Design and Development of Fully Automated Tea Making Machine to Africa Higher Educational Institution

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Abstract: Tea and coffee has become the most commercial products of the century. On the one hand, the rapidly rising population and changing lifestyles have increased the need for tea. Now a day's in African universities tea are available for students by using traditional tea preparing method this has result in various disadvantages. Particularly In Ethiopia, there is problem of providing tea to university and college students at required time with desired amount therefore we are try to design and develop the best and efficient tea making machine. Tea has become the most commercial products of the century but there are limitations to provide it to higher educational institution and the problem leads to conflict between students and admistration. To solve these problems, this project titled "Design and development of Automatic operated tea making machine" is developed to deliver the purified tea to the selected area by using the sensors and lever operating system based on the Mechatronics principles. It will be more cheap and economic for the mass production of tea. Currently traditional tea making mechanism that used for higher institution in Ethiopia has certain disadvantages in terms of amount of production, costs and injuries. For this reason, we try to develop tea and coffee making machine with some additional features that we tried to solve the problem with. To make it useful for people with disabilities, we try to design considering all phenomena. All types of users and their needs are taken into account in the developed machine. With this Automatic operated tea and coffee making machine customers save time and money to a certain extent. This way the designed machine have ability to control automatically since the sensor is installed there.

From the design analysis we find out the parameters PI (Internal Pressure) 1.55 MPa, TI (Internal Temperature) 1.00 °C, PE (External Pressure) 0.103 MPa, L (Shell Length) 1800mm, Di (Internal Tank Diameter) 1200mm are safe and The power required for the pump can be calculated by: 1.558KW and the H dynamic is similar for both the maximum and minimum and $Ht_{max} =$ 218.58m, $Ht_{min} =$ 216.98m and for sensing operation we select Arduino Uno with Microchip ATmega328P 5 Voltage Operating system.

Therefore, the machine can control the function by itself from the programmed position sensor devices and you receive a cup of tea without any contact with the machine.

***IndexTerms* - African universities, Tea and coffee, cheap, commercial products, maintenance**.

I. INTRODUCTION

1.1. Tea Making Machine

In today's world most of developing countries higher institution provides tea as one of daily product for their student meals, high number of African universities and colleges have over 21,000 students with in each institution. We have done our research on one of the 2nd generation university in Ethiopia which is Wolaita sodo University which includes above 28,788 in 2020 G.C education year. the institution provides tea every day at morning that means university cafes has responsibility to make 9,596 liter tea daily but it is difficult to them to prepare that much tea with in limited time due to this a lot of student cannot get the access and this is sometimes leads to conflict in addition the African universities use traditional or difficult tea making process and these result in wastage of labor force and have result in fire accident after doing research on the universities we decided to develop an efficient machine which solve the above problems with acceptable price. In present work the machine named Automatic operated Tea making machine to Africa Higher Educational Institution seems best machine to solve currently available problem which is use modern operating system, which is possible to control automatically and manually in addition to these the machine is applicable with position detector sensor so it is simple to use for students by themselves. The student number is one consideration in the project so the machine has five solenoid valves which means once a time five students can get the access.

1.2. Background

The first machine-produced tea bag in the world was the Pompadour gauze bag, introduced in 1928.the Manufactured machine was owned by the TEEKANNE subsidiary Seelig & Hille in Dresden.Like this process most of the African higher institutions are use this tea preparing method, But processes like this are limited for large number of community which is institution holds over twenty thousand students. The method is highly exposed to injuries on labors and also exposed to contamination. Taking Account this problems we are try to make best efficient and highly productive machine.

Fig.1. Traditional tea making and packing process.

1.3. Statement of the problem

The continuous problem that initiates us to develop Fully Automated Tea Making Machine is that the injuries on the labor within our university when trying to prepare the tea for the students are highly increase and the other problems that drive us to the development of the proposed machine are:-

- There is no developed tea making machine with in Ethiopian higher institution;

Current tea making process (traditional) has many disadvantages like:-

- It cannot produce high quantity;
- Result in fire and boiled tea injuries;
- Require labor force to prepare and to provide.
- Currently available machine which used for cafeteria application require enormous maintenance costs.

Fig.2. Result in boiled tea injuries.

Currently tea making process which is used in Ethiopian University is exposed for injuries on labors also in our universities at least 8 individuals are got accident within one semester on their bodies some of them are:-

1. Fikirte dengo;
2. Irtibuwa Gossaye;
3. Tamenech Bezabih;
4. Alemitu Gabenna;
6. Genet Mulatu;
7. Irbika Feleke;
8. Genet Ganta.

So the convincing areas of this project address the above problems and provides high productive machine to Ethiopian higher institution.

II.LITERATURE SURVEY

Two different types of tea and coffee machines were observed during the investigation: domestic machines and commercial vending machines. The operation of these devices is quite simple. The device consists of a plastic container into which tea or coffee premix powder is added, depending on the needs of the user. The device consists of a tank for storing water; this tank is connected to the measure. The amount of water is measured according to the needs of the user. When the user turns on the machine, the water is heated and poured into the container that provides the required beverage. However, it should be noted that these vending machines require enormous maintenance costs. Not all types of users are considered when designing the product. The most common defect observed during the examination was blockage of the drainage pipes. The vending machines available on the market have many integrated functions and offer a computer-aided automatic system as in Nescafé, Bravilor Bonamat, Bella. However, when it comes to institutional use, the cost of the product is due to the advanced features that may not be very useful for the institution; the mechanisms system is not affordable for everyone. But the developed ‘’Automatic operated Tea making machine’’ has ability to produce large amount of tea within limited time with safe operating system.

2.2. Objectives and Scope

- To make it cheaper and better;
- To have availability of various smart features like automated functionality;
- To have an easy operations and small maintenance as well;
- To be faster, safer and productive in comparison to existing one;
- To have a well-defined button and stirring systems;
- To have a proper utilization of by-products such as tea wastes, heat loss and water;

2.3. Advantages of the project

Compared to Traditional or current tea making process the design machine has the following advantages;

- Very cheap;
- Simple to move place to place;
- Safe enough;
- Safe and fire emergency system installed on machine parts;
- If there is electrical problem it shuts the whole system;

2.4. Beneficiaries

- Universities;
- Caffe employees;
- Operators,
- Rural area community,
- Students.

2.5. Elements of Automatic operated tea machine

2.5.1. Vertically shell

A shell / container are a container that keeps liquids at a pressure that is significantly different from the ambient pressure. The design includes parameters such as maximum safety operating pressure and temperature, safety factor, scope for corrosion and minimum design temperature (for fragile breaks). Many tanks are made of steel. To make a cylindrical or spherical pressure vessel, the laminated and possibly forged parts should be welded together.

