DESIGN AND CONSTRUCTION OF A PAR BOILER IN SMALL FOOD PROCESSING INDUSTRIES.

BY

ABUBAKAR A. Z. AHMAD.

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CERTIFICATION

This is to certify that this project was carried out by Abubakar A.Z. Ahmed in the Department of Agricultural Engineering. Federal University of Technology Minna Niger State.

....

ENGR. A. ONUACHU. **DATE**
SUPERVISOR

....

ENGR. DR. A. ADGIDZI **DATE**
HEAD OF DEPARTMENT

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ACKNOWLEGEMENT.

I am sincerely Grateful to Almighty "God" for giving me time and wisdom to design and construct this machine.

I am also grateful to **Engr. Mr. A. Onuachu** for my project which he supervised well, as well as that of my course co-ordinator **Engr. MRS. Z.D. Osunde** who had diligently and kindly guided me through the execution of this project study.

I wish also to express my sincere gratitude to my **H.O.D.Engr. Dr. D. Adgidzi** and to the **members of staff** of Agricultural engineering department, who either directly or indirectly advised me towards the success of this project.

I am finally, saying my sincere thanks to my parents and my family at large. As well as my friends and colleagues.

MAY GOD BLESS THEM ALL, AMEEN.

DEDICATION

This project is dedicated to my parents, my brothers and friends. They all contributed to the successful completion of this project study.

CHAPTER ONE.

1.1 INTRODUCTION

The increasing economic importance of food products together with complexity of modern technology for their processing, quality evaluation and marketing, demands a better knowledge of design and construction of parboiler machine for maximum efficiency.

The aims and objectives contributing to the design and construction of this parboiler cannot be over emphasized. It is aim at using available local raw-materials to construct grain parboiler which will be at the reach of Rural People. Also parboiler as to notice that, there equipment use and one in use by the rural farmers, and to convince the rural farmers that parboiling of any crop maintains higher quality of the product than could be achieved by direct cooking.

Steam is generated by the heat sources, which can be Firewood, rice-husk, sawdust, and dry cow-dung.

The steam produced by the heat sources or power source at

the boiler section will pass through section a pipe to the steaming section. The steam can be controlled by a valve device, which can be use to open and close the movement of the steam generated.

A pressure gauge may also be employed to determine the pressure in the pipe. The parboiler can be used to steam or cook cereal or tubers crops, such as Rice paddy and sweet potato respectively.

The material will be placed at the parboiling section in the parboiler cylinder. The parboiling of Paddy-Rice, which is measured 2.5 kilogrammes, will take at least 35 minutes to be well steamed or parboiled according to the test carried out.

The splitting of Rice hull which allows the exposure of the aleurone layers out shows that the paddy is parboiled. The rice should be dried well in the shade most necessarily before it was milled. The parboiler can also be used to blanch vegetables and fruits, such as Okro, tomatoes etc.

CHAPTER TWO

2.1 LITERATURE REVIEW

Parboiling is an antient practice in grain growing areas of the world. The variability in quality of milled grain can be traced in part to the efficiency of parboiling.

However, the practice of parboiling is being accepted in the main rice growing areas of the country. Parboiling improves the dietary and economic values of the rice or grains.

Parboiling is one of the latest well-developed, premilling treatments given to paddy rice to improve its quality, very little is known about its origin, however since early times, the rice has been treated with either cold or hot water and dried before hand pounding or milling.

The concept of parboiling which constitute the major volume of Rice grain is mainly composed of polygonal starch granular spaces, which are filled with air and moisture. The cracks fissures and voids developed during

maturity causes breakage's of paddy during milling process.

These breakage's may be avoided or eliminated by gelatinizing the starch, which fills the voids and correct the fissure and cracks.

It was notice that the use of firewood or dry cow-dung as Heat source can produce steam, which can parboiled or cook the raw paddy in 35 minutes.

