/Batch)							
					pH	TSS	TDS	O & G	BOD	COD	OH^-	Water Consumption
1	23-9-2004	500 kg/hr	Roasting process Quench Water	21.4 Lit/hr 4 hours process	7.23	2115 (0.255 kg/hr)	1768 0.212 kg/hr)	2068 (0.25 kg/hr)	5200 (0.625 kg/hr)	10240 (1.225 kg/hr)	5.2 (0.0006	5000 litre/ day
2	24-9-2004	320	Cooking process Cooker-4	2.4 5 batch in a day	7.03	700 (0.006)	8632 (0.066)	48 (0.0004)	5000 (0.038)	9440 (0.09)	6.7 (0.00005	
3	24-9-2004	320	Cooking process Cooker-3	5.0 5 batch in a day	6.83	350 (0.006)	9972 (0.16)	1844 (0.03)	2800 (0.046)	6080 (0.098)	5.6 (0.00009	
4	24-9-2004	320	Cooking process Cooker-1	3.75 5 batch in a day	7.3	565 (0.006)	6028 (0.074)	2436 (0.03)	–	–	6.0 (0.00007	
5	6-2-2007	320	Cooking process Cooker-3	4.6 5 batch in a day	4.5	-	7980	167	5100	8320	-	
6	6-2-2007	500 kg/hr	Roasting process Quench Water	23.5 Lit/hr 4 hours process	7.1	-	1155	5674	4350	7280	-	

Table – 7: WASTE WATER ANALYSIS DATA – PALASA – KASIBUGGA (ANDHRA PRADESH)

S No	Date	Cashew Nut Processed Kg/ Batch	Waste Water Source Details	Waste Water Generation Litre/ 100 kg of Nut	Pollution Parameters Concentration, mg/litre (kg/Batch)							
					pH	TSS	TDS	O & G	BOD	COD	OH^-	Domestic Water Consumption
1	7-10-2004	640	Roasting process Quench Water sample 1	20.3 (1 hrs of operation	7.6	1175 (0.15)	2240 (0.29)	1400 (0.18)	1210 (0.16)	4790 (0.6)	5.9 (0.0007)	4000 litre/ day
2	6-10-2004	400	Cooking process Cooker-2 discharge 2	1.9 Ten batches in a day	6.2	615 (0.005)	9135 (0.069)	28 (0.0002)	1470 (0.011)	5874 (0.044)	5.24 (0.00004)	5000 litre/ day
	6-10	400	Cooker -1	1.9 Ten batches in a day	5.3	720 (0.005)	9488 (0.071)	35 (0.0003)	2540 (0.019)	10,140 (0.076)	8.9 (0.00007)	

1) Bhagyalakshmi Cashew Co., - Roasting Process, Kasibugga
2) Vijayalakshmi Cashew Co., - Cooking Process, Kasibugga

INDIAN RESINS & POLYMERS, THENGEMPUTHOOR (TAMILNADU)

Table –8: COOKING BOILER - STACK EMISSION MONITOIRNG & ANALYSIS DATA

S No	Date and Time	**Cashew Proces** - sed Kg/batch	Source Details	Fuel Used, Kg/hr	Flow rate Flue gases		Temp ^{o}C	Flue Gas Composition, %			Pollution Parameters Concentration, mg/Nm^3 (kg/hr)			
					M^3/ hr	NM^3 /hr		CO_2	O_2	CO	OH^-	SO_2	NOx	PM
1	20-9-2004 10:00 – 13:00	3,20 [1]	Boiler Stack 6:00 – 13:00	Roasted Shell 36	388	181	367	4.2	15.5	0.5	3.23 (less than 0.001)	21 (0.004)	593 (0.11)	1270 3269 (12%) (0.23)

1) 10 Batches x 4 Bags x 80 kg cashew nut (seed) processed per day
2) Flow Rate is measured in Nm^3/Hr that is at the Normal Temperature ($298^{o}K$) and at Normal Pressure(760mmHg)
3) Stack Height & Dia – 12M & ϕ 0.15M
4) Natural Draft – 1.2 mmWc
5) Noise Levels: At Cooking section – 80 dBA, At cutting Section – 80 dBA

INDIAN RESINS & POLYMERS, THENGEMPUTHOOR (TAMILNADU)

Table –9: COOKING BOILER - STACK EMISSION MONITOIRNG & ANALYSIS DATA

S No	Date and Time	Cashew Processed Kg/Day	Source Details	Fuel Used, Kg/hr	Flow rate Flue gases		Temp ^oC	Flue Gas Composition, %			Pollution Parameters Concentration, mg/Nm^3 (kg/hr)			
					M^3/ hr	NM^3 /hr		CO_2	O_2	CO	OH^-	SO_2	NOx	PM
1	22-9-2004 10:00 – 13:00	3,20 [1]	Boiler Stack 6:00 – 13:00	De-oiled Cake 43	630	193	720	14.3	3.4	3.0	0.24 (less than 0.001)	29 (0.006)	645 (0.1)	535 449 (12%) (0.1)

