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Enhancement of Calorific Value of Bagasse with Distillery Spentwash through Briquetting

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ABSTRACT: Government of India has given stringent guidelines to dispose distillery effluent (spentwash) by zero liquid discharge to prevent environmental pollution. Treatment by anaerobic digestion followed by bio-composting has limitations of filler material availability and ground water pollution. Incineration of concentrated spent wash also has limitation of high capital cost and formation of hard scale of alkali earth metal on boiler tubes. The present experiment tries to overcome problems related to the existing disposal technology by preparation of biomass briquette of spent wash with sugar factory bagasse and studying its effect on bagasse characteristics. Results showed that caloric value of the bagasse increases from 2700 to 4100 cal/g and ash from 2% to 8%. Bagasse to spent wash ratio in briquette was 1:2.5 (w/v) for one time mixing.

KEY WORDS: Bagasse, Briquette, Calorific value, Spent-wash

I. INTRODUCTION

Molasses based distillery industry is one of the major revenue contributing industries in India and also one of the highest polluting included in the red category by Central Pollution Control Board (CPCB). CPCB has given mandatory guidelines (CREP guidelines) to distilleries for the disposal of distillery effluent by zero liquid discharge in inland surface waters [1]. The CPCB has recommended distilleries attached to the sugar factory to adopt bio-methanation followed by bio-composting for the safe disposal of spent wash. Distilleries generate about 10 to 15 lit of spentwash per lit of alcohol produced. In India, distilleries are set up in the sugar mill premises because of the readily availability of raw material, fuel and filler materials for compost. Bagasse is a value added byproduct of sugar manufacturing process. It is utilized as a fuel for the generation of steam and power which is utilized by the same factory. This helps in disposal of bagasse as well as generation of high grade thermal power.

II. BACKGROUND

At present, there are two preferred technologies in practice for safe disposal of the distillery effluent i.e. spentwash.

1) Anaerobic digestion followed by bio-composting

2) Concentration followed by incineration

However, these methods have few limitations / drawbacks. Considering first method of disposal, availability of filler materials viz. 'press mud' for the composting process is a problem [2]. Another limitation/drawback of this technology is the probability of pollution during the composting process due to following reasons,

- Improper construction of the bio-compost yard
- Improper handling of the process
- Uncontrolled effluent spraying
- Lake of skilled manpower

Evaporation followed by incineration useful for spentwash disposal and energy generation for distillery industry. This technology is less popular due to deposition of volatile alkali, alkaline earth metals and sulfates on the surface of the boiler tubes and forming scale. This scales reduces the heat transfer efficiency of the boiler [3]

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III. PRESENTATION OF THE MAIN CONTRIBUTION

In present work, spentwash was mixed with bagasse and biomass briquettes were prepared. These briquettes were analyzed for physical and chemical characteristics. By this technology disposal of highly polluted distillery effluent get treat and disposed safely & easily *(Patent filed by present authors)*

IV. METHODOLOGY AND DISCUSSION

1. Materials: Sugar factory bagasse was obtained from Shri Nath Mhaskoba Sugar Industries Ltd., Patethan, Tal. Daund, Dist. Pune, Maharashtra, India and distillery spentwash, raw (RSW) as well as bio-methanated (BMSW) was obtained from Malegaon Sahakari Sakhar Karkhana Ltd., Shivnagar, Tal. Baramati, Dist. Pune, Maharashtra, India. The raw materials i.e. bagasse RSW and BMSW were analyzed in laboratory and results are depicted in figures 3, 4 & 5

2. Analytical Methods: Standard method prescribed by Bureau of Indian Standards numbered IS 1350 part 1970 was used to analyze moisture, ash, carbon and calorific value. Briquette was prepared and drying of briquette by following all steps given in flowchart (Fig.1). Leachate was prepared by adding10 g sample to 1000 ml of warm (35-40^oC) distilled water. The mixture was shaken well the residue allowed to settle. The supernatant was taken as a leachate [4] and analyzed for calcium, magnesium, sodium and potassium [5]. Calorific value of the briquettes was determined by using Supresh make bomb calorimeter (India).

3. Experimental details: In present study the 100 g bagasse was mixed with 500 ml distillery spent wash and loaded in to the mold and pressure was applied to compressed the mixture (1.0 to 7.0 kg/cm^2). After application of pressure to the mold, the mixture was converted in to the briquette. The briquettes were made from RSW as well as BMSW as protocol given in the flowchart.