Parameters and operating conditions leading to the evacuation of the performance analysis of the parboiler have been monitored during the parboiling process, and the parboiled materials have been tested for good quality and suitability.

CHAPTER THREE

3.1 METHODOLOGY

3.2 METHODS OF PARBOILING

Parboiling involve two stages, soaking stage and boiling stage. Soaking can be done in cold or hot water of temperature 65-70°C. The paddy rice can be parboiled in a tank or in local made clay pots. The rice can be soaked in water for few minutes to remove the chaff, put in a hot tank adding water slightly above the rice level and covered with a Jute Bag.

Heat is applied under neath the drum and heating is continued untill the water begins to boil. When bubbles are noticed from the Jute bag, the heating is discontinued and allowed to cool.

In the following morning the top layers of the paddy are removed and washed separately with bottom layers. In order to ensure a complete heating the material is mixed and some water added and covered with Jute bag. Heat is again applied untill flow of steam is satisfactory. The

use of a steam for gelatinizing the starch in the rice, is preferably to other traditional methods of parboiling, because it does not remove the moisture from the soaked rice, rather it adds moisture by condensation which increases the moisture content of the grain. The duration of steaming is dependent upon the method adopted.

3.3 LOCAL METHOD OF PARBOILING

Traditional parboiling methods is sub-divided into two types:-

Single parboiling and

Double parboiling methods.

In single parboiling method, the paddy is soaked in ordinary water for 1-3 days and then transferred to cylindrical iron kettles for steaming in small batches under atmosphere pressure. The paddy is then dried in the sun before milling.

But in double parboiling methods, the steam is injected into the raw paddy in the steaming kettle before soaking, this method hastens the soaking process. The hot paddy raises the temperature of the water to 40-45°C which reduces the soaking time to 2 days. Therefore, soaked paddy is steamed as the single boiling method.

appropriate cleaning process before the paddy is led into parboiling unit or any other grain.

In other developments, when a crop to be steamed is placed in a steaming section, and the water heated by using any source of heat which is more economical such as fire-wood, rice husk and or dry cow-dung. The steam produced passes through a pipe to the steaming section to steam or blanch the material employed. This method is economically, cheap and easily done in a short period of time.

3.5 LIST OF THE MATERIALS.

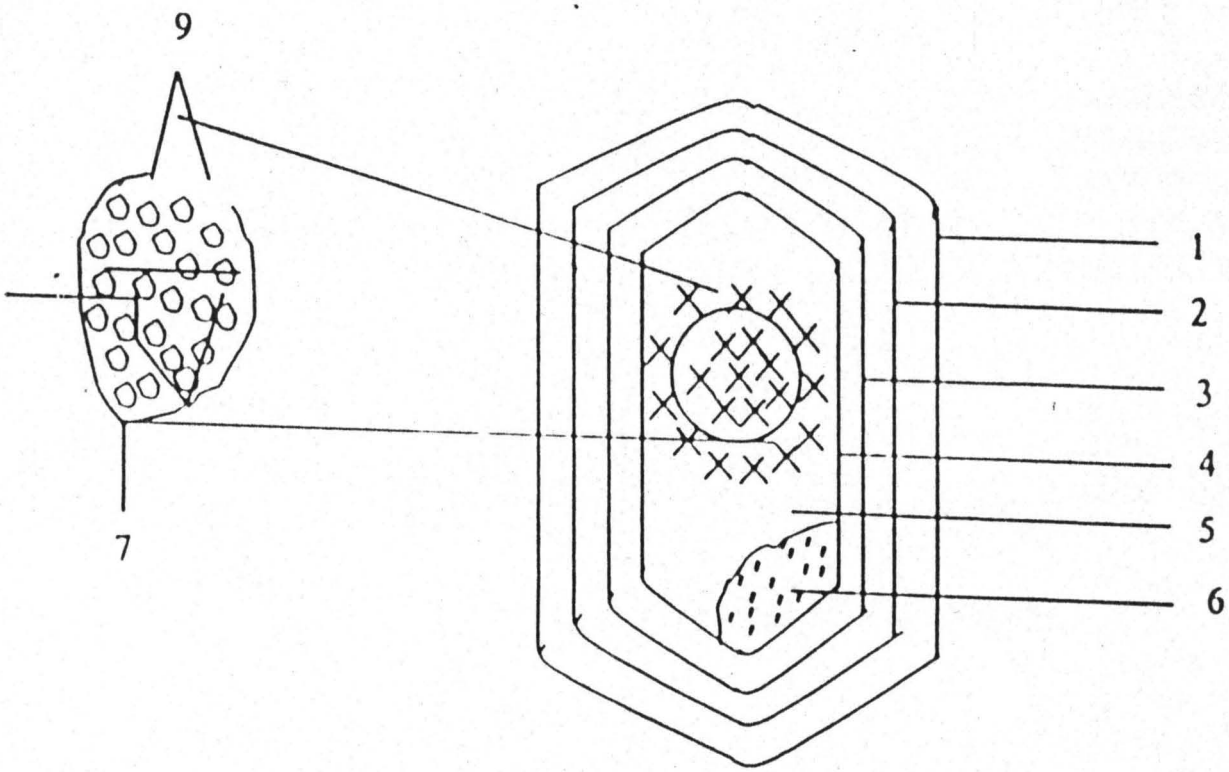
All the parts that make up the parboiler were constructed and joined together in the mechanical engineering work shop. Below is the list of all materials, tools and machine used in the construction:-