1. 10 Batches x 4 Bags x 80 kg cashew nut processed per day
2. Flow Rate is measured in Nm^3/Hr that is at the Normal Temperature (298^oK) and at Normal Pressure (760mmHg)
3. Stack Height & Dia – 12M & ϕ 0.15M
4. Natural Draft – 2.0 mmWc
5. Noise Levels: At Cooking section – 81 dBA, At cutting Section – 80 dBA

SUN FOOD CORPORATION, KUREEPALLY (KERALA)

Table –10: COOKING BOILER - STACK EMISSION MONITOIRNG & ANALYSIS DATA

S No	Date and Time	Cashew Nut Proces - sed Kg/ Batch	Sour ce Detai ls	Fuel Used, Kg/hr	Flow rate Flue gases		Temp ^oC	Flue Gas Composition, %			Pollution Parameters Concentration, mg/NM^3 (kg/hr)			
					M^3/ hr	NM^3 /hr		CO_2	O_2	CO	OH^-	SO_2	NOx	PM
1	24-9-2004 11:00 – 13:00	320 [1]	Boiler Stack 8:00 – 16:00	Deoiled Cake 70	487	204	483	12.9	3.5	2.0	0.6 (less than 0.001	12 (0.003)	158 (0.03)	382 355 (12%) (0.08)

(1) 4 Cookers in parallel, 20 Batches x 4 Bags x 80 kg cashew nut processed per day (Only two cookers were in operation)
(2) Flow Rate is measured in Nm^3/Hr that is at the Normal Temperature (298^oK) and at Normal Pressure(760mmHg)
(3) Stack Height & Dia – 18M & ϕ 0.2M
(4) Natural Draft – 7.5 mmWc
(5) Noise Levels: At Cooking section – 80 dBA, At cutting Section – 80 dBA

SUN FOOD CORPORATION, KUREEPALLY (KERALA)

Table –11: COOKING BOILER - STACK EMISSION MONITOIRNG & ANALYSIS DATA

S No	Date and Time	Cashew Nut Processed Kg/ Batch	Source Details	Fuel Used, Kg/hr	Flow rate Flue gases		Temp ^{o}C	Flue Gas Composition, %			Pollution Parameters Concentration, mg/NM^3 (kg/hr)			
					M^3/ hr	NM^3 /hr		CO_2	O_2	CO	OH^-	SO_2	NOx	PM
1	24-9-2004 14:00 – 16:00	3,20 [1]	Boiler Stack 8:00 – 16:00	Roasted Schell 56	373	182	340	5.7	12.9	0.5	4.3 (less than 0.001	30 (0.005)	227 (0.04)	992 2088 (12%) (0.18)

1. 4 Cookers in parallel, 20 Batches x 4 Bags x 80 kg cashew nut processed per day(Only two cookers were in operation)
2. Flow Rate is measured in Nm^3/Hr that is at the Normal Temperature (298^{o}K) and at Normal Pressure(760mmHg)
3. Stack Height & Dia – 18M & ϕ 0.2M
4. Natural Draft – 6.7 mmWc
5. Noise Levels: At Cooking Section – 80 dBA At Cutting Section – 82 dBA

VIJAYA LAKSHMI CASHEW CO. KASIBUGGA – PALASA (ANDHRA PRADESH)

Table –12: COOKING BOILER - STACK EMISSION MONITOIRNG & ANALYSIS DATA

S No	Date and Time	Cashew Nut Processed Kg/ Batch	Source Details	Fuel Used, Kg/hr	Flow rate Flue gases		Temp ^oC	Flue Gas Composition, %			Pollution Parameters Concentration, mg/NM^3 (kg/hr)			
					M^3/ hr	Nm^3 /hr		CO_2	O_2	CO	OH^-	SO_2	NOx	PM
1	6-10-2004 10:00 – 12:00	400 [1]	Boiler Stack 8:00 – 12:00	Deoiled Cake 60	1052	495	363	15.0	4.0	1.5	0.43 (less than 0.001)	24 (0.01)	124 (0.06)	397 318 (12%) (0.2)

1. Cookers in parallel, 10 Batches x 5 Bags x 80 kg cashew nut processed per day
2. Flow Rate is measured in Nm^3/Hr that is at the Normal Temperature (298^{o}K) and at Normal Pressure(760mmHg)
3. Stack Height & Dia – 18M & ϕ 0.2M
4. Natural Draft – 4.0 mmWc
5. OH^- Total Phenolic compounds expressed as C_6H_5OH
6. Noise levels – Cooking operation – 78.7 dBA Cutting Section – 80 dBA

INDIAN RESINS & POLYMERS, PHEMGEMPUTHOOR (TAMILNADU)