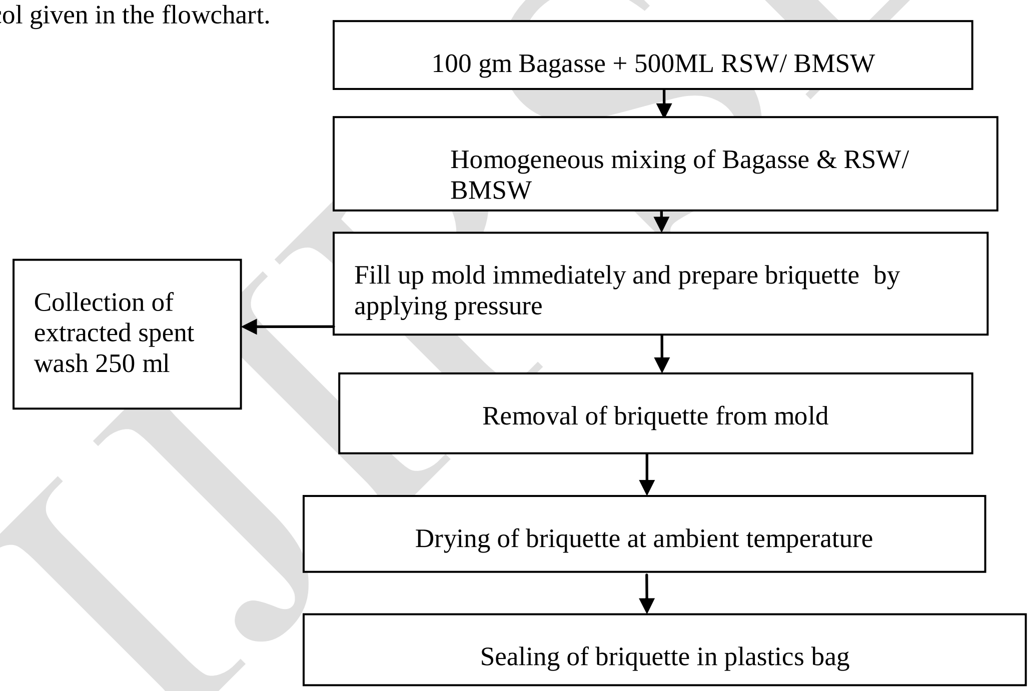

Fig.1 Flow chart for briquette making

4. **Briquette Making Apparatus:** In this experiment the briquetting apparatus (Fig. 2.0) has been indigenously designed in the laboratory and fabricated locally. Technical details of the apparatus are mentioned in table 1.

Sr. No	Particulars	Size (cm)	Make	Work description
1	Sleeper	120 (L) X 12(W)	Wood	For base of the machine
2	Mold	Ø 75.0 X 375.0 (L)	SS	To make a shape of briquette
3	Stand	8.5 (L)	SS	To support the mold and piston
4	Piston	Ø 5.5 X 10.0 (L)	SS	To apply the air pressure
5	Pipe	Ø 5.5 X 115.0 (L)	Plastic	To flow of air from pump to molding
6	Pressure gauge	Capacity 1-7 kg/cm^2	--------	To measure a applied pressure

