ISSN (ONLINE): 2454-9762
ISSN (PRINT): 2454-9762
Available online at www.ijarmate.com

IJARMATE

International Journal of Advanced Research in Management, Architecture, Technology and Engineering (IJARMATE) Vol. 4, Issue 8, August 2018

Methods for determining moisture content in bagasse of sugarcane using microwave oven

M Manickavasagam[1], T Elango[2], S Siddharth[3], T Senthilkumar[4], K Elangovan[5]

Assistant Professor, Mechanical Department, Mother Terasa College of Engineering and Technology, Pudukottai, India [1]

Professor, Mechanical Department, Mahendra Institute of Technology, Namakkal, India[2]

Assistant Professor, Mechanical Department, Mother Terasa College of Engineering and Technology, Pudukottai, India[3]

Dean/Anna University Tiruchirappalli, Mechanical Department, Anna University Tiruchirappalli, India[4]

Professor, Dhanalakshmi Srinivasan Institute of Research and Technology, Perambalur, India[5]

***Abstract*—Microwave oven is a latest innovation, which is used as a cooking unit. Microwaves cause food molecules to vibrate, creating friction that heats and cooks food. In a microwave oven, heat energy is created by electromagnetic waves produced by a magnetron which is led by waveguides into the oven compartment. Sugarcane bagasse is used as fuel in cogeneration of thermal power plant. Rate of bagasse consumption generally in a power plant would be 0.75 kg bagasse per kg jaggery. Heat losses in flue gas and lack of oxygen are the main reasons for decreasing the efficiency. Moisture content of bagasse affects the calorific value of the fuel. This paper explains microwave oven for drying of bagasse. It's taken about 10 to 15 minutes for the determination as compared to 6-8 hours in conventional drying method.**

***Index Terms*—About Microwave, Bagasse, electromagnetic waves, drying method.**

I. INTRODUCTION

Bagasse generally has a moisture content of 50% and reduction of moisture significantly improves its calorific value. Bagasse which is internally generated during juice extraction from sugarcane is used as the fuel for evaporation in a jaggery furnace. The calorific value of Fiber is 19259 KJ/kg and calorific value of Sugar is 16559 or 16747 kJ/kg. [1] Sugarcane is cultivated in tropical and sub-tropical regions for the sucrose that is found in its stems. It requires a frost-free climate with sufficient rainfall during the growing season to make full use of the plant's great growth potential. The crop is harvested mechanically or by hand, chopped into lengths and conveyed rapidly to the processing plant. Here, it is either milled and the juice extracted with water or extracted by diffusion. The juice is then clarified with lime and heated to kill enzymes. The resulting thin syrup is concentrated in a series of evaporators, after which further water is removed by evaporation in vacuum containers. The resulting supersaturated solution is seeded with sugar crystals and the sugar crystallizes out, is separated from the fluid and dried. Molasses is a by-product of the process and the fiber from the stems, known as bagasse, is burned to provide energy for the sugar extraction process. [2]

Bagasse is efficiently dried in sugar industries and in some khandsari units in counter-current type driers whereas, in jaggery units, this is normally sun dried. Variation in moisture content of sun-dried bagasse affects performance of jaggery making furnaces. Determination of moisture content to know its suitability for using it as fuel, therefore, becomes important. Calorific value of bagasse dried to half of its initial moisture content is about 10% higher. So, a well-dried bagasse will generate more heat per unit weight. [3] The composition of bagasse obtained from sugar mill and jaggery plant is given in Table 1. An estimation of fiber can give the amount of juice present in cane. Fiber also affects juice extraction

TABLE I: COMPOSITION OF BAGASSE OF SUGAR MILL AND JAGGERY/KHANDSARI UNITS

Composition, %	Mill bagasse	Jaggery/khandsari bagasse*
Fiber	43-52 (Avg. 47.7)	40
Moisture	46-52 (Avg. 50.0)	48
Soluble solids	2-6 (Avg. 2.3)	12

Normally, gravimetric method is used for moisture content determination. Bureau of Indian Standards suggests a method for moisture content determination of bagasse. This method is time consuming and normally takes 6 to 8 hours for the estimation. Many research workers have attempted using microwave technology for moisture determination of agricultural products and this has become popular in recent years. [4]

Market Value

The Indian Microwave ovens market, consistently growing between 20% – 25% over the last four years, since 2006, has received setback in volume terms. The year, 2010-2011 growth 9.5% - the market estimated at 1.38 million units, valued at £ 800 crore. The Global market for microwave

ISSN (ONLINE): 2454-9762
ISSN (PRINT): 2454-9762
Available online at www.ijarmate.com
International Journal of Advanced Research in Management, Architecture, Technology and Engineering (IJARMATE) Vol. 4, Issue 8, August 2018

ovens is projected to reach 72.5 million units by the year 2015.