Table –13: BORMA OVEN - STACK EMISSION MONITOIRNG & ANALYSIS DATA

S No	Date and Time	Cashew Processed Kg/Day	Source Details	Fuel Used, Kg/hr	Flow rate Flue gases		Temp °C	Flue Gas Composition, %			Pollution Parameters Concentration, mg/NM^3 (kg/hr)			
					M^3/ hr	NM^3 /hr		CO_2	O_2	CO	OH^-	SO_2	NOx	PM
1	21-9-2004 08:00 – 10:00	400 [1] 8:00 – 14:00	Boiler Stack	Roasted Shell 12	312	186	230	2.0	18.5	0.2	0.42 (less than 0.001)	10 (0.001)	61 (0.01)	587 3522 (12%) (0.1)

1. About 400 kg cashew kernels are processed at 80oC in 6hrs per day
2. Flow Rate is measured in Nm^3/Hr that is at the Normal Temperature (298^{o}K) and at Normal Pressure(760mmHg)
3. Stack Height & Dia – 13M & ϕ 0.15M
4. Natural Draft – 1.6 mmWc
5. Noise Level: At Borma Operation – 73dBA

SUN FOOD CORPORATION, KUREEPALLY (KERALA)

Table –14 BORMA OVEN - STACK EMISSION MONITOIRNG & ANALYSIS DATA

S No	Date and Time	Cashew Nut Proces - sed Kg/Day	Source Details	Fuel Used, Kg/hr	Flow rate Flue gases		Temp °C	Flue Gas Composition, %			Pollution Parameters Concentration, mg/NM^3 (kg/hr) [kg/T of Fuel]			
					M^3/ hr	NM^3/hr		CO_2	O_2	CO	OH^-	SO_2	NOx	PM
1	23-9-2004 10:00 – 12:00	3000 [1] 8:00 – 14:00	Air Heater Stack	Roasted Shell 90	1500	996	190	0.6	19.5	0.1	0.5 (less than 0.001)	48 (0.05)	55 (0.06)	363 7260 (12%) (0.36)

1) About 3000 kg cashew kernels are processed at 80oC –90oC in 6hrs per day
2) Flow Rate is measured in Nm^3/Hr that is at the Normal Temperature (298^{o}K) and at Normal Pressure(760mmHg)
3) Stack Height & Dia – 15M & ϕ 0.3M
4) Natural Draft – 1.7 mmWc
5) Noise level : At Borma Operation – 75 dBA

BHAGYALAKSHMI CASHEW CO. PALASA (ANDHRAPRADESH)

Table –15: BORMA OVEN STACK EMISSION MONITOIRNG & ANALYSIS DATA

S No	Date and Time	Cashew Nut Proces - sed Kg/Day	Source Details	Fuel Used, Kg/hr	Flow rate Flue gases		Temp °C	Flue Gas Composition, %			Pollution Parameters Concentration, mg/NM^3 (kg/hr)]			
					M^3/ hr	NM^3/hr		CO_2	O_2	CO	OH^-	SO_2	NOx	PM
1	5-10-2004 11:00 – 13:00	200 [1] 16:00 – 20:00	Air Heater Stack	Roasted Shell 50 kg in 60 mts	1349	643	352	6.7	11.9	2.0	0.8 (less than 0.001)	24 (0.015)	146 (0.09)	405 725 (12%) (0.26)

(1) 10 Bags x 20 kg cashew nut processed in a day(4 hrs)

(2) Flow Rate is measured in Nm^3/Hr that is at the Normal Temperature (298^{o}K) and at Normal Pressure(760mmHg)

(3) Stack Height & Dia – 12M & ϕ 0.3M

(4) Natural Draft – 2 mmWc

(5) OH^- Total Phenolic compounds expressed as C_6H_5OH

(6) Noise levels – Borma operation – 74.6 dBA

Table – 16: GROUND WATER QULAITY IN & AROUND CASHEW NUT PROCESSING UNITS

S.No	Parameter	Unit in Kollam		Unit in Nagercoil			IS10500 DW Standards
		1	2	3	4	5	
1	PH	6.5	5.9	7.3	7.6	7.8	6.5 – 8.5
2	Chlorides	22	28	80	65	20	250 - 1000
3	TSS	42	26	15	25	15	-
4	TDS	109	102	ND	ND	ND	500 - 2000
5	Nitrate	1.5	3.0	19	19	42	25 - 100
6	Phenol Compounds	ND	ND	ND	ND	ND	-
7	Total Hardness	22	16	135	71	264	300 - 600
8	Sulphate	10	5	44	30	69	200 - 400
9	Iron	ND	ND	ND	ND	0.2	0.3 – 1.0
10	BOD	ND	ND	ND	ND	ND	-
11	COD	16	20	27	16	70	-
12	Oil & grease	ND	ND	ND	ND	ND	-

A) Units in Kollam

1 - M/s Sun Food Corporation, Kurepally
2 - M/s Prakash Enterprises, Mylakkadi

B) Units in Nagercoil

3 – M/s Chetana Cashew, Peyankuzli
4 – M/s Jaya Cashew, Nagercoil
5 - M/s Rajalakshmi Cashew, Avvaiyaraman Koil