1. Steal metal sheet.
2. Galvanized metal
3. Wire Mesh
4. Mild steel
5. Shearing Machine
6. Folding Machine
7. Hand shearer
8. Steel Rule
9. Compass
10. Screw driver
11. Spanner
12. Hark Saw
13. Pipe Ranch
14. Vice and Die

15. Nails

16. Punch

STRUCTURE OF PADDY GRAIN



KEY

1	HULL (HUSK)
2	PERICAP
3	SCAD COAT
4	ALEUR ONE LAYER
5	STARCHY ENDOSPERM
6	GERMS OR EMBRYO
7	VOID OR INTEGRANULA SPACE.
8	STARCH CELL
9	STARCH GRANULE

3.6 DESIGNS

BOILER:-

Boiler cylinder was cut from the steel metal sheet. It has dimension of 400mm length and 230mm 320mm diameter for boiler and insulating cylinder respectively.

The material was rolled to cylindrical shaped, and welded to form the effective cylinders of height 400mm. Drain phig was fitted under neath of boiler.

BOILER CAP:-

Boiler cap was also cut from the metal sheet, has 330m diameter. Another sheet was a cut make inner and outer ring of 260mm and 330mm diameters respectively. The rings were joined by riveting and hook joint to hold the boiler firmly. Bolts and nuts were used to tight one cover, the replore holes of 40mm apart were drilled. Two pipes are placed on the cover and welded.

STEAMING UNIT:-

The steamer was cut metal sheet, has same construction procedure with Boiler. The cylinders are 500mm height, and clearance between them was filled with saw-dust which is sealed at one end. Drain plug was placed under neath of the steamer, it is 1.9 cm diameter.

STEAMER COVER:-

The steamer cover was also cut from the metal sheet, has 330mm diameter. Another sheet was also cut to make inner and outer rings of 260mm. And 330mm diameters respectively. 100mm length and width of sheet metal was cut to make a handle by riveting.

A hole of 2.54cm. is drilled and a plug sucket is fitted for inserting into water.

DELIVERY PIPE:-

This pipe was cut from a galvanized metal, the pipe was 600mm length. Both ends are threaded and joined with elbows of ¾ inch of the pipe was Joined by welding to the centre of the boiler cap to give height of 100mm.

At the bottom centre of the steamer, a pipe was also welded that give height of 50mm.

