

**BEFORE THE NATIONAL GREEN TRIBUNAL
WESTERN ZONAL BENCH AT PUNE
ORIGINAL APPLICATION NO. 106 OF 2025**

IN THE MATTER OF:

SANGRAM SUBHASH DIVEKAR AND ORS.

...APPLICANT

VERSUS

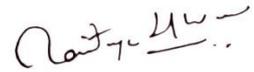
STATE OF MAHARASHTRA & ORS.

...RESPONDENTS

INDEX

S.No.	Particulars	Page
1.	Rejoinder on behalf of the Applicant to Affidavit-in-Reply dated 4.02.2026 filed by Respondent No. 5	
2.	<u>ANNEXURE A-27</u> Research paper titled " <i>A Review on "Briquette (Biocoal) from Crops Residual as A Feasible Energy Conversion Technology"</i> " published in International Journal of Engineering Research & Technology authored by Prof. Dharmendra D. Sapariya et al	

THROUGH



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Place: Pune

Date: 09.03.2026

BEFORE THE NATIONAL GREEN TRIBUNAL

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**REJOINDER ON BEHALF OF THE APPLICANT TO AFFIDAVIT-IN-REPLY
DATED 4.02.2026 FILED BY RESPONDENT NO. 5**

Most Respectfully Showeth:

1. The present Application has been filed under Section 18(1) read with Sections 14, 15 and 20 of the NGT 2010, by residents of Varvand village, seeking preventive and punitive measures against significant air and water pollution being caused due to illegal operation of a Skimmed Milk and Butter manufacturing unit (hereinafter referred to as the impugned 'Dairy Products' unit) located at Gut No.2104/1 B, Pune – Solapur Highway, village Varvand, Taluka Daund, District Pune, operated by Maharashtra Rajya Sahakari Dudh Mahasangh Maryadit' (hereinafter referred to as the 'Project Proponent') in violation of Consent to Operate ('CTO') dated 4.12.2024 granted by the Maharashtra Pollution Control Board ('MPCB').
2. That vide order dated 2.12.2025, this Hon'ble Tribunal had directed the Project Proponent to submit their reply within four weeks. Thereafter, the Project Proponent has filed their Affidavit-in-Reply dated 4.02.2026, in response to the issues raised by the Applicants in the present Original Application.

3. Accordingly, the present Rejoinder is being filed assailing the submissions made by the Project Proponent vide Affidavit-in-Reply dated 4.02.2026.
4. At the outset, the Applicants deny each and every averment and conclusion made in the said Affidavit-in-Reply dated 4.02.2026 submitted by the Project Proponent which is contrary to and/or inconsistent with what has been submitted on record in the present Application. Furthermore, nothing stated in the present Rejoinder on behalf of the Applicants shall be construed as an admission for the want of any specific and para-wise denial or non-traverse unless and until the same is specifically admitted hereinafter.

I. PRELIMINARY OBJECTIONS TO PROJECT PROPONENT

5. At the outset, the Applicants submit that the Reply Affidavit filed by Respondent No. 5 is misconceived, evasive and contrary to the material placed on record before this Hon'ble Tribunal. The Reply primarily consists of bald and sweeping denials which are unsupported by credible documentary evidence and which stand directly contradicted by the findings of the MPCB.
6. The said Reply does not meaningfully address the specific environmental concerns raised in the present Original Application. Instead of responding to the documented instances of pollution and regulatory violations, the Project Proponent has attempted to shift the focus toward proposed remedial measures and future improvements which, by the Respondent's own admission, remain incomplete or under consideration.
7. It is categorically submitted that such assertions cannot constitute a valid defence to the violations already observed and recorded by the statutory regulator, i.e., MPCB, and supported by evidence submitted by the Applicants.

8. The Applicants respectfully submit that the Reply itself contains several admissions which demonstrate that the pollution control infrastructure at the unit was either inadequate or not fully operational at the relevant time. When read in conjunction with the inspection reports and regulatory communications issued by the MPCB, the Reply Affidavit in fact reinforces the Applicants' contention that the operations of the impugned industrial unit have resulted in environmental pollution and nuisance to the surrounding residential locality.

II. FAILURE TO ADDRESS CRITICAL ISSUES

9. At the outset, it is respectfully submitted that the Reply Affidavit filed by Respondent No.5 fails to address several material allegations raised in the Original Application. The Respondent has chosen to selectively respond to certain technical aspects while completely ignoring several serious concerns supported by documentary evidence placed on record by the Applicants.
10. The following material allegations contained in the Original Application remain completely unaddressed in the Reply Affidavit.
- A. **Failure to ensure Environmental Monitoring** (Annexure A-15): No response by the Project Proponent to the issue pertaining to their failure to submit OCEMS data or Dioxin-Furan monitoring reports;
 - B. **Medical Officer's Site Visit and Report** (Annexure A-8): No response to government medical documentation of health impacts;
 - C. **Gram Panchayat Letter dated 06.12.2024** (Annexure A-6): No explanation why letter requesting pollution-free fuel was sent by the Local Body and ignored by the Project Proponent;

- D. **School's Complaint dated 22.05.2025** (Annexure A-9): No response to concerns about children's exposure to pollution by the Project Proponent;
- E. **Newspaper Reports** (Annexure A-3): No rebuttal to public documentation of residents' protest and health complaints provided by the Project Proponent;
- F. **Photographs of Soot Deposition** (Annexure A-2): No denial or alternative explanation for documented examples of black soot in homes of Applicants;
- G. **Independent NABL Lab Report** (Annexure A-19): No challenge to findings of ETP effluent non-compliance by Project Proponent;
- H. **Deficit of 317 m³/day groundwater availability:** As per CTO, Unit require 415 m³/day of groundwater to operate, but as per CGWA Clearance, only 98 m³/day has been permitted. No response to the said issue by the Project Proponent.