ANNEXURE - II

DRAFT INCREASE BY INCREASING STACK HEIGHT

Draft Created by 20m high Stack

$$\Delta P = 0.466 \cdot H \cdot P_a \times \frac{}{T_a} - \frac{}{T_s} \left\{ \begin{matrix} 1 & 1 \\ \hline \end{matrix} \right\}$$

$$= 0.466X20X750[(1/303)-(1/6230]=11.8 \text{ mmWc}$$

Frictional Losses by Stack

$$\mathbf{Fr} = \frac{\rho \cdot V^2}{2g} \left\{ 1.0 + \frac{f \cdot H}{D} \right\}$$

= (0.6 x 25 /19.62) x [1.0 + (0.2 x 20 / 0.46)]

= 0.765 x 9.7 = 7.4 mmWc

Draft available with 20m high stack is 11.8. –7.4 = 4.4 ≅ 5 mmWc

Annexure-III

MAXIMUM GROUND LEVEL CONCENTRAIONS

Emission Data:

Particulate Matter emission rate, Q: 0.2 kg/hr (0.06 gm/sec)

Stack Height, h	**: 20m (Proposed). (15m)**
Stack Exit Diameter,D	**: 0.46 m**
Stack Gas velocity, Vs	**: 5.0 m/sec**
Wind velocity, U	**: 3 m/sec (assumed)**
Atmospheric pressure, Pa	**: 1.0 bar**
Stack Temperature, Ts	**: 80 oC, 353 oK**
Atmospheric temperature, Ta	**: 30oC, 303 0K**

$$\text{Plume Rise, m} = \frac{Vs \times D}{U} \times \left\{ 1.5 + 2.68 \times Pa \times D \frac{Ts - Ta}{Ts} \right\}$$

$\Delta h = 0.77 \times 1.67 = 1.3$ m

Effective stack height H, m = h + Δh = 20 + 1.3 = 21.3 ≅ 20m

Maximum ground level concentration occurs where $\sigma Z = H / \sqrt{2} = 20 / \sqrt{2} = 14.1$ m (10.6 m)

X max = 250m σY **= 25 m (15m)** ***(for Neutral Stability 'D' from Pasquills Stability curves)***

$$C_{max} = \frac{Q \times 10^6}{e \times \pi \times \sigma Z \times \sigma Y \times U} = \frac{0.06 \times 10^6}{e \times \pi \times 14.1 \times 25 \times 3}$$

= 8.0 μg/m^3 …… *20m high stack with control*

Annexure –I V

BIO GASIFIER – SPECIFICATIONS

ASSOCIATED ENGINEERING WORKS

Manufacturers of Renewable Energy Devices : Biomass Gasifiers – Biogas Stoves

GASIFIER :SPECIFICATIONS :

Model	**:**	**GT-600**
Mode	**:**	**Heating Application**
Rated Output		**: 100 KW(2,50,000 K.Cal /Hr.)**
		Enough to replace 25 Ltr of Diesel per Hr.
Design		**: Downdraft with Throat**
Fuel	**:**	**Cashew Nut Shells etc.,**
Fuel Consumption	**:**	**100-125 Kg/Hr. (approx.)**
Fuel Loading	**:**	**Manual/Batch Type**
Acceptable Moisture content of Biomass	**:**	**Below 15%**
Hopper holding capacity	**:**	**800 Kgs (approx.)**
Air Blower Motor	**:**	**1 HP**
Floor Space required		**: 10' x 15'' x 15' (Ht.)**

The description of items are :

GASIFIER :

This is a downdraft Gasifier with throat and vertical in nature. The feed is fed into the Hopper. Air is admitted through a nozzle and Gas is formed by high temperature oxidation and subsequent reduction,. A rotating grate is provided and can be operated through a Hand Lever located outside. The Gasifier bottom is open and stands in a water tank. The ash & cinder from the combustion of Biomass fall into this water tank and to be collected. The Gasifier is provided with a loading platform and Ladder for ease of loading.

GAS BURNER :

The Burner is specially designed for burning Producer Gas generated in the Gasifier. The Burner is made of Stainless Steel.

SCOPE OF SUPPLY:

GASIFIER consisting of Reaction Chamber, Stock Hopper, Ladder, Pipes, Valves & Fittings, Air Blower with 1HP Motor, Producer Gas Burner and Installation & Commissioning.

PRICE OF THE SYSTEMS :
The cost of the 100 Kwe Thermal Mode Gasifiers as above is Rs.7,00,000/- (Rupees Seven Lacs only).