2.5.2. Pipe

In industry, pipes are a pipe system that transports liquids from one place to another. The technical discipline of pipe construction examines the efficient transport of liquids. Plumbing is a piping system that most people are familiar with because it is the form of liquid transportation that provides water and fuel to their homes and businesses.

2.5.3. A solenoid valve

Is electromechanically operated valve. Solenoid valves differ in the properties of the electrical current they use, the intensity of the magnetic field they generate, the mechanism for regulating the fluid, and the type and properties of the fluid they control. The mechanism varies from linear drives to piston drives to drives with swiveling armature and tilting drives. The valve can use a two port design to regulate flow or a three or more port design to change flow between ports. Solenoid valves are the most commonly used controls in liquids.

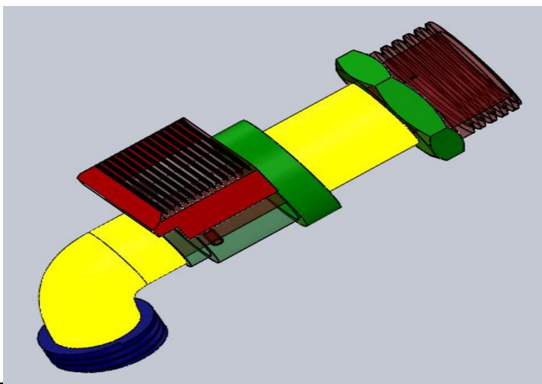


Fig.3. position detector sensor with solonoid valve.

Common components of a solenoid valve:

- Magnetic subset Retention clip (also called coil clip); Magnetic coil (with magnetic return path);
- Central tube (also known as anchor tube, piston tube; magnetic tube, sleeve, guide assembly);
- Plug nut (also known as a fixed kernel);
- Shading coil (also known as a shading ring);
- Central spring (also called counter spring);
- Core (also known as piston, armor);
- Central tube - hood seal hood (also called cover);
- Hood - membrane - body seal suspension;
- Loc, washer, Diaphragm, Flush the hole, Disc,Valve;

2.5.4. The Arduino Uno

Is an open-source microcontroller board based on the Microchip ATmega328P microcontroller and developed by Arduino.cc. The board is equipped with sets of digital and analog input/output (I/O) pins that may be interfaced to various expansion boards (shields) and other circuits. The board has 14 digital I/O pins (six capable of PWM output), 6 analog I/O pins, and is programmable with the Arduino IDE (Integrated Development Environment), via a type B USB cable.

Technical specifications

- Microcontroller: Microchip ATmega328P [7]
- Operating Voltage: 5
- Volts Input Voltage: 7 to 20 Volts Digital I/O
- Pins: 14 (of which 6 can provide PWM output) Analog Input
- Pins: 6 DC Current per I/O
- Pin: 20 mA DC Current for 3.3V
- Pin: 50 mA
- Flash Memory: 32 KB of which 0.5 KB

  EEPROM: 1 KB, Clock Speed: 16 MHz, Length: 68.6 Mm,

Fig.4.The Arduino Uno.

2.5.5. Infrared Diode LED IR Emitter and Receiver for Arduino

Infrared Diode LED IR Emitter and Receiver for Arduino is Smart electronics symbol Control in IR receivers and transmitters. Useful for Arduino experiments and remote projects, it connected a transmitter and a receiver to his Raspberry Pi and could control all IR devices in his house. The IR LED is like any other LED that can be connected directly to a GPIO connector. However, using a dropdown resistor will give you better results. This IR LED can be used to control a electronic system with the transmitter in an Adruino and can also use the receiver to read signals from other infrared devices. These infrared diodes are well suited for controlling small robots using infrared control.

An infrared emitter is an infrared emitter or IR emitter is a source of light energy in the infrared spectrum. It is a light emitting diode (LED) with which infrared signals are transmitted by a remote control. If you are interested in home automation, these IR receivers and transmitters solve many of your problems when working with Arduino, Raspberry Pi, etc.

Fig.5. Infrared Diode LED IR Emitter and Receiver for Arduino

2.5.6. Induction Heater

A super-high-efficiency induction hot water heater comprises: an external tank filled with water therein; an induction work coil provided in the external tank; a plurality of internal tanks having walls formed from induction conductor heating plates, and into which water flows, and arranged around the induction work coil by being spaced from the induction work coil; an alternating current/direct current conversion unit receiving an alternating current and converting the same into a direct current; and a high frequency generation unit generating a high frequency by receiving the direct current of the alternating current/direct current conversion unit, and providing the high frequency to the induction work coil, and allowing the water filled inside the external tank and the water flowing inside the internal tanks to be heated when the induction conductor heating plates are heated by the induced high frequency current.

✓ Liquid protection: - Overpressure and over-temperature protection;

✓ The heater will shut down if over output occurs.