Microwave ovens

Some household microwave oven brands are emphasizing on technology for the preservation of nutrients while cooking, keeping in mind health – conscious youth population and steam option. This option specially designed kit for making low calorie tasty food, by maintaining food temperature at a constant level without overcooking. Some of other functional options

1. Multilevel cooking option
2. Super-fast defrost
3. Attractive working option
4. Super-fast cooking option etc.,

Working method of microwave oven is simple. Start cooking without setting the power or time is very easy. Microwave inverter technology which uses pulse with modulation to provide effective, continuous heating at reduced power so that food is heated more quickly without being damaged by uneven heating, Infrared ovens are powerful ovens for heating, drying, and curing processes. [5]

Jain et al. [6] Conducted a feasibility study on moisture content determination of jaggery using microwave oven, they reported that exposure of the prepared samples of jaggery to low power levels (200-300W) of microwave (2.45 GH) for 2-3 minutes, gave the results at par with conventional method of hot air drying. Microwave oven method offers a quick and reliable means for jaggery moisture content determination.

II. Materials and Methods

TABLE II: Microwave Oven details

S.No.	Specifications	Microwave oven details
1	Make	LG
2	Model	MS2021CW SOLO
3	Input Voltage	230 V, 50 Hz
4	Input current	6 Amp A.C.
5	Output	2450 MHz, 500 Watts
6	Capacity	20 L
7	Size W x H x D	455 x 320 x 260 mm
8	Maximum Power Consumption	1050 W
9	Controls	Knob Type

These are the required basic materials for conducting the research.

1. Bagasse sample
2. Infrared temperature gun for measuring temperature
3. petty dish
4. Electronic weighing machine
5. household oven

Conventional method of hot air drying

Bagasse is a fibrous matter that remains after sugarcane stalks are crushed to extract their juice. For 10 tons of sugarcane crushed, a sugar factory produces nearly 3 tons of wet bagasse. Since bagasse is a by-product of the cane sugar industry, the quantity of production in each country is in line with the quantity of sugarcane produced. The high moisture content of bagasse, typically 40 to 50%, is detrimental to its use as a fuel. A typical chemical analysis of bagasse might be (on a washed and dried basis). [7] Cellulose 45–55%, Hemicellulose 20–25%, Lignin 18–24%, Ash1–4%, Waxes <1%

TABLE III: Moisture test on Bagasse sample 100g

Time hours	Weight of petty dish (g)	Bagasse weight after drying (g)	Bagasse sample Final weight with petty dish (g)	Moisture (%)	Yield (%)
10:00 AM	280	100	280	0	100.00
11:00 AM	280	88.26	291.74	11.74	88.26
12:00 AM	280	84.58	295.42	15.42	84.58
1:00 PM	280	80.38	299.62	19.62	80.38
2:00 PM	280	74.45	305.55	25.55	74.45
3:00 PM	280	71.75	308.25	28.25	71.75
4:00 PM	280	71.25	308.75	28.75	71.25

TABLE IV: Moisture test on bagasse sample 80g

Time hours	weight of petty dish (g)	Bagasse Weight after drying (g)	Bagasse sample Final weight with petty dish (g)	Moisture (%)	Yield (%)
10:00 AM	280	80	280	0.00	100.00
11:00 AM	280	72.36	287.64	9.55	90.45
12:00 AM	280	68.55	291.45	14.31	85.69
1:00 PM	280	63.48	296.52	20.65	79.35
2:00 PM	280	60.58	299.42	24.28	75.73
3:00 PM	280	58.85	301.15	26.44	73.56
4:00 PM	280	56.68	303.32	29.15	70.85

Moisture Test of hot air-drying method (Bagasse)

100 grams of bagasse were taken as specimen. Well-shredded samples were collected from the bagasse generated after sugarcane crushing via a 3-roller vertical crusher. After taking the weight on an electronic balance, every hour drying the bagasse pieces in the sunlight and find out the weight by weighing machine. This experiment will be taken in the morning 10 'O' clock. The details of moisture removal rate are given in the Table 3

ISSN (ONLINE): 2454-9762
ISSN (PRINT): 2454-9762
Available online at www.ijarmate.com

International Journal of Advanced Research in Management, Architecture, Technology and Engineering (IJARMATE) Vol. 4, Issue 8, August 2018