11. The silence maintained by Respondent No.5 in respect of multiple crucial allegations demonstrates the absence of any credible defense to the environmental violations highlighted by the Applicants.

III. FALSE CLAIMS OF COMPLIANCE REGARDING COAL STORAGE AND HANDLING

12. It is submitted that Respondent No.5 has attempted to portray its coal storage practices as fully compliant with environmental norms. In **Para 15, Pg. 353** of the Reply Affidavit, the Respondent states as follows:

"There is no dust travelling outside the shed. Apart from the same, green net has been erected over the entire compound wall so as to screen any dust which may be generated accidentally. Moreover, the respondent has planted over 200 Ashoka trees to mitigate the dust emissions."

13. This assertion is directly contradicted by the findings recorded by the Maharashtra Pollution Control Board during its inspection. The MPCB Site Visit Report dated 23.12.2024 (Annexure A-10) recorded that:

"Industry has provided coal storage yard which seems to be inadequate as 50% of coal is stored outside the yard and coal was stored near the boundary/compound wall and about 20 meters from the compound wall residential area was observed."

14. Similarly, the MPCB Show Cause Notice dated 17.02.2025 (Annexure A-11) recorded the following violation:

"You have not provided scientific storage for coal – about 50% coal stored on open land."

15. Further, the MPCB Directions dated 21.04.2025 (Annexure A-13) specifically recorded that:

"You have not provided dedicated and closed area for the storage of coal."

16. These observations by MPCB conclusively demonstrate that coal storage at the facility was neither scientific nor enclosed at the relevant time. Even more significantly, the Respondent's own communication dated 22.02.2025 (Annexure A-12) acknowledged that the coal shed had been damaged and that corrugated sheets were being installed for repairs. This admission itself confirms that the shed was not functioning as a fully enclosed structure capable of preventing fugitive dust emissions.

17. Therefore, the categorical claim made in the Reply Affidavit that coal is stored in an enclosed shed *"so that there is no transmission of any dust whatsoever..."*,

as made on **Para 15, Pg. 351**, is demonstrably inconsistent with the regulatory record as well as the Project Proponent's own prior admissions.

IV. OPERATION OF IMPUGNED UNIT WITHOUT ADEQUATE AIR POLLUTION MEASURES PATENTLY EVIDENCED

18. In **Para 13, Pg. 351** of the Reply Affidavit, Respondent No.5 claims that steps have been taken to improve emission control systems and states that a purchase order for an Electrostatic Precipitator (ESP) has been placed. The Respondent states:

"The purchase order for the ESP has been placed on 27 January 2026 and the same is expected to be completed by June 2026."

19. This statement reveals that the installation of effective air pollution control equipment had not been completed at the time of filing the Reply Affidavit.

20. The record demonstrates that the MPCB had already observed visible emissions from the stack much earlier. The inspection conducted on 23.12.2024 recorded brownish smoke emanating from the stack. Subsequently, the Show Cause Notice dated 17.02.2025 recorded that the Respondent had not installed adequate air pollution control systems. Thereafter, Directions dated 30.12.2025 (**Pg. 334**) issued under Section 33A of the Water Act, 1974, and Section 31A of the Air Act, 1981, clearly directs the Project Proponent to *"upgrade and provide adequate air pollution control systems to avoid air pollution."*

21. Despite these observations spanning several months, the Respondent continues to operate the coal-fired boiler without installing an effective emission control system. Even according to the Respondent's own timeline, the ESP

installation is expected only by July 2026, meaning that the unit would have operated for an extended period without adequate pollution control equipment.

22. Respondent No. 5 has also claimed that replacement of a rotary valve has reduced emissions from the chimney. However, no emission monitoring data or independent verification has been produced to substantiate this assertion. In the absence of any stack monitoring reports demonstrating improved emission performance, the claim remains an unsubstantiated assertion.
23. The record therefore clearly demonstrates that Respondent No. 5 continued operating the coal-fired boiler for a prolonged period despite the absence of adequate air pollution control infrastructure, and have accrued to themselves a significantly longer time-period for implementation of essential air pollution control mechanisms, indicating continued industrial operation in the face of established and undeniable pollution impacting the lives of the Applicants.

V. FAILURE TO ADEQUATELY SUPPORT ASSERTIONS REGARDING UNSUITABILITY OF ALTERNATIVE FUELS

24. In **Para 16, Pg. 353** of the Reply Affidavit, Respondent No.5 attempts to justify its continued reliance on coal by claiming that a trial of biomass briquettes was unsuccessful. The Respondent states:

"The Respondent purchased 300 MT briquettes vide a purchase order dated 18 March 2025... the required steam-pressure was not maintained by the usage of briquettes... the same was not found suitable as a fuel for burning in the furnace as the furnace is designed for baggase fuel."

25. It is submitted that the said explanation suffers from several fundamental inconsistencies. Firstly, the CTO dated 04.12.2024 explicitly authorizes the use of bagasse as well as coal as fuel for the boiler. The claim that the furnace is

designed for bagasse therefore does not explain why coal combustion has been the primary operational practice.

26. Furthermore, the Respondent has not produced any technical documentation from the boiler manufacturer or any engineering analysis demonstrating that briquettes were technically unsuitable for maintaining the required steam pressure. No combustion analysis, burner configuration report, or expert certification has been produced to substantiate this claim.
27. The explanation therefore appears to be a post-facto justification for continuing the use of coal despite the environmental concerns raised by the community.
28. It is submitted that as per research paper titled "*A Review on 'Briquette (Biocoal) from Crops Residual as A Feasible Energy Conversion Technology'*" published in International Journal of Engineering Research & Technology authored by Prof. Dharmendra D. Sapariya et al, Biomass briquettes can have calorific value upto 4500 kcal/kg, with bagasse specifically having a calorific value of 4200 kcal/kg, which is comparable to coal's 4000-5000 kcal/kg. A copy of the research paper titled "*A Review on 'Briquette (Biocoal) from Crops Residual as A Feasible Energy Conversion Technology'*" authored by Prof. Sapariya et al is annexed and marked herewith as **ANNEXURE A-27**.
29. While slightly lower, briquettes can maintain required steam pressure with minor combustion adjustments. Therefore, the claim of "failure" is technically implausible for a 10 TPH boiler with proper burner settings, which is well-known to be able to effectively operate on alternative fuels such as briquettes/biomass.