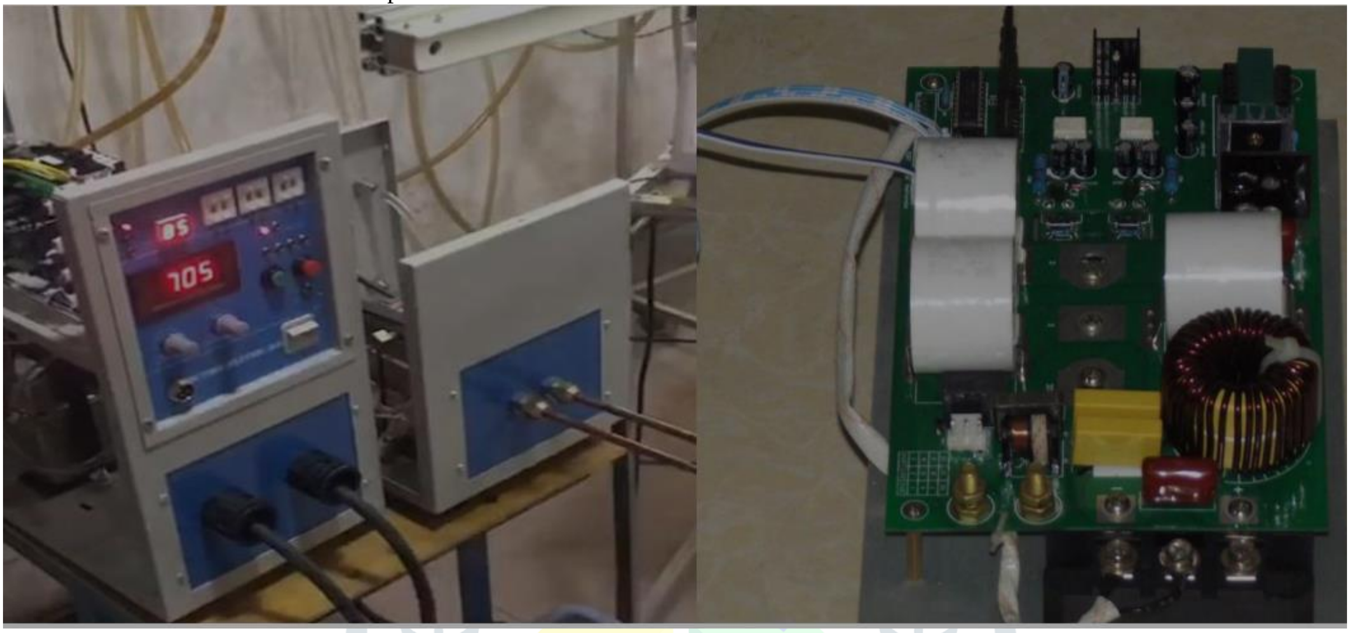


Fig.6. High frequency Induction heater.

III. CHAPTER THREE

3.1. Methodology

- Recognition of need

A project begins when higher institution in Ethiopia recognizes a need and we try to identify from my research what the customer and the student's needs. So we find out the need is simplified automatic tea and coffee making machine with safe operation principle and acceptable price.

- Data collection method

Primary data

- Observation;
- Interview with University student's cafe concerned body.

Secondary data

- Literatures;
- Collecting data from different sources like written books, internet websites and workshops.

- Data analysis; analysis includes detail study about raw materials, manufacturing process and operation principles of Automatic Tea making machine has been carried out using methodology.
- Observation, achievable data analysis and group discussion; observation is a method which has been used to understand the operation principle of the designed machine and identifying features.

Design and sampling method

This involves the application of engineering science: subjects explored extensively in traditional engineering courses, such as statics and dynamics, mechanics of materials and machine design. In this stage the following tasks are performed.

Using basic design equations and based on specifications of data perform

- Engineering analysis of parts and systems
- Stress and strength analysis of the machine parts
- Using different software (Solid work and ANSYS) we try to find out which part is highly stressed and which part is highly exposed to heat.

3.2. Organization of the project

This paper illustrates introduction of Automatic operated tea and coffee making machines, literature reviews that define the meaning of the machine, material selection, geometrical analysis and part design calculations, solid work modeling, ANSYS results. It also gives conclusion and recommendation.

3.3. Conceptual design

Before choosing the right or proper outline for my machine, we tried different conceptual designs; which are:-

- Cost
- Manufacturability
- Maintainability and
- Lapping quality/efficiency

Deliverability of the project

- Depending on cost;
- Depending on power;
- Depending on time and also the benefits listed are the reasons for deliverability the project.

B. Geometrical Analysis

Geometric analysis of machine

Given parameters and assumptions:

- Height of machine shell=1800mm
- Diameter of machine shell=1200mm

The machine has the above specification and the product to be produced with in this machine is tea and coffee.

3.4. Detailed Design analysis of components

3.4.1. Tea tank/ Shell

For designing vertical tea thank according to minimum and maximum requirements of design considering any failure parts the specialized code for vertical vessel are used within range of 0.1Mpa to 20 Mpa and for the above range of vertical vessel are better so we try select vessel and the selected vertical pressure vessel which is cylindrical have components of head, shell, nozzle, and base support.

While designing shell it is clear that the main consideration must be thickness and also the operation takes place like welding is also necessary.

To determine thickness:-

In case of stress which is circumference; where $P<0.385SE$

$ts = \frac{PR}{SE-0.6P}$; $Ps = \frac{SEts}{R+0.6ts}$; longitudinal welding;

In case of longitudinal

$ts = \frac{PR}{2SE+0.6P}$; $Ps = \frac{2SEts}{R-0.4ts}$; circumference welding where $P<1.25SE$

Where:-

E Coefficient of connection of welding

S Maximum allowable stress
R Internal radius
Ps Maximum pressure
P Design pressure
Ts Shell thickness; note that the coefficient of connection of welding is 1.0 if radiated tests are used.

The material selected and the studied vessel has pressure at internal is 1.55 Mpa and temperature is not exceeding 1000^0C the material that selected for the vessel is:-

Table-1. Material selected for the vessel.

Components	selected material
Tea thank sheel	SA 515-Gr 70
Head cover for sheel	SA 515-Gr 70
Nozzle	SA 106 Gr (B)
Base	SA 515-Gr 70
Legs	SA 106 Gr (B)

Table-I: Vessel dimensions and characteristics

PI(Internal Pressure)	1.55 MPa
TI(Internal Temperature)	1.00 ºC
PE(External Pressure)	0.103 MPa
L(Shell Length)	1800mm
Di(Internal Tank Diameter)	1200mm
Material type	SA 515 – Gr 70
S(Permissible Material Stress)	137.9 MPa
E(Link Efficiency)	1.0
C(Corrosion Permeability)	3mm
Density	7.73 g/cm3

Shell Thickness

$P < 0.385 * S * E = 1.55 < 0.385 * 137.9 * 1$

$$ts = \frac{PR}{SE - 0.6P} + C.a$$

$$ts = \frac{1.55 * 1200/2}{(137.9 * 1) - (0.6 * 1.55)} + 3 * 1$$

= 9.6988mm use standard value for ts which is 10mm

To find the maximum pressure: $Ps = \frac{SEt}{R + 0.6ts} = \frac{137.9 * 1 * 10}{\left(\frac{1200}{2}\right) + (0.6 * 10)} = \frac{1379}{3600} = 2.276Mpa$

Mass of Vessel shell:

$V = \frac{\pi * (Do^2 - Di^2)}{4} * L$ $V = \frac{\pi * (1210^2 - 1200^2)}{4} * 2000$

= $37837000mm^3$**;**

Mass = $\rho * v$ = $37837000mm^3/1000mm^3*7.80$ = 295.1286Kg

Liquid mass at the Shell; $V = \frac{\pi * Di^2}{4} * L = \frac{\pi * 1200^2}{4} * 2000 = 2260.0Kg$