Finally, after 6 hours weight of Bagasse sample weight = 29.25 g

Moisture = {(initial weight – final weight) x 100}/ Initial weight

= {(100-71.25) x 100}/ 00

= 28.75 %

Finally, after 6 hours weight of Bagasse sample weight = 56.68 g

TABLE V: MOISTURE TEST ON BAGASSE SAMPLE 60G

Time hours	weight of petty dish (g)	Bagasse Weight after drying (g)	Bagasse sample Final weight with petty dish (g)	Moisture (%)	Yield (%)
10:00 AM	280	60	280	0.00	100.00
11:00 AM	280	53.58	286.42	10.70	89.30
12:00 AM	280	50.54	289.46	15.77	84.23
1:00 PM	280	49.35	290.65	17.75	82.25
2:00 PM	280	45.27	294.73	24.55	75.45
3:00 PM	280	43.32	296.68	27.80	72.20
4:00 PM	280	43.25	296.75	27.92	72.08

Finally, after 6 hours weight of Bagasse sample weight = 43.25 g

TABLE VI: MOISTURE TEST ON BAGASSE SAMPLE 100G, 80G, 60G RESULTS

SL no	Bagasse pieces Initial weight in g	Bagasse pieces Final weight in g	Yield (%)
1	100 g	71.25 g	71%
2	80 g	56.68 g	71%
3	60 g	43.25 g	72%

Microwave oven method of drying

Moisture Test (Bagasse)

The experiment was conducted in two stages. In the first stage bagasse samples were drawn from different lots having different moisture content, in the second stage, three samples from the same lot having different moisture content were taken,

Initially the actual weight of bagasse samples was set as 100 g, 80 g, and 60 g

Every minute heating the bagasse pieces in the house hold oven and find out the weight by weighing machine,

In the second stage, initially the actual weight of bagasse samples was found for 100 g, 80 g, and 60 g

TABLE VII: MOISTURE TEST ON BAGASSE IN SAMPLE 100 G (15 G) , SAMPLE 80 G (14.5 G) AND SAMPLE 60 G (15.5 G)

T	Bagasse pieces Initial weight in (g)	Bagasse Weight after drying (g)	Bagasse pieces Initial weight in (g)	Bagasse Weight after drying (g)	Bagasse pieces Initial weight in (g)	Bagasse Weight after drying (g)
0	15 g	15.00	14.5 g	14.50	15.5 g	15.50
2	15.00	11.44	14.50	12.56	15.50	12.86
4	11.44	11.14	12.56	11.00	12.86	11.45
5	11.14	11.05	11.00	10.86	11.45	11.38
6	11.05	10.81	10.86	10.56	11.38	11.24
7	10.81	10.69	10.56	10.45	11.24	11.19
8	10.69	10.68	10.45	10.43	11.19	11.18

Finally, after 8 minutes weight of bagasse pieces (15 g, 14.5 g, 15.5 g) = 10.68 g, 10.43 g, 11.18 g

III. RESULTS AND DISCUSSION

Results of experiment for moisture content obtained from microwave oven and hot air drying for the bagasse samples collected from homogenous lot have been summarized in Table 3. This experiment used for moisture content determination from both the methods. The average values for hot air oven and microwave oven dried bagasse are 48 and 50 per cent respectively. So, it can be seen that microwave oven method gave the values very close to the values of hot air-drying method. Comparison of final values of moisture content obtained from hot air-drying method and microwave oven have been shown in Table 8.

TABLE VIII: RESULTS OF BAGASSE SAMPLES HAVING DIFFERENT LEVEL OF MOISTURE BY HOT AIR DRYING AND MICROWAVE OVEN METHOD

Bagasse Samples	Moisture (%) in hot air-drying method	Moisture (%) in oven method	Time taken for drying in conventional method (hours)	Time taken for drying in oven method (minutes)
Sample 100 g (15 g)	28.75%	28.80%	6 hours	7 minutes
Sample 80 g (14.5 g)	29.15%	28.07%	6 hours	7 minutes
Sample 60 g (15.5 g)	27.92%	27.87%	6 hours	7 minutes

IV. CONCLUSIONS

Typically, the bagasse moisture can be reduced from 30% to 25%. Fresh bagasse normally contains 50% moisture and

ISSN (ONLINE): 2454-9762
ISSN (PRINT): 2454-9762
Available online at www.ijarmate.com

