Design, Analysis and Fabrication of Polythene bricks Manufacturing Plant

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by

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EXAMINATION COMMITTEE

We hereby recommend that the dissertation prepared under our supervision by: Adnan Shafique, Bilal Ahmed Salar, Adeem Hassan. Titled: "Design, Analysis and Fabrication of Polythene bricks Manufacturing Plant" be accepted in partial fulfillment of the requirements for the award of Bachelors in Mechanical Engineering degree with (___ grade).

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Contents

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ABSTRACT

Through this plant we will be able to recover considerable amount of energy from waste polythene bags which if not recycled will have devastating effects on our environment. The harms such as sewerage block, reducing fertility of land etc. are discussed in detail later. The main criteria for selecting feed is lower calorific value. In our case it is above 40MJ/kg which is more than sufficient for using waste polythene bags as a feed. While recovering energy treatment of toxic exhaust is also main concern which can be treated through heat. Tests were conducted which are elaborated in next few pages.

WHY WE NEED POLYTHENE TREATMENT PLANT?

HARMS:

The effects of plastic bags on the environment are really quite devastating. While there are many objections to the banning of plastic bags based solely on their convenience, the damage to the environment needs to be controlled.

There is no way to strictly limit the effects of plastic bags on the environment because there is no disposal method that will really help eliminate the problem. While reusing them is the first step, most people either don't or can't based on store policies. They are not durable enough to stand up to numerous trips to the store so often the best that citizens can do is reuse them when following pooper scooper laws.

PLASTIC BAG LITTER:

Even when citizens try to manage their plastic bag disposal wind plays a role in carrying them away as litter. A bag that is eventually ripped to shreds from high winds or other factors doesn't disappear but instead is spread in smaller amounts throughout the area. This can cause more problems as these smaller pieces are carried away through storm drains and often end up in the waterways. With more the 500 billion and possibly as many as a trillion plastic bags in circulation annually this can lead to a catastrophic littering problem.

THE EFFECTS OF PLASTIC BAGS IN WATERWAYS:

One of the greatest problems is that an estimated 300 million plastic bags end up in the Atlantic Ocean alone. These bags are very dangerous for sea life, especially those of the mammal variety. Any hunting mammal can easily mistake the size, shape, and texture of the plastic bag for a meal and find its airway is cut off. Needless deaths from plastic bags are increasing every year.

THE EFFECTS OF PLASTIC BAGS ON LAND

Every bag that ends up in the woodlands of the country threatens the natural progression of wildlife. The land litter that is made up of plastic bags has the potential to kill over and over again. It has been estimated that one bag has the potential to unintentionally kill one animal per every three months due to unintentional digestion or inhalation. If you consider the number of littered plastic bags ranges from 1.5 million to 3 million depending on location, this equals a lot of ecosystem sustaining lives lost.

RECYCLING PLASTIC BAGS:

While it's a noble thought to place the plastic bags in the recycling bin every week, studies have proven that there are very few plants that actually recycle them. Most municipalities either burn them or send them off to the landfill after sorting. This is because it can be expensive to recycle this type of plastic. It doesn't melt down easily and is often not realistically able to be reused from its original form without considerable overhaul to the facility. Less than 1% of all bags sent to recycling plants worldwide end up in the recycling project. Most are left to become a pollution problem in one way or another.

ALTERNATIVES TO PLASTIC BAGS:

There are always alternatives to plastic bags and the search for more alternatives continues. Paper bags are a possible option but they also take their toll on the environment. The use of trees to increase the production of paper products combined with the increased energy that is required to make paper bags will also have a negative environmental effect.

However the reusable cloth bag is becoming a favorite among environmental supporters. While thus far no bag is without its issues these are the bags that are currently recommended for use to help protect environmental concerns.

USAGE OF POLYTHENENE BAGS IN PAKISTAN:

Statistics show that an average of 167 bags is being used per person in Pakistan, and 260 million tons worth worldwide. Only one in every 200 of these bags is recycled, leaving a high risk and threat to the world we live in. Stray plastic bags are normally thrown everywhere after it is used that results in blocked sewers, create an overall unaesthetic view of the environment, spread bacterial germinations, water borne diseases and also become good breeding grounds for mosquitoes which later on cause malaria and dengue. 80percent of the total litter in Pakistan is estimated to be plastic bags and above 80% of drainage blockages take place because of plastic bags. They cannot be broken down into the three elements of carbon dioxide, water and bio mass.