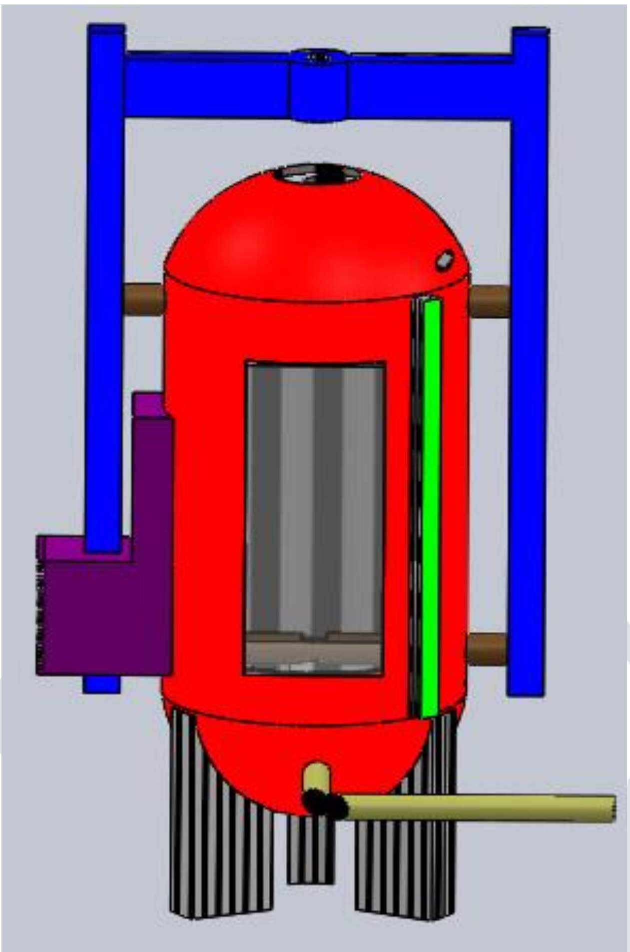


Fig.7. Tea tank/ Shell.

3.4.2. Shell head design

Most of the time the head of the shell is curved it is because to resist pressure considering the project system semi-elliptical head is selected in the elliptical shape the base diameter to the height is D/h=4/1.

There are two radius while designing head cover which are spherical head and radius of neck

L=0.9D (Spherical radius)

Ri=0.17D (radius of neck)

Where:-

th=head thickness

P=Designing pressure

Ph=Maximum pressure

S=maximum allowable stress

D=Internal diameter of tank body

E=Coefficient of connection of welding

Note:-Semi-Elliptical head cover type material Type SA 515-Gr70

Internal Spherical radius and height head;

4/1=D/h=1200/4=h=300mm

Thickness of required height (th) = $\frac{PD}{2SE-0.2P} + c.a$

$$= \frac{1.55Mpa * 1200mm}{(2 * 137.9) - (0.2 * 1.55)} = \frac{1860}{275.49} = 6.75mm$$

The thickness of height is less than the thickness of shell but to fit the both components and to eliminate the leakage within the system 10mm required thickness is calculated

Maximum pressure at the head:

$$Ph = \frac{2SEt}{D + 0.2th} = \frac{2 * 137.9 * 1 * 10}{1200 * 0.2 * 10} = 1.15Mpa$$

Mass of head $V = \frac{2}{3}\pi * (Lo^2 - Li^2) * h;$ $m = v\rho;$ Lo = 0.9D = 0.9(1200mm) =1080mm; Li = 1080mm-h =1080mm-300mm = 780mm ; $= \frac{2}{3} * \pi(1080^2 - 780^2) * 300$ =382,075.2 cm^3 $= v\rho = 382075.2cm * 1 = 382Kg.$

For two heads mass 2*(382Kg) =764Kg

Liquid Mass at Head

$Volume$ =2/3∗ (Li [2]) ∗ h

$Volume$ =2/3∗ (780^2) ∗ 300 = 1431388.153 cm 3

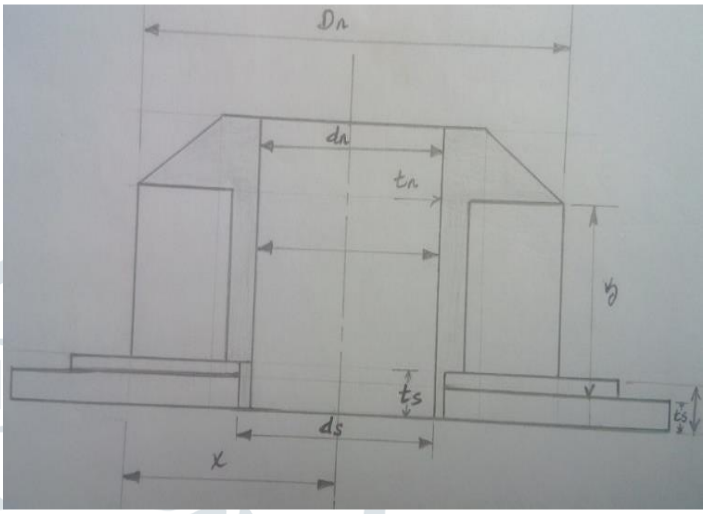
$Mass = Volume * Density$

Liquid Density=1.00 g/cm3

$Mass$ = 1431.388 Kg

$Liqud\ Mass\ of\ two$ heads = 2862.776 kg

3.4.3. Nozzle Calculation



Nozzle Length 180 mm 200

External Nozzle Diameter 200 mm 203

Material Type SA 106 Gr (B)

Permissible Material Stress 117.9 MPa

Link Efficiency 1.0

Corrosion Permeability 3 mm

Required Nozzle Thickness

$tn = PR/(SE - 0.6P)$

$$tn = \frac{1.55*(\frac{200}{2})}{117.9*1-0.6*1.55} = 1.4$$

($use\ ts$ = 12 mm, Ts = 20 mm and Tn = 10 mm).