International Journal of Advanced Research in Management, Architecture, Technology and Engineering (IJARMATE) Vol. 4, Issue 8, August 2018

reduction of moisture improves upon its calorific value. A dryer handling 80 t.p.h through put of wet bagasse at 50% initial moisture can be dried to around 76 t.p.h of bagasse at 45% outlet moisture with around 4.0 t.p.h of evaporated moisture. Microwave oven method can effectively be used for determination of moisture content of jaggery bagasse in much lesser time, 10-15 minutes as compared to conventional hot air-drying method, which takes about 6 to 8 hours

ACKNOWLEDGMENT

The authors would like to acknowledge the support given by Dr.M.Sanayullah, Advisor, Mother Terasa College of Engineeirng and Technology, for doing this research preferred spelling of the word “acknowledgment” in

REFERENCES

[1] Vishal, R. Sardeshpande, D.J. Shendage, Indu R. Pillai. (2010) ‘Thermal Performance Evaluation of a Four Pan Jaggery Processing Furnace for Improvement in Energy Utilization’, Energy
[2] USAID, (2006) ‘Sugarcane: Saccharum Offcinarum’, Govt of United States, p. 7.1.
[3] Anwar, S.I. (2005) ‘Assessment of calorific value of jaggery and khandsari bagasse and development of waste heat recovery system’, Proceedings of the National Seminar on Sugarcane production technique for increasing recovery of sugar in initial period of crushing season in sugar mills, Lucknow, India, 209-211.
[4] Anwar, S.I. (2010) ‘Determination of Moisture Content of Bagasse of Jaggery Unit Using Microwave Oven’, Journal of Engineering Science and Technology, Vol. 5, No. 4, pp.472 – 478.
[5] An ADI Media Publication. (2012) ‘Microwave ovens’, TV Veopar Journal, pp.77-80.
[6] Jain, P.C. and Singh, P. (2000) ‘Moisture determination of jaggery in Microwave Oven’, Sugar Tech, 2(3), pp.51-52.
[7] Rainey, Thomas J (2009) ‘A Study of the Permeability and Compressibility Properties of Bagasse pulp’, Brisbane, Australia: Queensland University of Technology.

Mr M Manickavasagam, Assistant Professor, Mother Terasa College of Engineering and Technology, He has received his Bachelor’s degree with Distinction in Mechanical Engineering in 2012 from Anna university BIT campus, Tiruchirappalli, He did his Master’s degree with Distinction in Thermal Engineering in oxford Engineering College affiliated Anna University, Tiruchirappalli in 2014, and He got the State 5thRank of Anna University in his Master degree. His work experiences were Technician Apprentice in Tamilnadu state transport corporation, Karaikudi in 2008, drafts man in Uttam Industrial Engg. Ltd. Ghaziabad, UP (Trichy Design Centre), Contractor in BHEL sub contract industries in mathur, Tiruchirappalli and one of the leading CAD Trainer in CADD Centre, Manapparai, Tiruchirappalli. His part time industrial experience of 6 years and regular academic experience of 4 years. At present he is working as assistant professor in Mother Terasa College of Engineering and Technology Mettusalai, Illuppur, Pudukkottai, Tamil Nadu, India.

Dr.T.ELANGO

Dr. T. ELANGO attended Karunya Institute of Technology, Coimbatore (presently Karunya University) to receive his Bachelor’s degree with Distinction in Mechanical Engineering in 1991. He is one among the University Rank holders of Bharathiar University in his bachelor’s degree. He did his Master in Design and Production of Thermal Power Equipment at NIT, Tiruchirappalli in 1999 and earned his Ph.D in Automobile Technology from Bharathidasan University in the year 2011. He is a teacher in Engineering since 1991 and carries academic and administrative experience of about 25 years. He has published over 20 research papers in various reputed International and National Journals and Conferences.

Dr. S. Siddharth is presently working as Professor in Mother Terasa College of Engineering and Technology, Pudukottai. He has completed his bachelor’s in technology form SASTRA University in Mechatronics in 2009. He has completed his postgraduation in Manufacturing Engineering from Anna University Chennai and Ph D in Mechanical Engineering from Anna University Chennai. He has published more than 34 + papers in reputed national and international journals.

Dr. T. Senthilkumar is presently working as DEAN – University College of Engineering, Bharathidasan Institute of Technology BIT Campus, Anna University Tiruchirappalli. He has completed his UG and PG in Mechanical Engineering and completed his Ph D in 2005 from Periyar University. He has more than 300+ publications in reputed National and International journals.

Dr K Elangovan is presently working as Principal Dhanalakshmi Srinivasan Institute of Research and Technology, Thuraiyur Road, Perambalur, Pin code : 621 212, Tamil Nadu in Department of Mechanical Engineering, He has more than 16+ publications in reputed National and International journals.