Instead, when plastic bags or any plastics are recycled, harmful toxicants are emitted which in turn eventually cause further ozone depletion. Despite a ban on the usage of plastic bags implemented by the provincial governments of Pakistan, the prohibition on the sale and use of polythene bags has failed.

ENERGY CONSUMPTION FOR PRODUCTION OF BAGS AND ENVIRONMENTAL IMPACT:

Table 4.2 Energy consumption and waste generation for film and cotton bags (per 1000 bags)

Bag type	Electricity	Heat (from natural gas)	Heat (from heavy fuel oil)	Waste
Conventional high-density polyethylene (HDPE) bag	6.151 kWh (22.144 MJ) (0.758 kWh/kg)			418.4 g
High-density polyethylene (HDPE) bag with a prodegradant additive	6.392 kWh (23.011 MJ) (0.773 kWh/kg)			426.1 g
Starch-polyester blend bag	17.24 kWh (62.064 MJ) (1.045 kWh/kg)			94.8 g
Low-density polyethylene (LDPE) bag	32.58 kWh (117.288 MJ) (0.932 kWh/kg)	13.953 kWh (50.23 MJ) (0.399 kWh/kg)		171.2 g*
Non-woven polypropylene (PP) bag			87.75 kWh (315.9 MJ) (0.758 kWh/kg)	5,850 g
Cotton bag	11 kWh (39.6 MJ) (0.06 kWh/kg) *			1,800 g*

CRITERIA FOR SELECTING FEED:

Key criteria:

- The average lower calorific value of the waste must be at least 6 MJ/kg throughout all seasons. The annual average lower calorific value must not be less than 7 MJ/kg.
- Forecasts of waste generation and composition are established on the basis of waste surveys in the collection area for the planned incineration plant. This task must be carried out by an experienced (and independent) institution.
- Assumptions on the delivery of combustible industrial and commercial waste to an incineration plant should be founded on an assessment of positive and negative incentives for the various stakeholders to use the incineration facility.(http://www.unep.or.jp/Ietc/Publications/spc/WastePlasticsEST_Compendium.pdf)

ENERGY RECOVERY:

Polythene bags could be used as feed because their lower caloric value is above 40MJ/kg.
Plastics have a very high heating value, often exceeding 40 MJ/kg. It results from a high content of carbon and hydrogen, and low ash content. Higher heating value is observed only for natural gas (48 MJ/kg), and comparable for heating oil (about 43 MJ/kg). Whereas, coal has a heating value of about 28 MJ/kg, and paper and wood approximately 15-16 MJ/kg. Such high heating value of plastics causes that plastic wastes can partially substitute fossil fuels, so that in direct way saves natural resources. Therefore, in case when recycling leading to the recovery of the material can't be carried out due to technical limitations or lack of economic viability energy recovery is definitely the best way to recover the value of waste plastics.

Physicochemical properties of plastics contained in polish municipal wastes compared to bituminous coal [3]

Type of plastic	Average content, % wag	Elemental composition, %D.M.						Ash content, %D.M.	Heating value, MJ/kg
		C	H	O	N	S	Cl	Ad	Qid
PE	25	81.89	12.37	0.00	0.46	1.92	0.97	2.39	41.80
PP	15	68.89	9.13	14.61	1.82	1.29	1.24	2.93	30.90
PVC	40	37.56	4.94	44.00	0.42	0.71	4.43	7.94	13.69
PA	5	65.39	10.38	10.54	8.49	1.41	0.43	3.36	36.76
PS	5	88.48	8.36	0.00	0.50	1.12	0.16	1.38	38.97
PET	10	56.40	5.68	33.10	0.44	0.80	1.43	2.15	21.81
Average	100	59.18	7.94	23.68	1.05	1.16	2.37	4.66	26.41
Bituminous coal*	100	66.90	4.14	9.94	1.17	0.80	0.33	16.70	26.00

* database of coal properties IChPC (Mieszko II)

http://www.chemikinternational.com/year-2013/year-2013-issue-5/energy-recovery-from-waste-plastics/

A mixture of paper and plastics of a 1:1 weight ratio gives a heating value of approximately 7,000kcal/kg or higher.