Table 1: Specification of briquetting apparatus

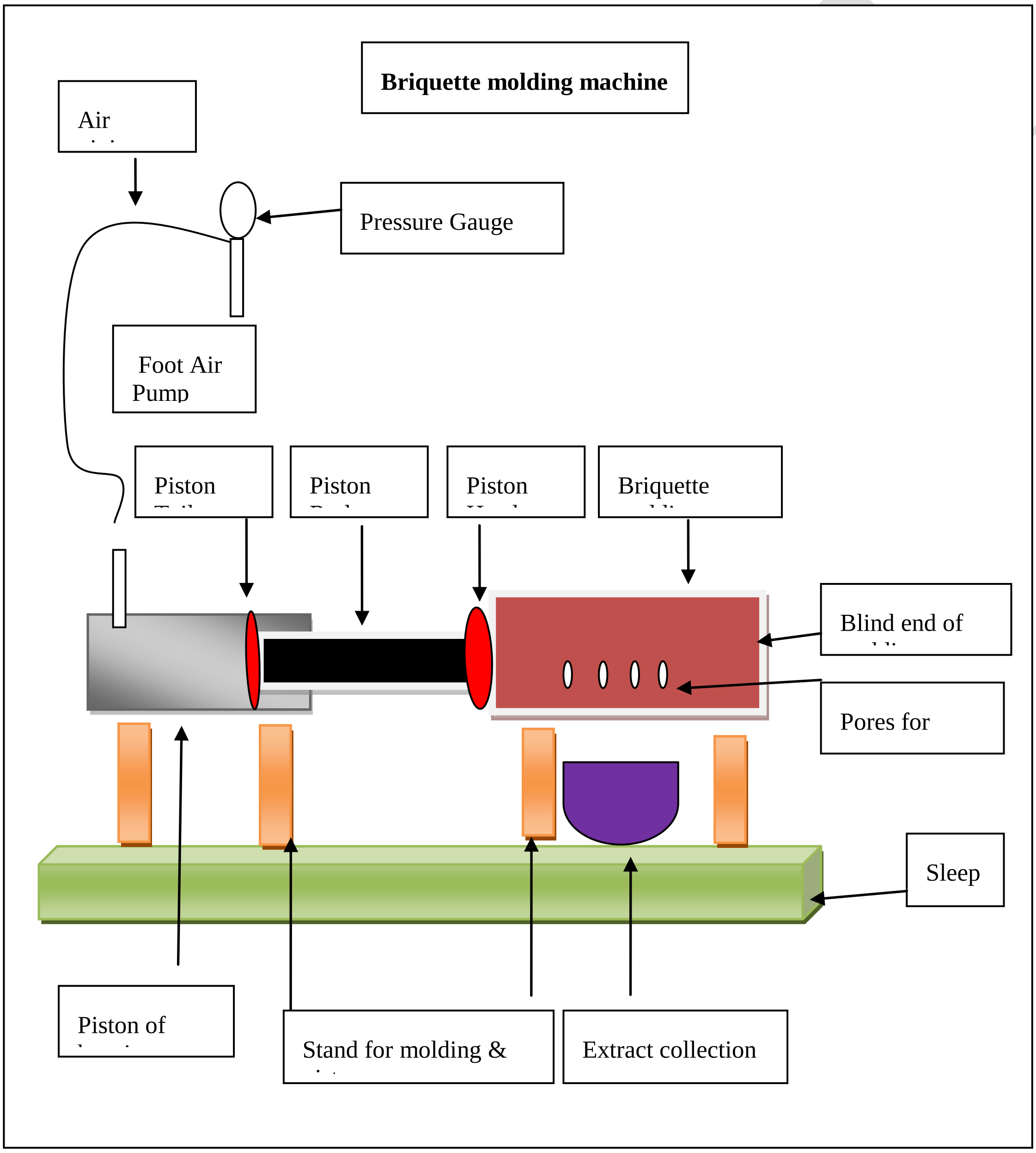

Fig. 2.0: Briquetting apparatus

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V. RESULTS AND DISCUSSION

Briquette made from RSW and BMSW were analyzed for the moisture, ash content, carbon content and calorific value whereas, the leachate of briquettes made from RSW and BMSW were analyzed for the content percent of calcium, magnesium, sodium and potassium. During the treatability study the effect of the applied pressure on spent wash consumption and the casting period has also been studied

1. Effect of applied pressure: The spentwash (RSW and BMSW) was independently mixed with bagasse in proportion of 1:5 (w/v). Since briquetting apparatus has maximum capacity for applied pressure is 7 kg/cm^2 so the applied pressure 1 to 7 kg/cm^2 was studied on the absorption of the spent wash. Casting period for maximum absorption of spent wash by bagasse was also been studied.

