

Air Quality Management for Cashew Nut Industries (Cluster)

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Abstract - Cashew Nut Industries are under small scale/cottage sector under orange category without any effective pollution preventive techniques. The pollution from single unit has no major effect to environment but the pollution load from the cluster becomes culprit to environment. The source of different environmental pollutants emits in to the atmosphere during the processing by roasting process and cooking (steam roasting) process, the main pollutant is particulate matter (PM). This paper deals with the appraisal of Pollution load from the cashew nut processing units (cluster) and suggest techno-economic and air quality management for gaseous emissions from cashew cluster.

Key Words: Cluster, Particulate Matter (PM), suggestive methods

1. INTRODUCTION

Cashew (*Anacardium occidentale*.) is one of the commercial crops in India, 0.43 million tonnes of raw nuts being harvested from an area of 6590 km². India processed about 1.19 million tonnes of raw cashew seeds through 3650 cashew processing industries in India around 5lakhs people are working. There are about 300 units in Nagercoil district, Tamilnadu, 270 units in Kollam district, Kerala and around 130 units in Palasa-Kasibugga, Andhra Pradesh. There are also small amount of these industries in Cheerla, Mangalore, Maharashtra, Odissa and few in Goa. The capital cost on the units is varying between 6-15lakhs. The cashew industry in India employed different unit operations/methodology for processing depends on variety of raw material, place, technological mechanization and availability of fixed energy supply. Commonly we have two methods for processing they are Roasting process and cooking process (steam roasting).

2. FEED AND PROCESS STEPS

The general processing steps involved in cashew processing are drying of freshly harvested raw seed for storage, soaking of seed, Steam cooking or roasting, Shelling or cutting, Separation, Kernel drying, Peeling and Packaging.

Raw nuts drying: Sun dried in yards weight loss varies from 3% to 10% depends on time of harvesting and place of origin. The raw nuts after harvest are sun dried for 2-3 days to reduce the moisture from 25-9% and stored. Moisture content less than 3% soaked with water.

Roasting process: Roasting of cashew seeds is carried out in a manually rotating open drum of diameter of 0.6m and 2.5 m length, with an angle of 15-20° to axis to comfortable to the flow of 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 25-30 kg of roasted cashew or de oiled shell for about 15-20 min. Once the drum is getting heat, the cashew nuts are fed manually through a hopper into the inlet of the hot drum. The drum is rotated manually with 5-10rpm, so that the cashew nuts are moved out of the drum. The manual feeding of the raw cashew nuts and the rotation of the drum are so synchronicity that about 450-560kg (6-7 bags) of cashew nuts are roasted in an hour.

Cooking process: This method is adopted now-a-days in all over the India widely. The dried nuts are steam cooked. Well dried raw nuts are subjected for steam boiling, which is commonly, adopted method of nut conditioning in India. The raw nuts are steamed conditioned about 7-8 kg/cm² steam pressure for 25-30 min and then allowed to cooling in shed. For steam generation baby boiler is used.

Baby Boiler: The baby boiler is a hand stoked fire tube boiler, which produces steam at 7-8 kg/cm². The roasted cashew shell or de-oiled cakes are feed (about 2-3 kg fuel once in 15-min) and burned at the bottom of the boiler. boiler, which produces steam at 7-8 kg/cm². The roasted cashew shell or de-oiled cakes are feed (about 2-3 kg fuel once in 15-min) and burned at the bottom of the boiler.