Annexure - V

VENTURI SCRUBBER AIR POLLUTION CONTROL SYSTEM FOR
CASHEW NUT ROASTING PROCESS

Supplier: AIRCON SYSTEMS. (Since 1987)
(Manufactures of Pollution Control Device For Air, Water & Noise)
7/488-504, G.T. Road (First Back Lane) SHAHADRA. (Near Dilshad Dharam Kanta) Delhi – 110 095. Phone:- 011- 22573079 , 24504067, 22593079 Tele-Fax:- 22593079 Fax:-011-22118128
E-MAIL: aircons@bol.net.in / aircons@vsnl.com Web: www.airconsystems.net

VENTURI CUM PACKED BED SCRUBBER

Venturi Scrubber is designed to remove both plus- micron and sub- micron particulate from various effluent gases, where extremely high collection efficiency is required. In this high energy / high efficiency venturi type scrubber, the contaminated gas flow is downwards entering from the top and accelerating to a high velocity in the throat, where it impinges on the liquor stream (usually water). The scrubbing liquor is introduced from a tangential entry shelf surrounding the gas inlet nozzle. The liquor then flows down the inlet cone face, ensuring the internal surface is fully irrigated, thus preventing wet-dry line build up. At the throat the gases and the liquid meet and are then forced through the opening at elevated velocities, dependant on the selected pressure drop. This atomises the liquor into a fine droplet mist where the difference in velocity between the gas and the droplets promote impaction of the gas-borne particles and droplets. The mist entraps the dust contaminants by inertial impaction. The entry into the lower section of the separator is tangential, creating a centrifugal action to separate liquor and contaminants from the gas stream prior to entering second stage scrubbing

These gases are then pass through packing bed of Pall rings to have contact with scrubbing solution introduce from the top of the scrubber in counter direction of gas and trickles down through it. The packing breaks down the scrubbing solution into high surface area film. The gas stream to be cleaned flows through the packing. Counter current scrubbers have the greatest contact area and there fore the most efficient scrubbers. Clean gases are then vented out through exhauster and chimney into atmosphere. To control mist, Packing rings are filled above the scrubbing solution. Collected mist drops through the ring and drains off the bottom of scrubber. Depending on the characteristics of the fume scrubbing solution will be neutralize with alkaline water or other chemicals in such a way that its absorption capacity with various gases will be maintained through out the operation. The clean gas exiting the top outlet to the fan or stack.

Advantages and Competitive Considerations:
1. **No internal nozzles in the slurry circuit, no small diameter baffles, which can plug.**
2. Venturi exit regain diffuser minimises the exhaust fan power demand

3. Fully irrigated Wet - Dry interface.
4. Minimal space is required for installation, due to compact size.
5. High collection Efficiency

TECHNICAL SPECIFICATIONS:

Application	
Air handling Capacity	**5,000 ACMH**
APCM offered	**Ventury cum packed Bed Scrubber.**
Centrifugal Exhauster	**12.5 HP 1440 rpm**

After Installation of APCM we confirm SPM contents shall be less than the standards laid down which are as under:
PM level Less than 150 mg / NMCu

1. VENTURY CUM PACKED BED SCRUBBER:

Type : Ventury and Packed
Dia : 1,250 mm, 3 mm thick
Height : 2,500 mm
Material of Construction : M.S.
Packing Bed Depth : 1.0 Meter
Packing Material : Pall Ring of 40 x 40mm

2. Blower (Optional if required**)**

Type : Centrifugal
Model : AS-ORB-15S
Capacity : 5,000 M^3/Hr
Gas I/L Temp. : 250 - 300^oC.
Differential Pressure : 350 MMWG
Blower BHP : 9
MOC : MS Epoxy paint
Drive Arrangement : V Belt Pulley
Motor Recommended : 12.5HP / 1440 RPM
Scope of Supply : Blower, Base Frame, Suction Damper, Foundation bolts, Set of Pulleys and Belts.

Arrangement for Inspection/cleaning of impeller and casing and casing drain plug

3. Ducting : **260 dia B Class Pipe**

OUR SCOPE OF SUPPLY:

1. **Ventury cum Packed Bed Scrubber**
2. **I.D. Fan with Motor & Accessories.**
3. **Water line**

4. **Inter connecting Pipes**
5. **Scrubbing Solution Pump.**
6. Support and Structure.

CLIENT'S SCOPE:

1. **Electrical Connection (Main switch, Fuse, Starter and Wiring).**
2. **Erection.**
3. **Testing Fees**
4. **Civil Tank 5,000 lts.**
5. **All Foundation to mount Scrubber and Blower.**

PRICE: -

Description	Qty	Price Per Set	**Total Price**
Complete Scrubbing System	1 Set	Rs.2,25,000/-	Rs.2,25,000/- Rs.Two lacs Twenty Five Thousand Only.

Annexure - VI

EFFLUENT TREATMENT FOR A CASHEW NUT PROCESSING INDUSTRY

1.0 PREAMBLE

As part of MINAS, CPCB desires to establish norms for wastewater treatment of a typical Cashew Nut processing discharging 200 litre/day at a BOD of 5000 mg/l, COD of 10000 mg/l and Oil & Grease (Extractable, mostly in the form of phenolics compounds) at 2000 mg/l. Obviously, wastewater of this magnitude can not be handled in conventional manner. The suggested Mini ETP reclamation system alternatives, viz, a) Pre-engineered Rotating Biological Contactor and b) Sequential Batch Reactor are easy to operate and maintain, complying to BETNEEC (Best Environmental Technology Not Entailing Excessive Cost) approach.