VI. COSMETIC SOLUTIONS PROVIDED BY PROJECT PROPONENT
UNEVIDENCED AND UNLIKELY TO SIGNIFICANTLY CONTAIN
POLLUTION

30. In **Para 15, Pg. 353**, Respondent No. 5 has attempted to rely on peripheral measures such as green net installation and tree plantation to demonstrate environmental compliance. As stated earlier, the Respondent claims:

"Green net has been erected over the entire compound wall... moreover the respondent has planted over 200 Ashoka trees to mitigate the dust emissions."

31. The Applicants submit that these measures, even if implemented, cannot address the core sources of pollution arising from the coal-fired boiler and coal handling operations. Coal dust emissions, stack emissions, and combustion-related pollutants such as sulphur dioxide and nitrogen oxides cannot be mitigated merely through boundary nets or ornamental tree plantations.

32. Effective pollution control therefore requires installation of appropriate emission control equipment and transition to cleaner fuel sources.

33. The reliance on such measures therefore appears to be an attempt to create a superficial impression of environmental responsibility without addressing the fundamental issues identified by the regulatory authorities.

34. However, notwithstanding the above-mentioned, no evidence regarding such tree plantation has been submitted on record whatsoever.

IX. COMPARATIVE ANALYSIS: COMPLIANCE CLAIMS VS. REGULATORY**FINDINGS**

35. A comparison between the claims made in the Reply Affidavit and the findings recorded by the MPCB clearly demonstrates multiple inconsistencies, which are detailed in a tabular format as follows:

Parameter	Project Proponent's Claim	MPCB Observations
Coal Storage	Stored in enclosed shed, no dust transmission (Para 15)	50% stored outside yard, within 20m of residences (MPCB Report 23.12.2024)
Air Pollution Control	Rotary valve replaced, emissions reduced (Para 13)	Brownish smoke observed, inadequate APC system (MPCB 17.02.2025, 21.04.2025)
ETP Operation	Operated round-the-clock by third party, compliance achieved (Para 16)	Not operated properly, standards not achieved (MPCB 21.04.2025)
Effluent Quality	Within parameters per self-reports (Annexure D)	Exceeds limits per MPCB analysis (Annexure N) and independent lab (Annexure A-19)
OCEMS Data	No mention in Reply Affidavit	Not submitted to MPCB (RTI Reply 27.06.2025)
Dioxin-Furan Monitoring	No mention in Reply Affidavit	Not conducted/submitted (RTI Reply 27.06.2025)
Briquette Transition	Tried but failed, furnace designed for bagasse (Para 16)	CTO permits bagasse, one-month deadline (27.02.2025) violated
Groundwater Abstraction	415 m ³ /day required per CTO	Only 98 m ³ /day authorized by CGWA - 317 m ³ /day deficit unexplained

X. TRANSITION TO ALTERNATIVE FUELS IS ONLY SUSTAINABLE SOLUTION IN THE PRESENT MATTER

36. In view of the persistent regulatory violations and the demonstrated environmental and public health impacts caused by the continued use of coal at the Respondent's facility, the Applicants respectfully submit that the most effective and proportionate remedial measure is to direct the Project Proponent to transition from coal-based combustion to biomass-based fuel such as bagasse or biomass briquettes, or other such alternate fuels. Such a direction would be both technically feasible and legally justified on the basis of the material already placed on record before this Hon'ble Tribunal.

37. From a technical standpoint, the transition to biomass fuel is not only feasible but has already been contemplated within the regulatory framework governing the Respondent's operations. The CTO dated 04.12.2024 explicitly permits the use of bagasse and coal as fuel for the boiler installed at the facility.

38. The inclusion of bagasse as an authorized fuel source in the Consent conditions demonstrates that the MPCB itself considered biomass fuel to be compatible with the operational design of the boiler system. Consequently, the Respondent No. 5 cannot now contend that the use of biomass-based fuel is technically impracticable when the very regulatory consent governing its operations recognizes such fuel as permissible.

39. Further, the feasibility of transitioning to cleaner fuel was expressly acknowledged by the Respondent No. 5 itself. By its communication addressed to the Gram Panchayat dated 27.02.2025 (Annexure A-7), the Respondent

assured the local authority that it would undertake steps to transition towards biomass-based fuel in response to the pollution concerns raised by residents.

40. This assurance constitutes an admission by the Respondent No. 5 that such a transition is technically achievable within its operational framework. Having made such representations to the local governing body, the Respondent cannot now seek to avoid the implementation of the same without producing any credible technical justification.
41. The authority of this Hon'ble Tribunal to direct corrective measures flows from the statutory framework of the National Green Tribunal Act, 2010. Under Section 15(1), this Hon'ble Tribunal is empowered to grant relief and compensation for environmental damage and to order restitution of the environment, which necessarily includes directing operational changes required to prevent continuing pollution. Further, Section 20 mandates that this Hon'ble Tribunal apply the precautionary principle, polluter pays principle, and the principle of sustainable development while adjudicating environmental disputes. In circumstances where an industrial activity poses a risk of serious environmental harm, the precautionary principle requires preventive intervention even in the absence of complete scientific certainty.
42. Additionally, Condition 8 of the CTO dated 4.12.2024 reserves the power of the MPCB to amend or impose additional conditions in the interest of environmental protection. Consequently, directing the Respondent to transition to cleaner biomass-based fuel would be a proportionate and legally sustainable measure consistent with statutory regulations. Accordingly, it is humbly prayed that this Hon'ble Tribunal reject the submissions made by Respondent No. 5.