$tn = PR/(SE-0.6P)$
A r =d n * t s * f
A s = D n (T s - t s) - 2T n (T s - t s)
A n = 2[2.5(T s)*(T n - t n)]
A r < (A s +A n)
ds = d n + 2(t n)
x = r n + T n , y = 2.5*T s
d n = D n – 2 (T n + Corrosion Allowance)
f = correction coefficient = 1
Ar = Area of nozzle hole

where: Dn = External nozzle diameter
dn = Internal nozzle diameter
ds = Diameter of nozzle on tank wall
ts = Required thickness of tank
Ts = Actual body thickness
tn = Required nozzle thickness
Tn = Actual nozzle thickness
rn = Radius of internal hole
As = Area of connecting region
An = Area of nozzle wall

Nozzle Reinforcement

d n = D n – 2 (T n + Corrosion Allowance)
d n = 200 – 2(10+3) , d n =174 mm
d s = d n + 2(t n) d s = 174+2(1.5) , d s = 176.8 mm
A r = d n * t s * f A r =174*10*1, A r =1740 mm^2
A s = D n (T s - t s) - 2T n (T s - t s) A s = 200*(20 - 10) - 2*10*(20 - 10) , A s = 1630 mm^2
A n = 2[2*1/2(Ts).(T n - t n)] A n = 2[2.5(20).(10 – 1.4)] , A n = 938 mm^2
A r < (A s +A n) 2124< (1830+935)
x = R n + T n x = (174/2) +10 , x= 97 mm
y = 2.5*T s; y = 2.5*20 , y = 50 mm

3.4.4. Support Base Design

During designing of high vessels, the support bases, size, volume, weight, wind and earthquake should be taken into consideration. In this work the legs support were used. The support legs are shown in Figure 3. The number of legs depends on the size of the tank and the size of stored material in the tank. The dimensions of the legs and stresses can be calculated as: - Longitudinal stresses

$$Sl = \frac{Q}{Th^2}[cos\alpha(k1 + 6K2) + \frac{H}{L}Sqrt(\frac{L}{Th(K3\ +\ 6K4)}$$

Circumference stresses

$$Sc = \frac{Q}{Th^2}[cos\alpha(k5 + 6K6) + \frac{H}{L}Sqrt(\frac{L}{Th(K5\ +\ 6K6)}$$

Mass of Nozzle

$Volume = \pi/4 * (Dn^2 - dn^2) * L$

$Volume = \pi/4 * (200^2 - 174^2) * 20 = 152.666\ cm3$

$Mass = Volume * Density$

$Mass = 10.82\ kg$

$Mass\ of\ two\ nozzles = 10.82 * 2 = 21.64$Kg

Total Mass of Pressure Vessel

Total mass of vessel parts = 295.1286Kg + 764Kg + 21.64Kg =1080.7686Kg

Total liquid mass = 2260.0Kg + 2862.776Kg =5122.776Kg

Total mass (Tm)= 1080.7686Kg + 5122.776Kg = 6203.5446Kg

Design of Pressure Vessel Support

Total mass Tm = 6203.5446Kg

Twf = 6203.5446Kg*9.81 = 60856.7725N

Q = Twf/n=60856.7725N/4 = 15214.2N

H=200mm, 2A=2B = 320mm

$\cos\alpha = 0.95$, $c = \sqrt{AB} = 160$

$$Dl = 1.8\frac{c}{l}\sqrt{\frac{L}{th}} = 1.8 * \frac{160}{1300} * \sqrt{\frac{1300}{10}}$$

= 1.8*0.123*11.4= 2.524mm

$$E*S = \frac{Q}{A} = \frac{Q}{3.14/4(Do \wedge 2 - Di \wedge 2)}$$

$$D_O = \sqrt{\frac{4*(15214.2)}{0.6*177.9*3.14}} + 80_{2}$$

=18.312mm say 20mm standard.

3.4.5. Pump, pipe, fitting selections

Tea is pumped with low pressure from the reservoir to the pipe and from the pipe to valve. the tea level in the reservoir varies but the discharge level in the receiving valve remains constant. the pump is required to pass forward a flow of 62.5m^3/hr to the receiving valve. The designed system the operating pressure or total head to the system is:

H(total to the system): =H(static)+(H(dynamic)+(P1-P2) ……………''(1)''

P1=pressure on the surface of tea in the receiving tank (m);

P2= pressure on the surface of tea in the valves (m).

The atmospheric pressure varies with height, the variation in the pressure that occurs over the pumping height can be considered as negligible because of very small. in this system the difference in pressure over the elevation from the tank to the valve is negligible therefore the above equation becomes:-

H total to the system: =H static + H dynamic……………'' (2)'

The H static is the physical variation in the elevation between the ground of the tank and the point of the discharge in to the valve in our system. As the tea level in the tank can vary the H static for the system vary between a maximum and minimum.

Minimum static head = Discharge position point-Tank top tea level;

Maximum static head = Discharge position point-Tank bottom tea level

Minimum static Head=1.2-1.8=-0.6m

Maximum static head=1.2-0.2=1m

The dynamic H is generated as a result of overall friction with in our system. By using the basic Darcy Weisbach equation:-

HD=$KV^2/2g$……………''(3)''

Where g=acceleration due to gravity (m/sec^2)

V= velocity (m/sec) with in the pipe

K=coefficient loss

We can determine the velocity in the pipe by:

V=Q/A……………'' (4)''

Where:
Q=flow rate; A=Area (m^2)
The coefficient loss is the combination of fittings used in the pipe work of the above system to the power/pump the tea from thank to valve. The value can be searched from table below and so the coefficient loss is the sum of pipe and fittings. The value can be calculated by summing all the coefficient loss with in fitting for each individual fitting into the system. Hence the total coefficient loss for the plant under consideration=24.95.

$K=K_{fittings} + K_{pipe}$

$K_{fittings}$:-

is associated with the fittings used in the pipe works of the system to pump the water from reservoir to the receiving tank. Values can be obtained from standard tables and a total fittings $K_{fitting}$ value can be calculated by adding all the fittings $K_{fitting}$ values for each individual fitting within the system. The following table sho ws the calculation of $K_{fittings}$ for the system under consideration.

Table-II: Calculating $K_{fittings}$ for the system under consideration

Fitting item	No of item	Kfitting value	Item total
Pipe Entrance (bell mouth)	2	0.05	0.1
90^0 Bend (short radius)	21	0.75	15.75
Butterfly Valve (Fully Open)	3	0.3	0.9
Bell mouth Outlet	8	1.00	8
Total fittings K Value			24.95

Hence, the total fittings for my system $K_{fittings}$ under consideration is 24.95.
Kpipe is length (straight length) pipe used within the overall system.
Kpipe=FL/D
Where F= friction coefficient
L= length of pipe
D= pipe diameter
By using modified equation of Cole brook white it is possible to find friction coefficient (F);

$$f = \frac{0.25}{[\log(k/3.7D) + \frac{5.74}{\mathrm{Re}\wedge 0.9}]\wedge 2}$$

Where K=roughness factor (m)

Re=Reynolds number ; Re=VD/*V*

Where *V*= kinematic viscosity (m2/s)

In the project the total length of pipe on the system is 6.4m.