2.0 PLANT DIAGNOSIS – EVOLUTION OF INPUT DATA

The Cashew Nut processing unit involves deployment of employees, food preparation or prepared food supply in the complex etc, besides generating process wastewater.
Domestic Effluent: **The entire water used for WC/Urinal, Dining Hall will re-appear as sewage. @ 45 LPCD and allowing 10% floating population the total sewage flow can be estimated for domestic sewage/sullage, knowing the connected population.**

Trade Effluent: **200 litre/day @ BOD of 5000 mg/l, equivalent to 22 to 25 Population Equivalent.**

The required treatment system: **A mini Effluent treatment with reclamation mode, so that the treated water can be used for Landscaping (to be applied @ 2.5 to 3.5 litre/sqm/day) and the WC/Urinal wastewater after septic tank or raw wastewater as such be mixed with trade effluent for combined treatment.**

Drainage and other Infrastructure**: The plot allotted for the factory has to have an organized drainage system around and water requirement has to be met from ground water resources or through procurement strategy. The sewer network and common collection system will result in terminal manhole at some invert level. Based on this, the post pumping or gravity flow requirement has to be decided.**

3.0 INNOVATIVE MINI ETP RECLAMATION SYSTEM EVOLVED FOR SITE SPECIFIC SITUATION

DESIGN FORMULATION

Flow : The design wastewater flow will be 200 litre/day
BOD : The wastewater will be collected in a terminal collection cum buffer tank. At 5000 mg/l, the BOD load is 1000 grams/day. Being a reclamation project, the entire wastewater has to be collected in a central place and treated to meet the good quality BOD norm of < 20 mg/l. The wastewater will be treated to render the following treated effluent quality:

- pH 6.5 to 8.5

- BOD, mg/l < 20
- Turbidity, NTU < 3

Alternate -1 : SBR System

A typical SBR (Sequential Batch Reactor) system was evolved deploying 'Process knowledge" and restricting number of "Hardware", as they lead to O & M problems. This system will consist of:

- **Collection-cum-aeration-cum-settling tank**
- **Sand Bed Filter system for decanted water filtration**
- **Sludge drying bed for excess sludge**

Aeration Tank Volume:

Since the BOD concentration is 5000 mg/l and flow is very low, the load is more important than the concentration for effective treatment. SBR system is an extended aeration activated sludge process. The F/M ratio is considered in the range 0.06 to 0.1 only, so that the system is starved for food during regular run.

Volume of aeration tank = 1kg/day/(0.06*3.5)
= 4.76 cum

The system will be operated on "Aerate-settle-decant" mode. Due to extreme low flow, once in a week, decantation mode will be adopted. Hence the volume for one week @ 200 litre/day is 1.4 cum. This volume to be added to the above calculated aeration tank volume. Thus the total volume of the aeration tank is 6.16 (4.76 + 1.4), say 6.5 cum

Oxygen & Air requirements:

@ 2 Kg O2/Kg BOD, Oxygen required = 2000 grams/day or 83.3 grams/hr
@ 10 grams/cum/m L.D, Air required = 83.3/10*2.0 or 4.165 cum/hr
@ 0.020 cum air/cum tank/min, mixing air = 7.8 cum/hr

Hence provide 7.8 and 30% excess to counter losses. The blower air requirement is 10 cum/hr. Considering dome type diffuser @ 1.5 cum/hr/dome, number of dome type diffuser required is 7 Nos.

Sand Bed Filter System for decanted water filtration:

Once a week, 1.4 cum of treated water will be removed from the system via a sand bed filter. The regulated flow of withdrawal will be @ 2 cum/hr and hence time required for removing 1.4 cum will be about 45 minutes. The filter area required @ 12 cum/hr/sqm is 0.17 sqm. 2 Nos SBF each of 0.4m X 0.4m X 0.8m Total depth will be provided for filtration purpose. The filtered water will meet the BOD less than 20 mg/l

The operational sequence will be:

- **Continue to receive the process wastewater for seven days, while aeration is on**

- **On 7th day, stop the blower and allow the sedimentation for 1 hr.**
- **Switch on the transfer pump (pre-set at a depth) and regulate the withdrawal @ 2 cum/hr for 45 minutes via 2 Nos Sand Bed Filter system (1W + 1SB). This will drop the level equivalent to 1400 litres, 7 days feed rate.**
- **Once in a month, also carryout settled sludge withdrawal @ 2 cum/hr for 20 minutes. The sludge will be sent via 2 Nos Sludge Drying Bed of 0.4m X 0.4 m X 0.8 m (1W +1SB)**
- **Switch on the blower and repeat the above steps.**

Excess sludge production:

Being SBR, the net sludge production will be about 0.15 Kg TSS/Kg BOD destroyed. The daily BOD reduction expected is 1 Kg and TSS generation of 0.15 Kg. For 30 days, the net accumulation will be 4.5 Kg. The settled sludge will be @ 0.8 consistency and hence monthly sludge volume removal requirement is 0.6 cum.
A comparison of conventional system with that of evolved mini SBR system is presented below:

EQUIPMENT/FACILITY	Mini SBR System
Buffer Tank with pre-aeration	**6.5 cum, below ground level, SBR concept**
Raw Effluent transfer pumps	**Eliminated by SBR operational feature**
Aeration Tank	**SBR of 6.5 cum size with 7 Nos dome diffusers**
Sedimentation tank	**SBR itself renders Solid/Liquid separation provision**
Sludge re-circulation pumps	**Not required for SBR system**
Treated water and sludge withdrawal pumps	**1 No treated water transfer pump On/OFF operated and 1 No sludge withdrawal pump ON/OFF operated**
Mini Blower	**2 Nos (1W +1SB) each of 1.5 HP rating**
Dome Type diffusers	**9 Nos (2 as reserve)**
Treated water holding tank	**Not required, if disposal planned**
PSF & ACF	**Organic removals are maximum done using F/M ratio < 0.1 and for filtration "Sand Bed Filter" incorporated.**
Process Controls	**Timer control for pumps and simplified Operational Instructions for SBR mode of operation**
Sludge drying beds	**2 Nos based on net sludge production**
Plant Aesthetics	**All units below ground level in a compact size and only 2 pumps and 2 blowers involved. Pump operates ON/OFF, while one blower continuously**

Alternate -2 : Rotating Biological Contactor System:

In this system, except holding tank, all other items are pre-engineered. The system will consist of:

- **Buffer tank, integral part of packaged plant**
- **Feed pump of Water Wheel type connected to the RBC Drive itself**
- **Disk area 50 sqm, with adjoining lamellar separator**
- **Sludge disposal timer operated pump**

4.0 HOW EXHAUSTIVE VERSUS HOW COMPREHENSIVE

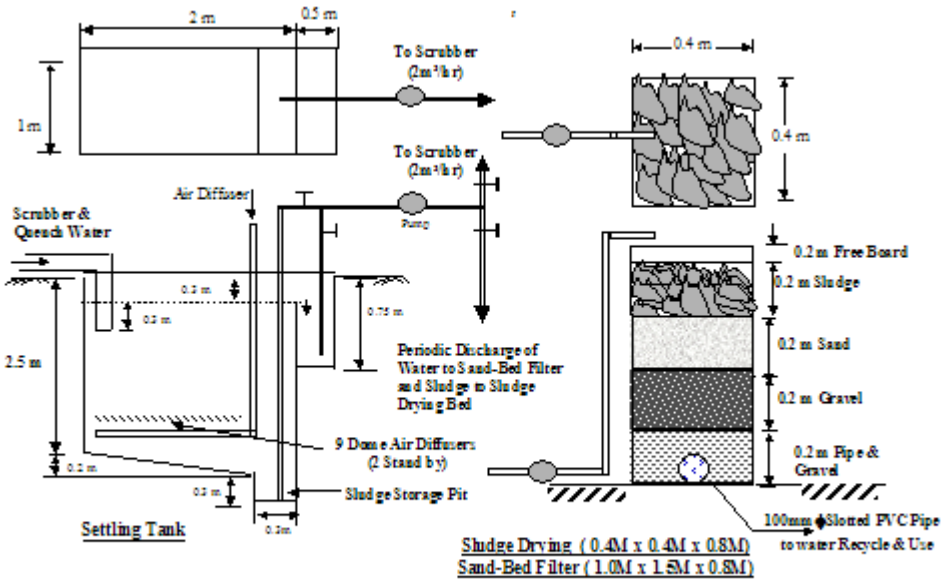
The SBR system evolved by us consists of:

- **An aeration tank capable of operating in "Aeration-sedimentation-decantation" mode with maximum organic removal capability (very low F/M ratio and high MLSS)**
- **One ON/OFF operated transfer pump directly to 2 Nos (1W + 1SB) Sand Bed Filter system, which receive on-line hypo dosing arrangement, and delivers the filtered water into an underground treated water holding tank. The plant hydraulic has been so chosen to eliminate a separate pump (also PSF & ACF) for raw wastewater feed purpose**
- **One ON/OFF sludge withdrawal pump directly to 2 Nos sludge drying beds (1W + 1SB), which operates for weekly once basis. The filtrate goes back to aeration tank**
- **Continuous operated blower (1 W + 1SB)**