484
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...APPLICANTS

VERSUS

State of Maharashtra & Ors.

...RESPONDENTS

AFFIDAVIT

I, Sangram Subhash Divekar, R/o Gopinath Nagar, Post Varvand, Taluka Daund, District Pune, do hereby solemnly affirm and state as under:

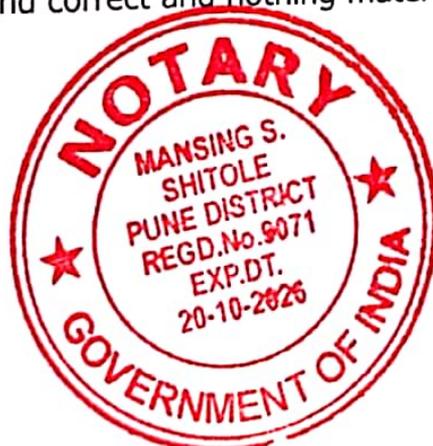
1. That I am the Applicant No. 1 in the above titled Application and am conversant with the facts and circumstances described in the present case and as such, I am competent to swear this affidavit.
2. That the contents of the present Rejoinder are true and correct and nothing material has been concealed therefrom.

Sangram Divekar

DEPONENT

VERIFICATION

Verified on this 10th of March 2026 that the contents of the above mentioned affidavit are true and correct and nothing material has been concealed therefrom.



Sangram Divekar

DEPONENT

P-T.O.



485



NOTED AND REGISTERED
AT SRL NO 202/2026
DATE 10/03/2026
Page No. : 2899

BEFORE ME
10/03/2026
MANSING S. SHITOLE
NOTARY
GOVT OF INDIA



A Review on “Briquette (Biocoal) from Crops Residual as A Feasible Energy Conversion Technology”

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Abstract:- Every year millions of tons of crops residual are generated which are either destroyed or burnt inefficiently in loose form causing air pollution. Agro wastes can be recycled & can provide a renewable source of energy by converting biomass waste into energy sources. Bagasse, ground nut, saw dust, cotton stick grass and rice husk were used as major biomass in the form of raw biomass, hydrolyzed biomass and carbonized biomass. Agro wastes with carbonized biomass were found suitable as compared to raw and hydrolyzed biomass for briquetted fuel. The briquettes were prepared on briquetting machine for different combinations of major biomass. After sun drying of agro wastes converts in briquettes were subjected to various tests for analysis of the quality of fuel. The suitability of briquetted fuel as industrial fuel is studied.

Keywords— Crop residual, pollution, recycle, hydrolyzed and carbonized biomass, briquette

INTRODUCTION

Many of the developing countries produce huge quantities of agro residual. These wastes are used inefficiently and burn directly which causing extensive pollution to the environment. The major agro residues are bagasse as sugarcane production waste, rice husk, coffee husk, coir pith, jute sticks, groundnut shells, mustard stalks and cotton stalks. These residual can be converted in to briquette. Briquettes can also be called as white coal as per its characteristics. Briquettes can be used in thermal applications. Briquette produced from agro wastes give earning a value addition of minimum 150%. [1]

Briquettes are used in various industries like,

- | | | |
|-----------------------------|------------------------------|------------------------|
| 1) Distilleries | 2) Dyeing units | 3) Tobacco processing |
| 4) Tea processing | 5) Leather industries | 6) Garment industries. |
| 7) Hotels | 8) Power plants | 9) Brick kilns |
| 10) Polymer industries | 11) Paper mills | 12) Cement plants |
| 13) Gasifier | 14) Food processing industry | 15) Milk dairies |
| 16) Pharmaceutical industry | 17) Tire retreading industry | 18) Wineries |

- 19) Household boilers
20) Any other boiler application

II. ANALYSIS OF CROPS RESIDUAL

A. Ultimate analysis (analytical chemistry):

It is the determination of the percentage of elements contained in a different biomass. It's including different proximate and ultimate analysis of biomass, which help in to find out different emission components generate after burning of biomass.

Biomass	Ash Contain	C%	H%	N%	O%	Calorific value (Kcal/kg)
Bagasse	4.00	47.00	6.50	0.0	42.50	4200
Rice husk	22.20	36.42	4.91	0.59	35.88	4000
Saw dust	1.20	52.28	5.20	0.47	40.85	4400
Ground nut shell	3.10	33.90	1.97	1.10	59.93	4500
Cotton shell	4.60	44.19	5.87	0.73	44.61	4200
Coconut shell	6.31	46.69	5.89	0.07	41.04	3720

Table 1 Ultimate Analysis of crop residual

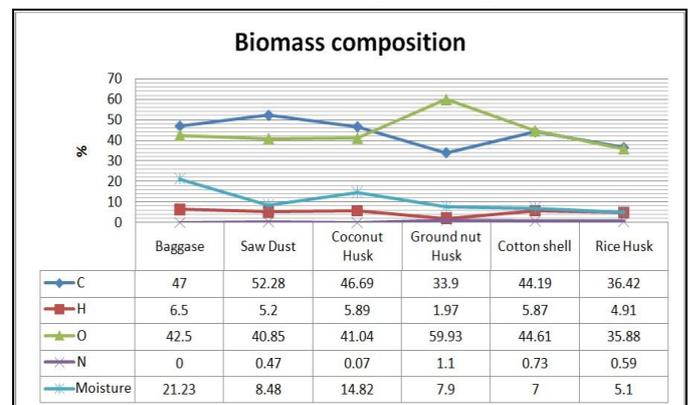


Fig.1 Ultimate analysis of crops residual

B. Proximate analysis:

Analysis for moisture, volatile matter, ash and fixed carbon contents were carried out on samples ground to -72 mess size by standard method. The details of these tests are as follows.