Terminology used in different types of plastics recycling and recovery.

ASTM D5033 definitions	equivalent ISO 15270 (draft) definitions	other equivalent terms
primary recycling	mechanical recycling	closed-loop recycling
secondary recycling	mechanical recycling	downgrading
tertiary recycling	chemical recycling	feedstock recycling
quaternary recycling	energy recovery	valorization

(http://rstb.royalsocietypublishing.org/content/364/1526/2115.full).

PLASTIC TYPE SELECTION:

Polymer as feedstock for fuel production:

Types of polymer	Descriptions	Examples
Polymers consisting of carbon and hydrogen	Typical feedstock for fuel production due to high heat value and clean exhaust gas.	Polyethylene, polypropylene, polystyrene. Thermoplastics melt to form solid fuel mixed with other combustible wastes and decompose to produce liquid fuel.
Polymers containing oxygen	Lower heat value than above plastics	PET, phenolic resin, polyvinyl alcohol, polyoxymethylene
Polymers containing nitrogen or sulfur	Fuel from this type of plastic is a source of hazardous components such as NO_x or SO_x in flue gas. Flue gas cleaning is required to avoid emission of hazardous components in exhaust gas.	Nitrogen: polyamide, polyurethane Sulfur: polyphenylene sulfide
Polymers containing halogens of chlorine, bromine and fluorine.	Source of hazardous and corrosive flue gas upon thermal treatment and combustion.	Polyvinyl chloride, polyvinylidene chloride, bromine-containing flame retardants and fluorocarbon polymers.

All of the above harms and extensive usage are compelling us to install polythene bags treatment plant to safely use or dispose them. In our project we will consider their usage as well as their exhausts will also be taken into consideration. End product of this will be used to produce steam.

You can get only 50 to 55 percent fuel from the distillation of petroleum crude oil. "But since this plastic is made from petroleum in the first place, we can recover almost 80 percent fuel from it through distillation."

(http://www.sciencedaily.com/releases/2014/02/140212132853.htm).

COMPARISON WITH OTHER FUELS:

Calorific Value of Materials

Material	Btu per pound	kilojoules per kilo
# 2 fuel oil	20,900	48,500
Plastics		
Polyethylene	20,000	46,500
Polypropylene	19,300	45,000
Polystyrene	17,900	41,600
PET	9,290	21,600
PVC	8,170	19,000
Coal	11,500	27,000
Newspaper	7,200	17,000
Wood	6,700	15,500
Average MSW	4,650	10,800
Yard Waste	3,000	7,000
Food Waste	2,600	6,000

Fuel	Calorific value/MJ kg^{-1}
Methane	53
Gasoline	46
Fuel oil	43
Coal	30
Polyethylene	~ 43
Mixed plastics	30–40
Municipal solid waste	~ 10

(Polymers and the Environment By Gerald Scott)

EXHAUST OF PLASTIC ON BURNING:

Evaluation of fuel gases produced from pyrolysis of waste polyethylene was carried out. Waste polyethylene (pure water sachets) was pyrolysed at low and high temperatures. Pyrolysis of the waste for 300secs at temperatures of 250C -1400C produced 2.53% ethane, 21.67% propane and 75.82 % propylene. The volume of the gaseous products at this low temperature is far less than the initial volume of the waste resulting into over 80% reduction in the volume of waste generated by discarding the polyethylene waste. Fresh samples of the waste were pyrolysed at higher temperature range from 500C – 2500C and cooled in a condenser. The non-condensable gas produced were collected and analyzed with Shimadzu gas chromatography. The analysis shows that C1 – C6, and other alkenes and isoparaffins (18 ethylene monomers) were produced. The gaseous products being 75.82% propylene at low temperatures and 48.6% (normal and Iso) butane at higher temperatures. The flame test carried out shows that the gaseous products burns with a blue flame at lower temperature range. Above 3000C the flame becomes more luminous and production of fuel gases stops at 5500C. Production of fuel oil from waste polyethylene led to production of large volume of gaseous products, some of which are non-condensable at room temperature. The gaseous products can serve as feedstock and as fuel gas.