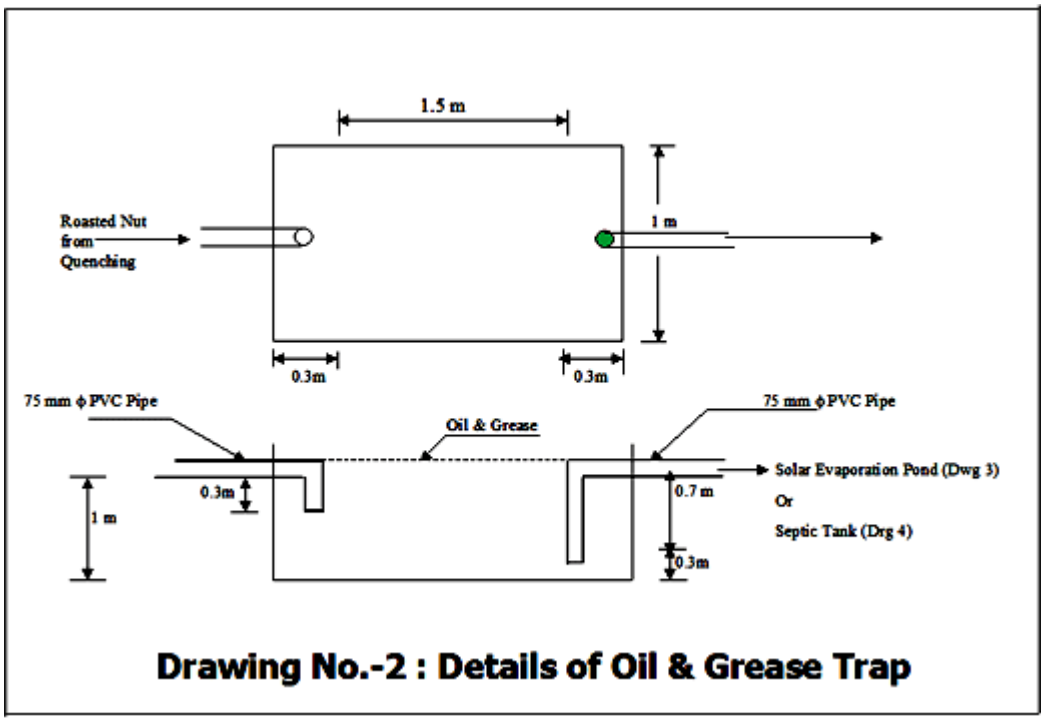
The pre-engineered package RBC Technology will eliminate even the above operations. The concept of integrating sanitation improvement with reuse & recycle secures "Ownership Role" of client.

5.0 PRICE

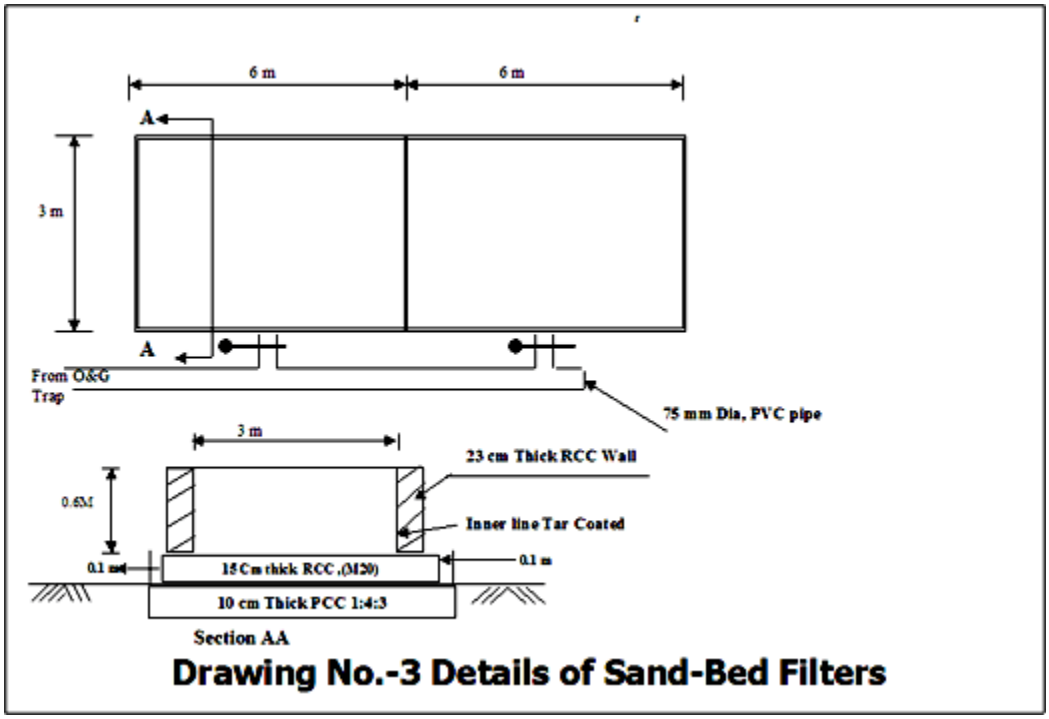
The cost of SBR will be Rs 4.5 Lakhs, while the RBC Technology will be EUR 5000/Unit (Rs 3.0 Lakhs without customs duty), subject to order placement of 10 numbers per consignment.



Drawing No.-1 Details of Aeration cum Settling Tank, Sludge Drying & Sand-Bed Filter



Drawing No.-2 : Details of Oil & Grease Trap



Drawing No.-3 Details of Sand-Bed Filters