(1) Moisture Determination

One gram of air dried powdered sample of size -72 mess was taken in a borosil glass crucible and kept in the air oven maintained at the temperature 110°C. The sample was soaked at this temperature for one hour and then taken out from the furnace and cooled in a desiccators. Weight loss was recorded using an electronic balance. The percentage loss in weight gave the percentage moisture content in the sample.

(2) Volatile Matter Determination

One gram of air dried powdered sample of size -72 mess was taken in a volatile matter crucible (made of silica) and kept in the muffle furnace maintained at the required temperature of 925°C. The sample was soaked at this temperature for seven minutes and then crucible was taken out from the furnace and cooled in air. Weight loss in the sample was recorded by using an electronic balance having a sensitivity of 0.001 grams. The percentage loss in weight – moisture present in the sample gives the volatile matter content in the sample.

(3) Ash Content Determination

One gram of air dried powdered sample of size -72 mess was taken in a shallow silica disc and kept in the muffle furnace maintained at the temperature of 775-800°C. The sample was kept in the furnace till complete burning. Weight of ash formed was noted down and the percentage ash content in the sample was determined.

(4) Fixed Carbon Determination

The fixed carbon content in the sample was determined by using the following formula:

Fixed Carbon Content (Wt. %) = 100 - Wt % (Moisture + VM + Ash)

(5) Calorific Value Determination

The calorific values of the biomass samples were measured in a Bomb calorimeter apparatus. In this test an over dried sample briquette of weight 1gm (approx.) was taken in a bomb and oxygen gas was filled into this bomb at a pressure of 25-30 atm. The sample was then fixed inside the bomb and rise in temperature of water was noted with the help of Beckman Thermometer. The calorific value was calculated by using the following formula:

Gross Calorific value = (W.E X T) / W_o - (fuse wire + thread connections)

Where,

- W.E = water equivalent of the apparatus
- T = Maximum rise in temperature in °C.
- W_o = Initial weight of briquette sample. [2]

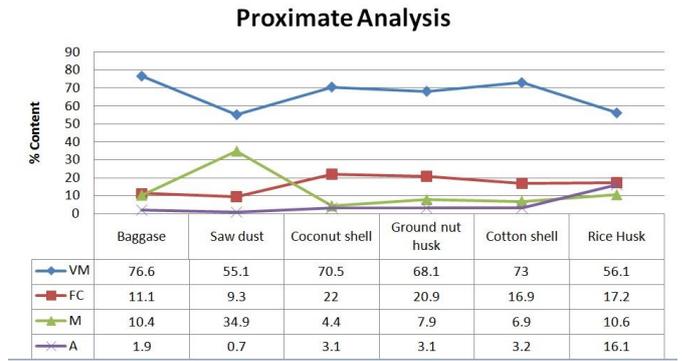


Fig.2 proximate analysis of crop

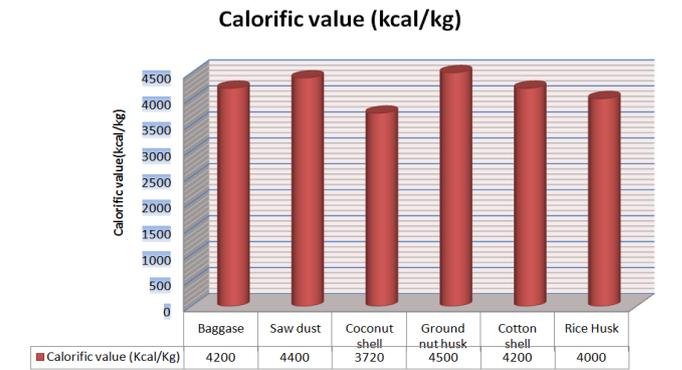


Fig.3 Calorific value

III. BRIQUETTING OF BIOMASS

A. Briquetting technique

Briquetting is densification of the loose biomass; this is achieved by subjecting the biomass to heavy mechanical pressure to form compact cylindrical form known as briquettes. Owing to high moisture content direct burning of loose bagasse in conventional grates is associated with very low thermal efficiency and widespread air pollution. The conversion efficiencies are as low as 40% with particulate emissions in the flue gases in excess of 3000 mg/ Nm³ In addition, a large percentage of unburnt carbonaceous ash has to be disposed off.

The densification of the biomass can be achieved by any one of the following methods: (i) Pyrolysed densification using a binder, (ii) Direct densification of biomass using binders and (iii) Binder-less briquetting. [3] Depending upon the type of biomass, three processes are generally required involving the following steps:

- (a) Sieving - Drying - Preheating - Densification - Cooling – Packing
- (b) Sieving - Crushing - Preheating - Densification - Cooling –Packing
- (c) Drying - Crushing - Preheating - Densification - Cooling – Packing

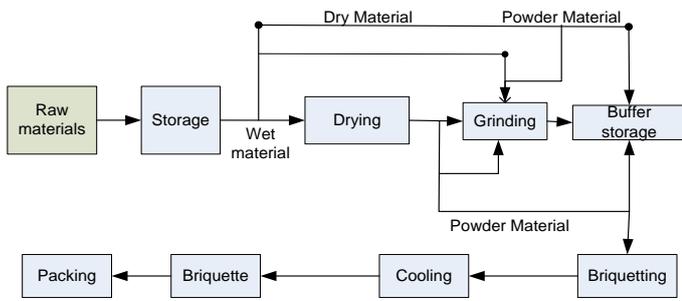


Fig. 4 Briquette making processes

When sawdust is used, process A is adopted. Process B is for agro- and mill residues which are normally dry. These materials are coffee husk, rice husk, groundnut shells etc. Process C is for materials like bagasse, coir pith (which needs sieving), mustard and other cereal stalks.

B. Advantages and disadvantages of briquetting

Advantages:

- a) High calorific value ranges between 3,500-5,000 Kcal/Kg.
- b) Moisture percentage is very less (2-5%) compared to lignite, firewood & coal where it is 25-30%.
- c) Economic to users compared to other forms.
- d) Briquettes can be produced with a density of 1.2g/cm³ from loose biomass of bulk density 0.1 to 0.2 g/ cm³.
- e) Easy in handling and storage due to its size.
- f) Consistent quality.