Flow chart for processing and environmental discharges

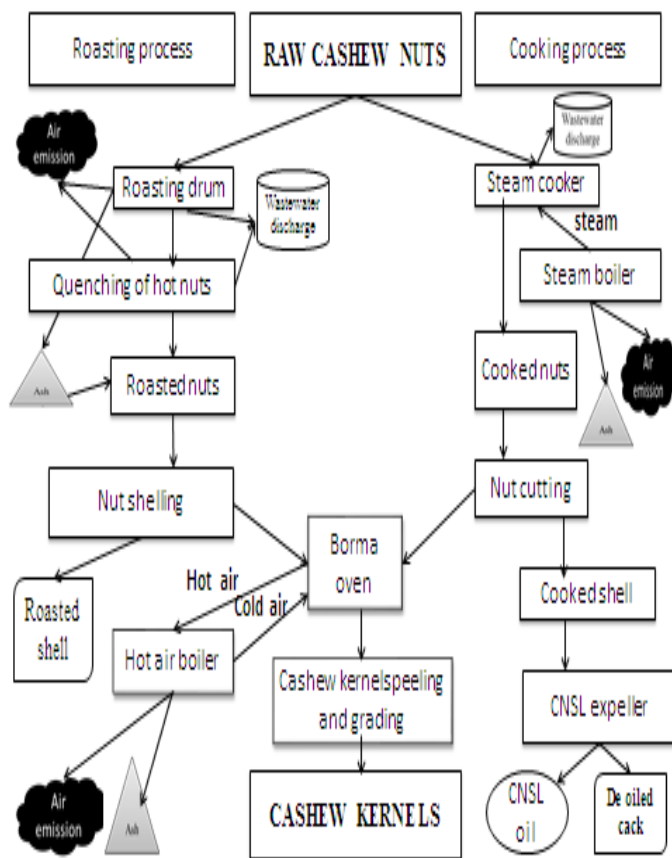


Fig1- Processing and environmental discharges

3. SOURCES OF AIR EMISSIONS

Cluster surrounded by an area all the units operation happen at the same time there is a visible build-up of smoke in the ambient air. The main sources of air emissions are

Roasting Process:

Due to the high temperature of the drum the Cashew Nut Shell Liquid (CNSL) in the raw cashew nuts catches the fire voluntarily and the nuts are roasted through the entire length of the drum without any help of fuel. The hot gases from the inlet of the drum are evolving into atmosphere by a natural draft stack of about 15-18 m height. The water vapor and fumes generated while quenching of raw nuts are discharged by individual short vents connected to the dog-house. In some units, these vents are also connected to the chimney.

Cooking Process:

The flue gas emissions from the baby boiler are the source of air pollution.

Kernel Drying:

The kernel coming from both the shelling and Cutting Section contains a brown cover over kernel known as testa. To remove testa over the kernel and also control the moisture content in the kernels, they are exhibit to extended and controlled heating with hot air at 60-70°C for about 6-7 h in the drying chamber of Borma oven. About 5-8% of moisture is removed from the kernels in the procedure; this process is known as Borma. Indirect heating of atmospheric air generates the hot air over hot surface in an Oven. The Borma ovens are fired with cashew shell or de-oiled cashew cake. The ovens evolve the flue gases to environment. Sometimes it connected to main stack

Monitoring Methodology:

The sampling and analysis of the environmental pollution parameters were conducted by Central Pollution Control Board, New Delhi (Emission Regulations - III, CPCB Publication 1985).

4. RESULTS

- To estimate the pollution load from cashew seed processing units, the monitoring of air emissions was carried out from all the pollution generating operations i.e. Roasting Process (using fuel as roasted shells), Cooking Process (using fuel both i.e. de oiled shells and roasted shells), Borma oven (using fuel as roasted shells).
- The hot air oven is fired with Roasted shell or De oiled 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 PM concentration from the Roasting process (use fuel as roasted shell) found to be in the range of 665-1468 mg/Nm³.

The PM concentration from the Cooking process (use fuel as roasted shell) found to be in the range of 992 -1270 mg/Nm³.

The PM concentration from the Cooking process (use fuel as de-oiled shells) found to be in the range of 382-535 mg/Nm³.

The PM concentration from the Borma operation (use fuel as roasted shells) found to be in the range of 405-587mg/Nm³.

Table-1: Emission rates and Component of pollution from cashew cluster are shown in table below

Sources of emissions	Flow Rate of flue Gases NM ³ /hr (CO ₂ %)	Temp °C	PM mg/ Nm ³ (Kg/hr)	SO _x mg/ Nm ³ (Kg/hr)	NO _x mg/ Nm ³ (Kg/hr)
Roasting Drum Stack Emissions	1500-2500 (1.5%-4.0%)	135-360	665-1468 (1.3-2.6)	10-36 (0.02-0.07)	27-131 (0.05-0.17)
Baby Boiler Stack Emissions- Roasted shell	181-182 (4.2%-5.7%)	340-367	992-1270 (0.18-0.23)	21-30 (0.004-0.005)	227-593 (0.04 - 0.11)
Baby Boiler Stack Emissions- De oiled cake	193-495 (13%-14%)	340-720	382-535 (0.08-0.1)	12-29 (0.003-0.006)	124-645 (0.03-0.1)
Borma Oven Emissions- Roasted shell	186-996 (1.0%-2.7%)	190-352	405-587 (0.1-0.36)	10-48 (0.001-0.05)	55-146 (0.01-0.09)

Avg concentrations are in mg/Nm³ and values in () are kg/hr

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.