The pipe on my system has a roughness factor of 0.3 mm and the tea kinematic viscosity is 1.31*10-6 m^2/sec, then:

$$V = Q/A = \frac{62.5}{3600} * \frac{1}{0.000314}$$

$$\mathrm{Re} = \frac{0.825m/s * 0.02m}{1.28*10\wedge -6m\wedge 2/\sec} = 12890.625$$

$$f = \frac{0.25}{[\log(\frac{0.0003}{3.7*0.02} + \frac{5.74}{(12{,}890.625)\wedge 0.9})]\wedge 2} = 26.03$$

$$Kpipe = \frac{fL}{D} = \frac{26.03*4.8}{0.02} = 6247.2$$

Total k value becomes = 24.95+6247.2 = 6272.15

$$HD = \frac{KV\wedge 2}{2*g} = \frac{6272.15*(0.825m/s)\wedge 2}{2*9.81} = 217.58m$$

The H dynamic is similar for both the maximum and minimum H static conditions as it is independent of the system elevation.

Hence the maximum and minimum H total value for the system at $0.93m^3$/hr can be determine by using the following equation.

Ht_{max} = 1m+HD; = 1m+217.58m = 218.58m

Ht_{min} = -0.6+ HD; = -0.6+217.58m=216.98m

The required speed of pump can be determined by using the first affinity laws:

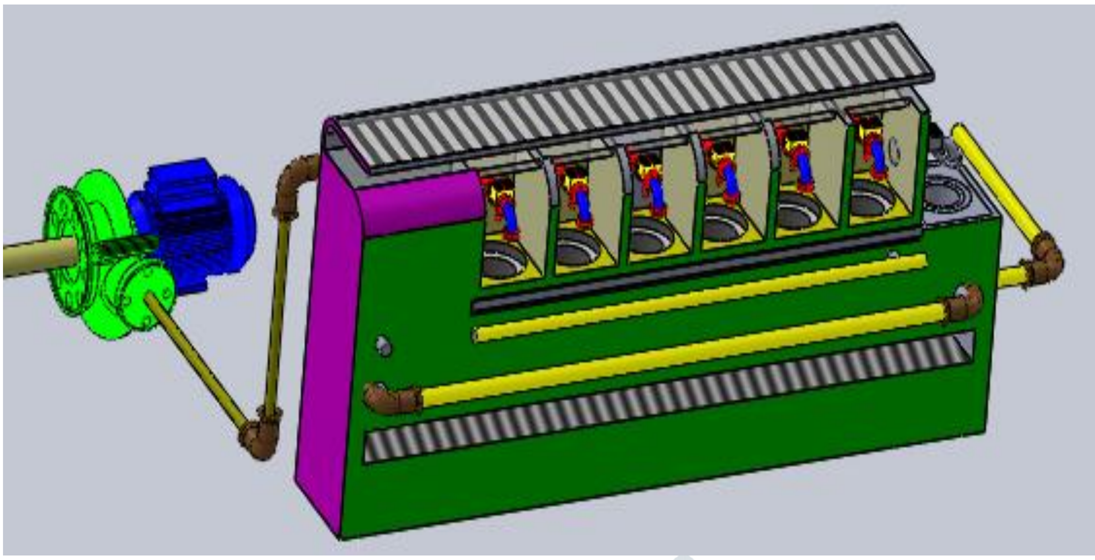


Fig.8. Pump, pipe, fitting.

$$\frac{Q1}{Q2}=\frac{N1}{N2}$$ where Q = Flow through the pipe (m 3 /sec); N = Shaft speed (rpm)

Second affinity law;

$$\frac{H1}{H2}=\frac{N1\wedge 2}{N2\wedge 2}$$; H = Head (m)

Using the above formula we can check the selected speed is good or not taking flow rate of our system the speed of pump 500 rpm is selected.

The power requirement for the pump can be calculated by:

$$P=\frac{Q*H*g*\rho}{\eta}\ \frac{62.5*218.58*9.81*1000}{0.86}=1.558KW$$

3.4.6. Elements and Installation steps of Position detector sensor with Control valve.

Elements:-

1.12 Volts solenoid valve;

2. ARDUINO UNO R3;

3. Sensor 1=IR receiver;

4. IR 1= Infrared led;

5. R1= 20 kΩ 0.5 Watt;

6. R2= 200 kΩ 1 Watt;

7. R3=9.4 kΩ 0.5 Watt;

3.4.6.1. Steps for connect elements.

Step A. Connect infrared led leg b to the resistor 2 and also connect another leg of resistor 2 to arduino 5 volts pin;
Step B. Connect infrared led leg L and sensor leg F pin to arduino Gnd socket;
Step C. connect sensor 1 leg D to resistor one leg and Arduino AO socket, connect another leg of resistor one pin to Arduino 5 volts pin without touching the wire of the above step;
Step D. Connect TR1 H pin to arduino D13 pin, connect TR1 H pin to resistor three.
Step E. connect another R3 leg to TR1 spin;
Step F. connect TR1 W pin to the solenoid valve;
Step G. connect 12 volt solenoid valve another leg to 12 volts power supply V+;
Step H. connect 12 volts power supply V- or ground or volts to TR1 T leg;
Step I. connects 12 volts power supply to Arduino uno resistor three power input socket.

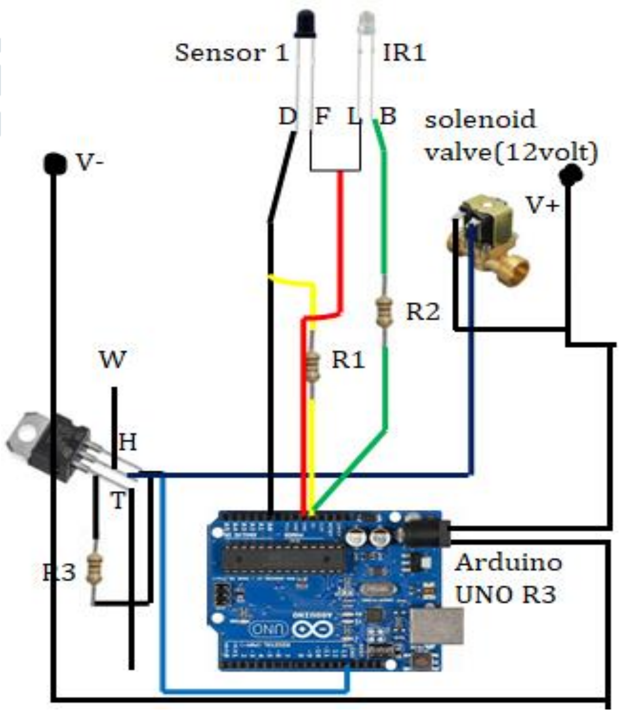


Fig.9. System of position detector sensor.