Disadvantages:

- a) High investment cost and energy consumption input to the process
- b) Undesirable combustion characteristics often observed e.g., poor ignitability, smoking, etc.
- c) Tendency of briquettes to loosen when exposed to water or even high humidity weather text into it.

IV. METHOD OF BRIQUETTE MAKING

A. Binding less techniques for briquette making

1. *The screw extrusion:* The Prepared homogenous raw material is fed to briquetting press by screw conveyor for regular feeding. In briquetting press it passes through toper die and due to high pressure & heat, powder form is converted into solid cylindrical briquettes. Although both technologies have their merits and demerits, studies have shown that the screw pressed briquettes are superior to the ram pressed solid briquettes in terms of their storability and combustibility. However the screw extrusion machines have low production capacity (150 – 200 kg/hr) and high operational cost, due to the possibility of screw breakages.

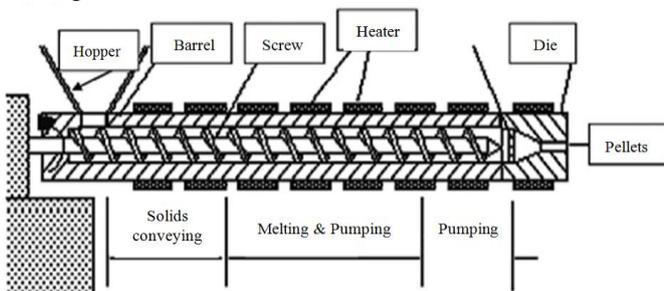


Fig. 5 Screw extruder

2. *The reciprocating ram/piston press (briquetting press):*

Piston press (ram) machine has higher production capacity (above 1000kgs/hr) as compared to screw machines, the briquettes are completely solid and screw press briquettes on the other hand have a concentric hole which gives better combustion characteristics due to a larger specific area. The screw press briquettes are also homogeneous and do not disintegrate easily. Having a high combustion rate, these can substitute for coal in most applications and in boilers.

The energy to the piston is transmitted from an electric motor via a high pressure hydraulic system. The throughput of a hydraulic press is lower than that of a mechanical press since the cycle of the cylinder is slower. In addition, the briquettes have a lower bulk density 6 (<1000 kg/m³) due to the fact that pressure is limited. However, these machines can tolerate higher moisture contents than the usually accepted 15% for mechanical piston presses **Fig 6** represent making of briquette by hydraulic piston press machine.

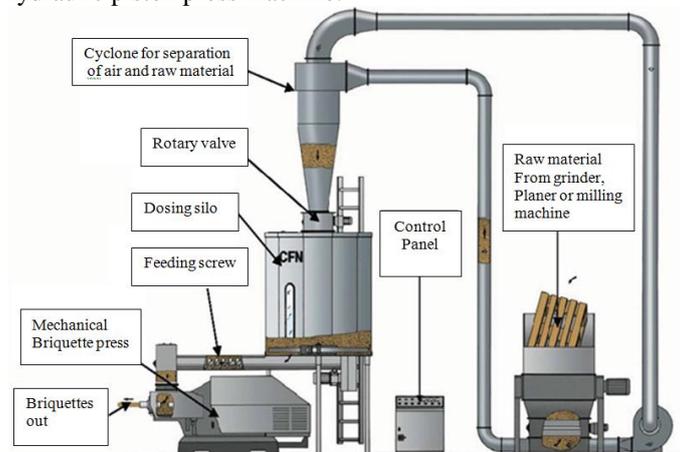




Fig. 6 Different Types of Feedstock for Piston Press Type Briquetting Machine

Another roll press type includes Densification of biomass using roller presses works on the principle of pressure and agglomeration, where pressure is applied between two counter-rotating rolls. Ground biomass, when forced through the gap between the two rollers, is pressed into a die, or small pockets, forming the densified product. Design parameters that play a major role on the quality of the densified product are the diameter of the rollers, the gap width, the roller force, and the shape of the die. [4]

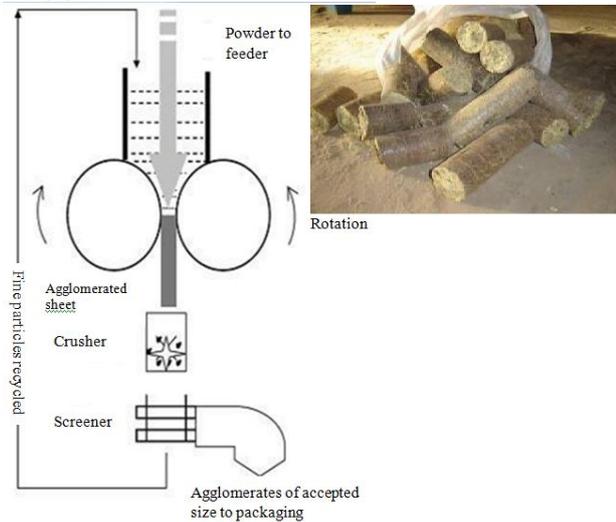


Fig. 7 Roll press type briquetting

In the case of agglomerate production, by using smooth rolls, the machine output can be a sheet having a specific thickness based on the gap provided between the rollers. The sheet produced is used to produce the agglomerates, as shown in Fig. 7 and the fines are again recycled back to the feeder.

B. With Binding material techniques for briquette making

Pelletizing is similar to briquetting except that it uses smaller dies (~ 30 mm) to produce smaller densified products called pellets.