Table-2: Air Pollution Emission Standards for 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 **	De oiled Cake	Roasted Shell **	De oiled Cake
Particulate Matter	150*mg/Nm ³ at 4 %CO ₂	150 **mg/Nm ³ at 4 %CO ₂	150mg/NM ³ at 4 %CO ₂	150 ** mg/NM ³ at 4 %CO ₂	150mg/N M ³ at4 % CO ₂
Minimum Stack Height, m	20m from ground level	15m from ground level or 2m above the height of the nearest building, whichever is higher		15m from ground level or 2m above the height of the nearest building, whichever 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-gasifier to meet the emission standard especially wherever roasted shell is used for firing. Alternatively the de oiled cake may be used.

5. SUGGESTIVE METHODS FOR AIR QUALITY MANAGEMENT OF CASHEW NUT INDUSTRIES (CLUSTER):

Main pollutants in the emission are particulate matter, SO_x, NO_x, phenols

1. End pipe control techniques
2. Pre-treatment of nuts
3. Energy source modification
4. Process change
5. Sharing of pollutant remediation

5.1. End pipe control techniques

For SO_x, NO_x, phenolic compounds the suggested increase the 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. For particulate matter reduce the emissions from Roasting Process great efficiency control systems like packed bed wet scrubbers are useful.

5.2. Pre-treatment of nuts

Depend on nut characteristics pollution loads are reduced they are Moisture content, nut size, and roasting time (or) SET. Moisture content, steam exposure time (SET) and nut size distribution for large, medium and small sized nuts at MC*SET combination of 8.34%*30 min, 11.80%*32 min and 8.34%*30 min, respectively. This can decrease the soot formation so that Pre-treatment of cashew nuts by steam boiling is found to decrease in pollution loads from cluster.

5.3. Energy source modification

Solar heating:

Use of solar Energy for cooking as well as extraction cashew nut shell oil

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. The heat can be generated by biogas, produced by a bio-gasifier using roasted shell or de oiled 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.

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 environment friendly leaves no atmospheric pollution.

5.4. Process change

Replace the roasting process with cooking process it will give less pollutants compare to roasting process. In addition valuable CNSL can be recovered as by product. This is used in paints, lubricants etc.

5.5. Sharing of pollutant remediating equipment

Mainly cashew industry is a small scale/cottage sector because of this the industries have no perfect remediating equipment also the cost of the equipment was high.

For this group of industries share the cost of equipment and pollution removal. Result in reduction in pollution load.

6. Conclusion

By this study emission by single unit is comparatively less but the group of units (cluster) becomes very high. Cashew industries are small scale /cottage sector under orange category and they have no effective pollution remediation methods are in operation. Due to this the industrial cluster as well as ambient environment was polluted. For this i suggest to adopt the techno economical and remediated methods like End pipe control techniques, Pre-treatment of nuts, Energy source modification, Process change, sharing of remediating equipment for management and cut off cluster pollution loads.

REFERENCES

- [1] Atul Mohod, Sudhir Jain and A.G. Powar, "Pollution Sources and Standards of Cashew Nut Processing", American Journal of Environmental Sciences 6 (4): 324-328, 2010.
- [2] Babatunde Sunday Ogunsina, Adeleke Isaac Bamgboye, "Pre-shelling parameters and conditions that influence the whole kernel out-turn of steam-boiled cashew nuts", Journal of the Saudi Society of Agricultural Sciences 13: 29-34, 2014.
- [3] Alka srivastava and a.b.akolkar "Assessment of pollution load and preventive measures from cashew nut processing industries", Journal of Industrial Pollution Control 25 (2) pp 131-138, 2009.
- [4] Comprehensive Industry Document for Cashew Seed Processing Units COINDS/75/2007, CPCB, New Delhi, India.
- [5] Anonymous, "Comprehensive Industrial Document And Environmental Standards For Cashew Seed

Processing Industries", Central Pollution Control Board, N.Delhi, (2006).

- [6] Balasubramanian, D., "Optimization of processing parameters using farm level cashewnut processing". J. Agric. Eng. Today, 32: 35-41. 2007.
- [7] "Energy Park", Department of Electrical and Other Energy Sources, C.A.E.T, Dapoli, March 2006.
- [8] Emission Regulations – III, CPCB Publication 1985. CPCB, New Delhi, India.
- [9] Government of India Ministry of Environment and Forests.