Threaded vertical pipe of 600mm length at the centre, and a control valve was fitted to controll the movement of the steam.

BASKET:-

Basket is a wire mesh of 460mm. Height and 260mm diameter to ensure smooth movement in the steam cylinder. A metal sheet of 260mm length is placed and riveted on top of the basket.

It is used as handle, another sheet was also riveted under neath of the basket to hold the required quantity of the material. Three stands of 20mm height are made at the bottom of the basket, so as to allow the condensed steam passing through to the drain plug.

RETURN PIPE:-

Return pipe has the same construction procedure with delivery pipe, and the same material was used. One end of the pipe is welded to the steamer of 50mm. Length at the top while the other end is welded on the boiler cap at

50mm. This Joined to give 100mm height and 150mm inside the water of the boiler.

HEAT SOURCE:-

Heat source was cut a metal sheet with 330mm. Diameter and 140mm. Height. Another sheet was cut of the same diameter and riveted at the bottom as bottom cover. It has an opening of 140mm. Feeding fuel into the burning chamber.

Another sheet was cut and role, and fitted to the chamber, and is inclined at 60° angle with length of 200mm for exhaust smoke.

BOILER AND STEAMER STANDS:-

Both the stands are made up from mild steel of square pipe 1.5mm thick. It has three-(3) iron sheet of 100mm. Height and 140mm. Horizontal length, that are made to support the cylinders and welded for a ring of 2mm radius.

PARBOILING OF PADDY RICE:-

Paddy rice 2.5 kilogrammes was soaked into worm water for 17hours, and was steamed to give a better qualitative result of paddy.

The following data were taken during the experiment: of paddy Rice:-

1. Quantity of the Rice used. 2.5kg
2. Quantity of the fuel used (firewood) 7.5kg.
3. Initial temperature of water 29.5°C
4. Temperature of water after soaking. 28.2°C
5. Volume of water used 30liters
6. Temperature of which the steam was generated 90°C
7. Final temperature that cooked the paddy 103°C
8. Time taken for steam to be generated 45min.

PROCEDURE:-

The rice was placed in the basket and inserted into the steamer. The steam generated by the heated water in the boiler flows through the pipe into the steaming section.

The cylinder was closed to avoid loss of steam. Similarly the capacity of boiler is measured with the volume of water it can hold. The capacity of steamer is measured by the basket inserted into the steamer.

CHAPTER FOUR

4.1 RESULTS AND DISCUSSIONS:

The boiler gave efficient required results after it has been tested. The boiler was used to steam different types of crops such as rice paddy and Potato. The machine can also be used for blanching vegetables and fruits.

The table below shows 3 different samples taken at different time intervals of steaming and assessment made on paddy rice.

Table One:-

STEAMING AND ASSESSMENT MADE ON PADDY RICE AT DIFFERENT TIME INTERVALS

Samples.	Time(minutes)	Assessment Made.
1	20	The paddy rice was still hard, and very few crads are Noticed.
2	35	The husk weakens, and many cracks are noticed. Grains turns reddish and soft.
3	55	Many Grains exposed

aleurone layers, and only very few good cracks are Noticed. Grains become very soft and easily crushed.

Sample frames are also taken measured as splits grains, and is shown in the table below:

Table Two:-

THE MEASURED SPLIT GRAINS AT DIFFERENT TIME INTERVALS:-

Time (minutes)	Quantity of sample split	Percentage of split (%)
20	45	34
35	47	63
55	43	80

CHAPTER FIVE

5.1 CONCLUSION AND RECOMMENDATION

CONCLUSION:-

From the discussion of result of the two test carried out it was clear that the parboiler is functioning well.

The result of the test showed maximum efficiency in the performance of the machine. The report is intended for small scale of food processors in countless compound and villages, and for any person who may wish to carry out further work on this machine.

5.1 RECOMMENDATION:

Due to the time factor the parboiler was tested only on few crops, therefore it is recommended that it should be tested for blanching vegetable and fruits, to determine its maximum efficiency.