Result and discussion.

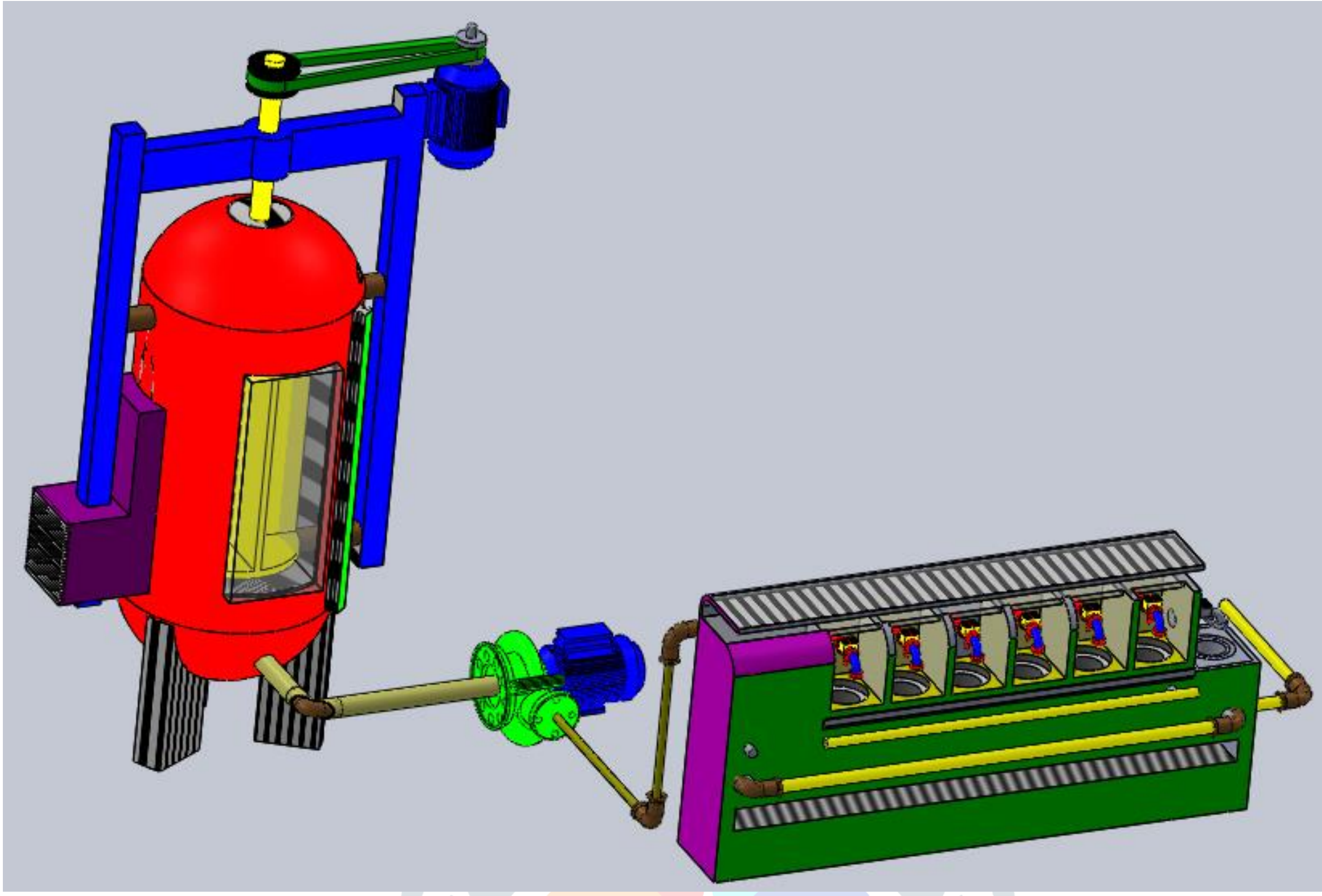


Fig.10. 3D Solid work drawing of ''Automatic operated Tea and coffee making machine''.

Result and discussion

Result

Since our objective is to design Automatic operated Tea and coffee making machine, we try to cover mathematical analysis, modeling and structural and thermal analysis of all parts and the resulting dimensions of parts. From the ANSYS analysis of parts, we can observe that where the heat is more dispassion is concentrated and the point where failure occurs. As a result, there is no any failure on machine parts to avoid the problems we try to eliminate the Failure by the proper selection of materials at the beginning of the project.

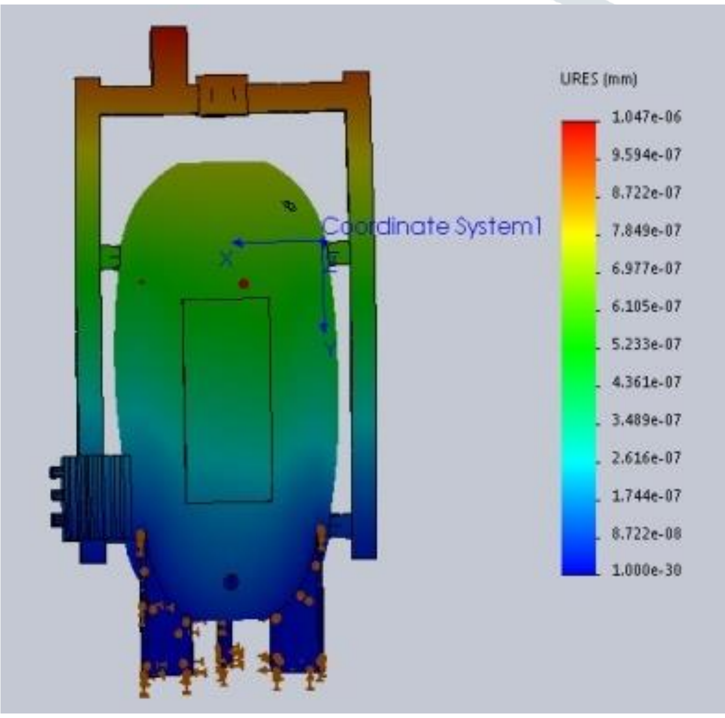


Fig.11.a. displacement Analysis.