Applied pressure Kg/cm^2	Ratio of Bagasse to concentration spent wash in briquette (wt/v)	Casting period (Min).
1.0	1:4.9	1440
2.0	1:4.1	1440
3.0	1:3.8	1440
4.0	1:3.5	720
5.0	1:3.0	240
6.0	1:2.8	3
7.0	1:2.5	3

Table 2: Concentration of bagasse to spent wash and casting period against applied pressure

It has been observed that if the applied pressure is increased then spent wash quantity in the briquette get decreases. The ratio of bagasse to spent wash in the briquette was 1:4.9 at 1kg/cm^2 and 1: 2.5 (w/v) at 7 kg/cm^2 applied pressure. To get a solid briquette suitable for handling was the criteria for casting period. Therefore various pressure and time of casting was studied. (Table 2) briquette prepared using 7 kg/cm2 with casting period of 0.05 hrs was used for further studies

2. **Moisture:** Briquette made from RSW has moisture content around 63% and 82% for BMSW and RSW respectively as compared to bagasse alone (47%). This may be because of solid contents (or Brix) percent in RSW (12%) and BMSW (6%) (Refer fig. 3)

3. Total Ash: Concentration of total ash was analyzed by igniting of briquette in the furnace at 550^{0}C. It was observed that the total ash percentage of briquette made from RSW (10%) and BMSW (6.6%) was higher with compared to bagasse (2%) alone. It may due to higher inorganic matter in the spent wash (Refer fig. 3)

4. Carbon: Fig. 3 shows that the carbon concentration of bagasse alone was found to be 33% which increased up to 36% in briquette made from RSW and 34.02% in briquette made from BMSW. Dissolved organic matter present in the spent wash may be the reason to increases the carbon percentage in the briquette. During bio-methanation process, CH_4 recover from RSW, hence briquette made from BMSW found less carbon percent than the briquette made up from RSW.

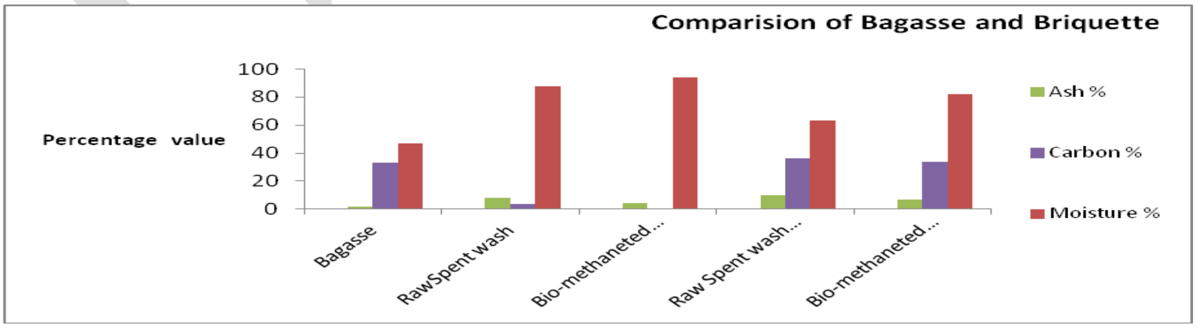

Fig.3 Comparative graph of bagasse and briquette of ash, carbon and moisture percentage

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5. **Calorific value (CV):**

By using bomb calorimeter) calorific values was estimated on Supresh make bomb calorimeter. It has been noticed that (Fig.4) the CV of briquette made from RSW was 3434 cal/g briquette made up from BMSW was 2834 cal/g where as bagasse alone had a CV of 2200 cal/g. Increases in CV in briquette made from RSW are due to the organic matter present in the raw spent wash.

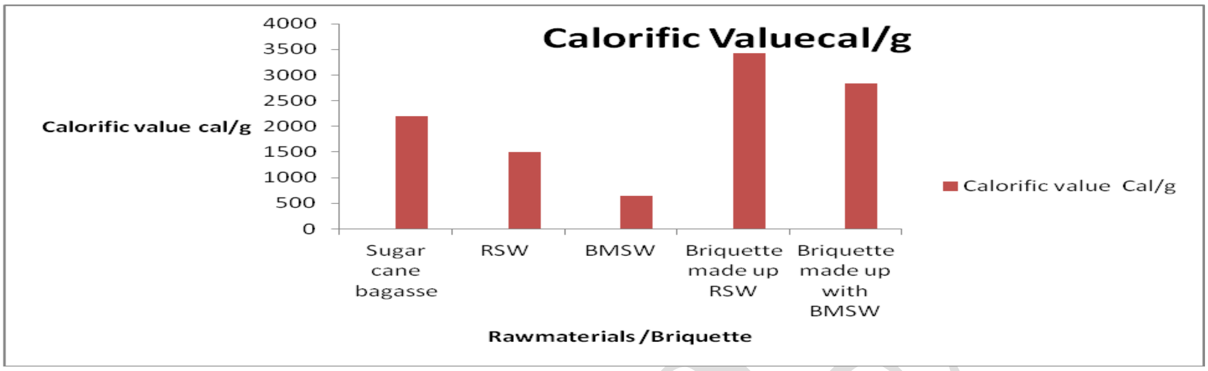

Fig 4; Calorific value of bagasse, RSW, BMSW alone and briquette made from RSW and BMSW