The testing should be done using fuel such as firewood, rice husk, and dry cow dung. The parboiler was tested suitably on 2 kilogrammes weight rice, it is therefore recommended to be tested on 4 kilogrammes weight of these materials.

6.1 REFERENCE LIST (BOOKS)

1. Frank, P.I. and P.D. David (1990) Fundamentals of Heat and Mass Transfer. John Willey and sons Inc. PP.49-50.

2. Philips T.A. and P.O. Ngoddy (1964) Introduction to Agriculture. A.I Ihekoronye and Francis Ekwu C. PP. 27-30

3. Salako E.A. (1984) Rice Production in Northern Nigeria. W.C. Fran Zir. PP. 25-28

4. Kipps M.S. (1971) Crop Production. D.C. Westhorf. PP. 339-346.

APPENDIX I

COST INCURED.

The cost incurred in the construction of this machine consist of the materials and that of labour. The cost of Labour however veried with time, the material cost is estimated on current market situation.

The table below shows the break down of the material cost analysis in cured. In the construction.

TABLE Three:-

COST INCURED IN THE CONSTRUCTION:

S/No 66666	Materials	Quantity	Specification	Unit price (N)	Total price (N)
1	Sheet metal (1.5mm)	1	1800x1200x16mm	1,240	1,240
2	Pipes (3/4 inch)	1	¾ x 16mm	1,120	1,120
3	Elbows (3/4 inch)	7	¾ x 16mm	110	570
4	Control valve (3/4 inch)	1	¾ x 16mm	60	560
5	Drain phig (1inch)	2	¾ x 16mm	10	20
6	Wire gauge	1	¾ x 16mm	10	20
7	Gum	1	¾ x 16mm	10	10
8	Bolts and Nuts	8	8	2	16
9	Paints	3	-	15	45
10	Phig and Sucket	1	1x16mm	15	15

11	Electrodes	8dozens	-	60	1048
12	Nails	35 pieces	$1^{1/2}$ x 16mm	1(7	5
13	Putty	2	½ kilo	6	12
14	Rice Paddy	2.5 kg	2.5 kilo	5	10
15	Fuel	4kg	4kg	1.5	6
16	Square Pipe	25x25x1mm	25x25x1mm	30	300
17	Sweet Potato	5kg	5kg	1.20	6
					₦
6666					4738:0

COST INCURED IN THE LABOUR.

The cost incurred of the wages paid to workers on this construction was estimated at an assumed cost of man work at N10:ook per days.

Three people work for seven days: labour cost is calculated as =10x3x7= ₦ 210:00k.

PERSONAL COST INCURED:-

These are cost incurred by the owners that are not usually included into the total cost original cost. The cost includes transportation cost, cost of minor items such as Razor blades, needle, and matches.

The cost of the minor items was assumed to be 5% of the material cost.

Personal cost = 5/100xM.C.

= 0.05x4738

= N36.90k

Total cost = MW +L.C=P.U

= 4,738+210+36.90

= N4.984: 90k

The total cost of construction is estimated to be approximately about N4984:90k per unit. This machine could be as economically and reasonably preferable for the peasant farmers.

APPENDIX 2.

The sample Grades measuring splits and un-splits grains is shown in the table below:-

Table Four:-

AVERAGE OF SPLITS AND UN-SPLIT GRAINS AT THE TIME INTERVALS

QUATITY TAKEN (GRAMMES)	SPLIT SAMPLE TIME (MINUTES)			UN-SPLIT SAMPLE TIME (MINUTES)		
	20	35	55	20	35	55
45	15	30	35	30	15	10
47	18.5	31	46	28.5	16	7
43	13	23.5	35	30	19.5	9
TOTAL 135	46.5	84.5	108	88.5	50.5	26
AVERAGE: 45	15.5	28.17	36	29.5	16.3	8.7