Size	6 to 12 mm Diameter with variable length of 10mm to 50mm
Ash contains	Max 8%
Moisture contains	Max 6%
Density	1150-1400 Kg/m ³
Bulk density	600-650 Kg/m stereo
Calorific value	4400+200 Kcal/Kg
Sulfur & phosphorus contains	Almost nil

There are two main types of pellet presses: ring die and flat die. In general the die remains stationary and the rollers rotate. However, some pellet mills have dies that rotate and rollers that remain stationary during production. The die of a pelletizer is made of hardened steel that is perforated allowing the biomass to be forced through by the rotating die or rollers. The various pellet mill components are shown in Fig. 8 shows the dimensions of a commercial pellet mill die and shows pellet make from crops residual. In principle, the incoming feed from the feeder is delivered uniformly to the conditioner for the controlled addition of steam or binders such as molasses to improve the pelletization process. Unlike piston or screw presses, commercial pelletizers are not restricted by the density of the raw material having capacities in the range of 200 kg/h to 8000 kg/h and power consumption in the range of 15-40 kWh/ton.

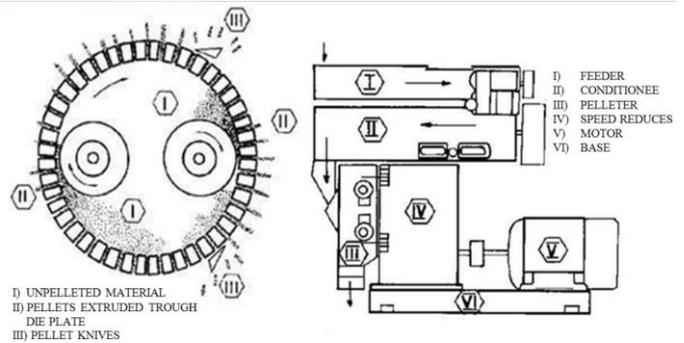


Fig. 8 Pelletizing process

	Screw press	Piston Press	Roller press	Pellet mill
Optimum moisture content of the raw material	8-9%	10-15%	10-15%	10-15%
Particle size	Smaller	Larger	Larger	Smaller
Wear of contact parts	High	Low	High	High
Output from machine	Continuous	In strokes	Continuous	Continuous
Specific energy consumption (kWh/ton)	36.8-150	37.4-77	29.91-83.1	16.4-74.5
Through puts (ton/hr)	0.5	2.5	5-10	5
Density of briquette	1-1.4 g/cm ³	1.2 g/cm ³	0.6-0.7 g/cm ³	0.7-0.8 g/cm ³
Maintenance	Low	High	Low	Low
Combustion performance of Briquettes	Very good	Moderate	Moderate	Very good
Carbonization of charcoal	Makes good charcoal	Not possible	Not possible	Not possible
Suitability in Gasifier	Suitable	Suitable	Suitable	Suitable
Suitability for co-firing	Suitable	Suitable	Suitable	Suitable
Suitability for biochemical Conversion	Not-Suitable	Suitable	Suitable	Suitable
Homogeneity of densified Biomass	Homogenous	Not homogenous	Not homogenous	Not homogenous

Table 2 Comparison of Briquetting technique

C. Manual Presses and Low pressure Briquetting

There are different types of manual presses used for briquetting biomass feed stocks. They are specifically designed for the purpose or adapted from existing implements used for other purposes. Manual clay brick making presses are a good example. They are used both for raw biomass feedstock or charcoal. The main advantages of low-pressure briquetting are low capital costs, low operating costs and low levels of skill required to operate the technology. Low-pressure techniques are particularly suitable for briquetting green plant waste such as coir or bagasse (sugar-cane residue). The wet material is shaped under low pressure in simple block presses or extrusion presses. The resulting briquette has a higher density than the original material but still requires drying before it can be used. The dried briquette has little mechanical strength and crumbles easily. The use of a binder is imperative.

Define abbreviations and acronyms the first time they are used in the text, even after they have been defined in the abstract. Abbreviations such as IEEE, SI, MKS, CGS, sc, dc, and rms do not have to be defined. Do not use abbreviations in the title or heads unless they are unavoidable.

V. ANALYSIS OF BRIQUETTE

After making of briquette determination of the percentage of elements contained in a briquette. It's including different chemical components of biomass, which help in to find out different emission components generate after burning of briquette.

Biomass	Ash Content	C%	H%	N%	O%	Calorific value (Kcal/kg)
Bagasse	2.88	57.26	3.98	1.84	37.78	4700
Rice husk	16.10	45.20	5.8	1.02	47.6	3626
Saw dust	2.6	53.07	4.10	0.28	39.6	4654
Ground nut shell	5	16.49	16.42	0.28	68.79	4500
Cotton shell	14.8	40.52	8.61	0.2	38.90	4566
Coconut shell	9.8	46.6	4.4	1	42	4146

Table 3 Ultimate Analysis of crop residual Briquette

Biomass	VM	FC	M	A	Calorific value (Kcal/kg)
Bagasse	69.84	21.04	5.42	2.88	4700
Rice husk	68.20	15.7	12.67	16.10	3626
Saw dust	71	20.7	5.7	2.6	4654
Ground nut shell	88.47	6.53	9.18	5	4500
Cotton shell	75.56	9.64	5.2	14.8	4566
Coconut shell	53.55	18.1	18.65	9.8	4146

Table 4 Ultimate Analysis of crop residual Briquette [5][6][7][8][9]

III. CASE STUDY

“Vasudhara Dairy” Co-firing system of steam-coal and Bio-coal.