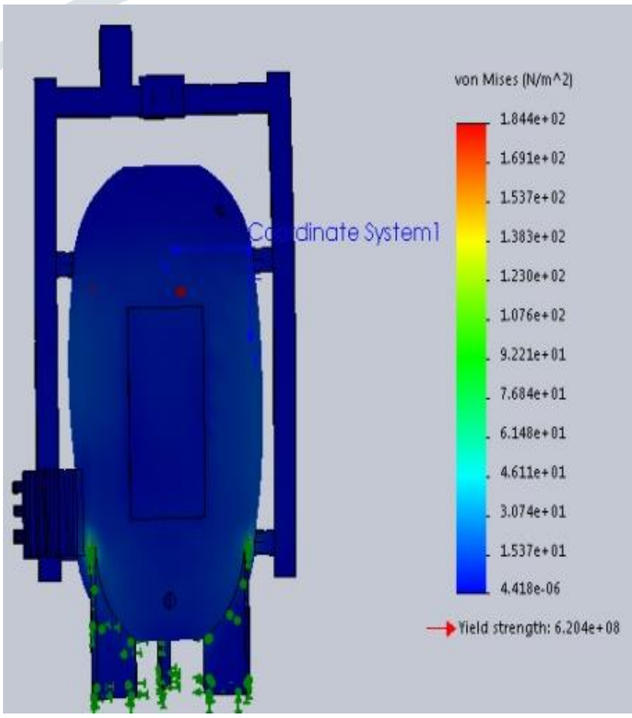


Fig.11.b. Von-mises Analysis.

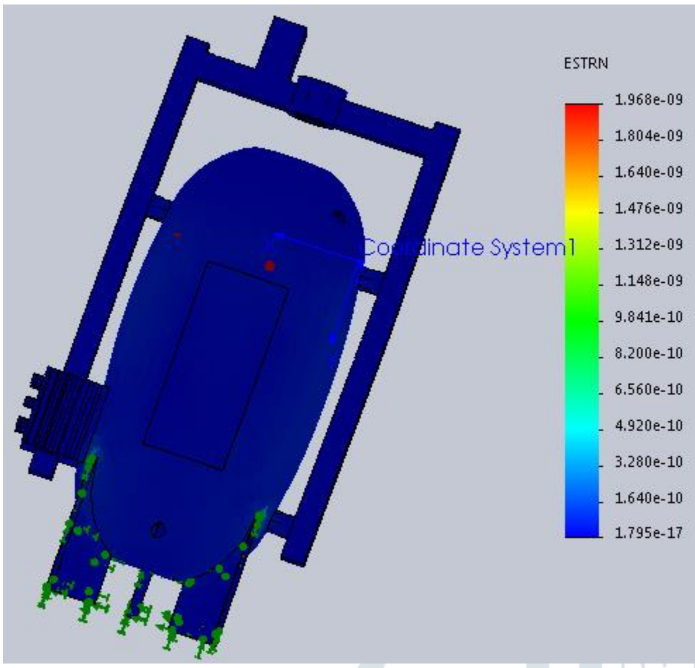


Fig.11.c. Strain Analysis.

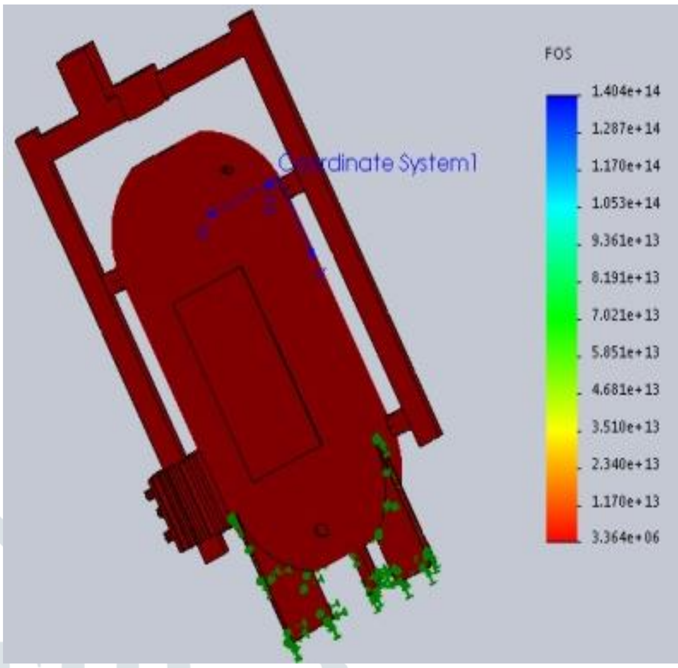


Fig.11.d. Factor of Safety

Conclusion

The scope of the project was to Design and model Automatic operated tea and coffee making machine to African higher education institution machine. By Using mechanical software we try to determine the area that are highly head despite and found that the part is safe. Therefore with this design it can applicable for practical use to satisfy the anticipated task in improving safety and mass production.

Since tea and coffee are widely used in many areas specially areas like Universities and colleges. Now a day tea machines were not well designed and qualified to universities and colleges and have result in increasing accidents. By considering this pneumonia, we tried to design and model the best machine to solve the problems. The machine has effective performance that reduces the faced problems.

Generally we conclude that, the needs of the customer will be solved as much as possible because of the machine has basic features such as it increases mass production, reduces working time, reduce injuries, reduce wastage of labor forces. We believe the customers have been satisfied by this project.

References

1. www.google.com/ https://en.teekanne. at/en/all-about-tea/tea-knowledge/machine-history[Accessed 12 February 2020].
2. Hamaji (25 February 2016). *"Kericho Estate, a sustainable tea plantation in Kenya"*. HAMAJI MAGAZINE. *Retrieved 21 February 2020*.
3. R.S, KHURMI, J.K. GUPTA, A text book of Machine Design, Eurasia publishing house pvt, L, 2005 New Delhi
4.Hibbeler, R., 1997. Column Buckling: Design using Euler Theory. In: R. Hibbeler, ed. Mechanics of Materials. 3rd ed. Englewood Cliffs: Prentice Hall.
5. *Jump up to:[a] [b]* *"History of Kenya Tea"*. Slope and Peak Products. Archived from *the original* on 17 March 2016.
6.www.google.com/ https://en.teekanne. at/en/all-about-tea/tea-knowledge/machine-history[Accessed 12 February 2020].
7.Technology Comparison of Motion Detectors. [Online] Available at: http://www.ecosirius.com/technology.html.
8.Patani, S. P., 2007. AN ATTEMPT TO IMPROVE SAFETY SYSTEM, Unjha: Dabhi.
9.*"Trade Map: Product #090240, Black tea, > 3 kg packings". International Trade Centre.*