6. Analysis of briquette leachate

1. **Calcium:** As fig 5 shows that calcium concentration in bagasse alone was found to be 270 mg/l which increased in briquette made from RSW (1,800 mg/l) and briquette made from BMSW (2,200 mg/l).

2. **Sodium:** From the fig 5 shows that the concentration of sodium found in briquette made from RSW was 18,000 mg/l. Concentration of sodium in briquette made from BMSW was 18,400 mg/l whereas, sodium concentration of bagasse alone shows 18,000 mg/l. suggesting measure contribution of sodium is from bagasse itself.

3. **Magnesium:** It was observed from fig 5 that the magnesium concentration of briquette made from RSW was 18,000 mg/lit and in briquette made from BMSW it was found to be 12,000 mg/l. Concentration of magnesium in the bagasse (alone) leach-ate was observed 7,800 mg/l. It means that the concentration of the magnesium in briquette made from RSW as well as BMSW get increased as compared to bagasse alone.

4. **Potassium:** It was observed (Fig. 5), that the concentration of potassium in the briquette made from RSW found 12,800 mg/l whereas for BMSW it was noticed 6,400 mg/l. Briquette made from RSW and BMSW showed higher concentration of potassium as compared to bagasse alone (180mg/l) because, concentration 22,000 mg/l of potassium in RSW and BMSW 15,000 mg/l. The excess leached RSW as well as BMSW drained during the preparation of the briquette was also analyzed for potassium concentration. It was observed that the concentration of potassium in the excess leached from briquette made from RSW found to be 12,500 mg/l and 8,600 mg/l in briquette made from BMSW

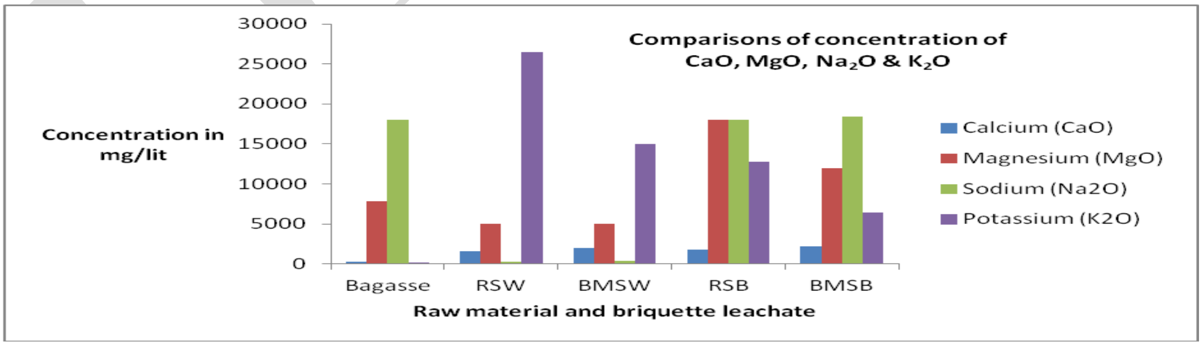

Fig 5: Comparisons of concentration of CaO, MgO, Na_2O & K_2O in briquette leachate

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VI. CONCLUSION

- Spentwash disposal by briquetting can help the distillery industry to achieve zero liquid discharge as ample availability of bagasse
- The bagasse absorbed the spentwash in a briquette as 1:2.5 wt/v similar to composting process; however composting process has many disadvantages as discussed above. So the present method will be very suitable and substitute and time saving against the present practices of disposal of spent wash
- An increase in calorific value of the bagasse in the form of briquetting is observed to the extent of 56% in briquette made from RSW and 28% BMSW which will reduces bagasse consumption in the sugar industry

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