Co-firing is combustion of two different types of materials at the same time. One of the advantages of co-firing is that

- An existing plant can be used to burn a new fuel, which may be cheaper or more environmentally friendly. For example, biomass is sometimes co-fired in existing coal plants instead of new biomass plants.
- Co-firing can also be used to improve the combustion of fuels with low energy content. For example, landfill gas contains a large amount of carbon dioxide, which is non-combustible. If the landfill gas is burned without removing the carbon dioxide, the equipment may not perform properly or emissions of pollutants may increase.
- Co-firing it with natural gas increase the heat content of the fuel and improves combustion and equipment performance. As long as the electricity or heat produced with the biomass and landfill gas was otherwise going to be produced with non-renewable fuels, the benefits are essentially equivalent whether they are co-fired or combusted alone.
- Co-firing can be used to lower the emission of some pollutants. For example, co-firing biomass with coal results in less sulphur emissions than burning coal by itself. [10][11]

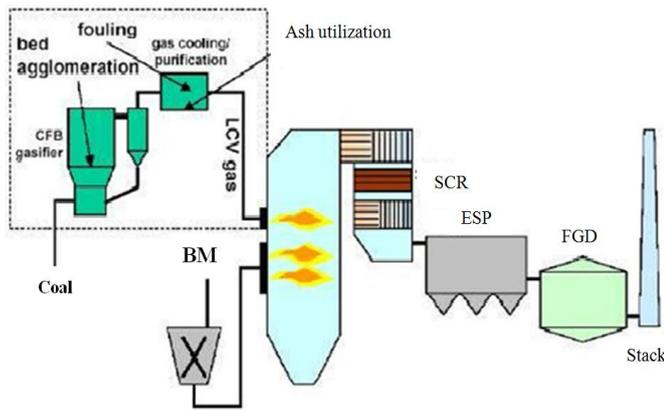


Fig. 9 Co-firing system of "Vasudhara Dairy"

Cost effectiveness with use of steam-coal and Bio-coal as a Boiler fuel.

Name of supplier	Material	Name of testing Lab	GCV	DOS
M/s Narayan Traders	Steam coal	Premier Analytical Laboratory, Nagpur	5168 Kcal	02.01.2010
M/s Jayshree Traders	Steam coal	Premier Analytical Laboratory, Nagpur	4809 Kcal	09.01.2010
M/s Renewal Bio-Energy	Bio coal	Mantra, Surat	4790 Kcal	17.02.2010

Table: 5 Biocoal details used at Vasudhara dairy

- 1) The consumption ratio of steam coal: Biocoal = 1 : 1.19
- 2) The GCV comparison of steam coal : Biocoal = 5100 : 4700 (1 : 0.92)
- 3) The Rate comparison of steam coal : Biocoal = 4100 : 3550 (1 : 0.86)

Example of trial during April 2010

Sr. No.	Parameter	Steam Coal (Actual)	Biocoal (Expected)
1	Consumption	173.400 MT	206.346 MT
2	Rate	4100/ Ton	3550/Ton
3	GCV	5100	4700
4	Total Cost	Rs. 7,10,940	Rs. 7,32,528
5	Saving	Rs. 21,588.30	

Table: 6 Boiler trials during April 2010

SR NO.	Rate different	Steam coal	Biocoal	Saving
1	550	Economic	Costly	21588
2	655	At par	At par	0
3	700	Costly	Economic	9363
4	800	Costly	Economic	29998
5	900	Costly	Economic	50632
6	1000	Costly	Economic	71267

Table: 7 Rate different of steam coal & Biocoal with respect to GCV

Sr. No	Month	Milk Throuput(Lit)	Cones of Steam coal+ Bio Coal(Kg)	Total	Rate/Ton(Rs) Landed	Total Cost(RS)	Milk proc./Kg coal	Coal/Lit (Rs.)	Qty of Cond. Recovery per day.
1	Jan 10	1,10,20,788	203116+0	203116	4000+0	812464	54.25	0.073	11351
2	Feb 10	97,68,185	21352+189632	210984	4000+3550	758601	46.29	0.077	9371
3	Mar 10	1,07,33,252	12580+209758	222338	4000+3550	794960	48.27	0.074	13167
4	Apr 10	1,05,00,000	173400+0	173400	4100+0	710940	60.55	0.067	12897

Table: 8 Vasudhara dairy- co-firing system data

Year	Price of fuel(Rs./TR)	
	Biocoal	Steam coal
2006	2800	3500
2010	3550	4100
2013-2014	5000	6300

Table: 9 Price of fuel used at Vasudhara dairy in boiler during different year

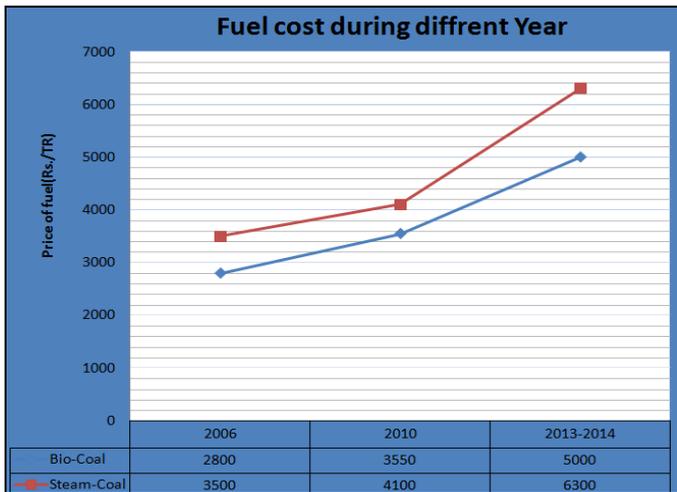


Fig. 10 Fuel cost of Vasudhara dairy

CONCLUSION

- From this paper conclusion can be made maximum percentage of fixed carbon (21.04 %) was obtained from bagasse based briquette where as in sawdust and coconut shell was 20.7 % and 18.1% respectively. Carbonized biomass was found suitable as compared to as such and hydrolyzed biomass for briquetted fuel. Calorific value was found more in bagasse briquetted fuel as 4700 kcal/kg.
- To produce good quality briquettes of selected crop residues which have the characteristics of fuel and are suitable for gasification and combustion and are also easy to handle transport and store.

- Conduct field evaluation of briquettes as fuel for combustion and gasification and work out cost economics and energy analysis.
- Briquette from crop residual can be replace coal in thermal system for producing heat and briquette can also be used in co-firing system, which result in reduction of fossile fuel consumption.

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