(Fuel gases from pyrolysis of waste Polyethylene sachets ADEMILUYI, T; 2ADEBAYO, T A Department of Chemical/ petrochemical Engineering, Rivers State University of Science and Technology, Port Harcourt. 2Department of Petroleum Engineering, Rivers State University of Science and Technology, Port Harcourt.)

COMPARISON OF FOSSIL FUELS AND PALSTIC BAGS EMMISSION

The carbon footprint of plastic (LDPE or PET, poyethylene) is about 6 kg CO2 per kg of plastic. If you know the weight of your plastic bags, you can multiply it with the number of plastic bag you are using per year. Then you can easily calculate the carbon dioxide emitted by your own usage of plastic bags. See below for some background information.

- The production of 1 kg of polyethylene (PET or LDPE), requires the equivalent of 2 kg of oil for energy and raw material. Polyethylene PE ist the most commonly used plastic for plastic bags.
- Burning 1 kg of oil creates about 3 kg of carbon dioxide. In other words: Per kg of plastic, about 6 kg carbon dioxide is created during production and incineration.

- A plastic bag has a weight in the range of about 8 g to 60 g depending on size and thickness. For the further calculation, it now depends on which weight for a plastic bag you actually use. A common plastic carrying bag in our household had a weight between 25 g and 40 g. So I took the average of 32.5 g.
- Take the above relation between kg plastics and kg of carbon dioxide, and you get about 200 g carbon dioxide for 32.5 g of plastic, which is the equivalent of the average plastic carrying bag in our household. Or in other words: For 5 plastic bags you get 1 kg of CO2.

(http://timeforchange.org/plastic-bags-and-plastic-bottles-CO2-emissions)

TREATMENT AND IDENTIFICATION OF EXHAUST:

Polyethylene emits fumes that include compounds such as methane, ethane, aldehydes, ketones and acrolein, plus additional compounds. None of these exhaust are good for the environment. So their treatment is necessary.

Possible treatment of hydrocarbon exhaust is as follows;

- SER(Steam Enhanced Remediation)
- DPVE(Dual Phase Vacuum Extraction)
- Chemical Oxidation
- Air Sparge/Vacuum Extraction
- In-situ Bioremediation
- Reactive Barriers

http://www.churngold.com/remediation/problems/hydrocarbon-contamination.html

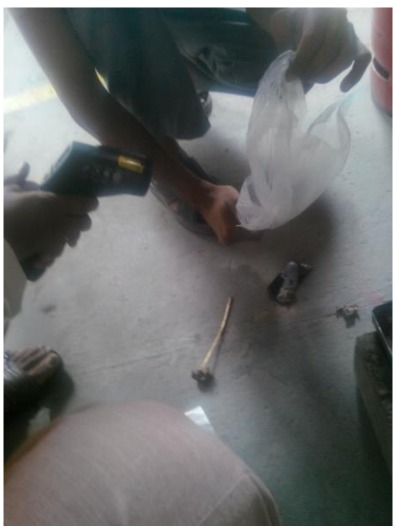
APPARATUS USED FOR THE TEST:

BURNING AND MELTING TEMPERATURE:

Plastic type	Melting point	Ignition temperature
polyethylene LDPE	107C-124C	349C
Polyethylene HDPE	122C-137C	349C

http://www.tcforensic.com.au/docs/article10.html

TEST AT MRC FOR MEASURING MELTING TEMPERATURE:



MATERIAL TESTING:

A test was performed to test material to check material which material is suitable for us. First we went with mild steel. Its main problem was sticking. The moment polythene bags melted got stuck with material. After consulting to supervisors we studied the theory of stainless steel.

What Is Stainless Steel?

Stainless steel is an alloy of Iron with a minimum of 10.5% Chromium. Chromium produces a thin layer of oxide on the surface of the steel known as the 'passive layer'. This prevents any further corrosion of the surface. Increasing the amount of Chromium gives an increased resistance to corrosion. Stainless steel also contains varying amounts of Carbon, Silicon and Manganese. Other elements such as Nickel and Molybdenum may be added to impart other useful properties such as enhanced formability and increased corrosion resistance.

Stainless steel is usually divided into 5 types:

a. Ferritic – These steels are based on Chromium with small amounts of Carbon usually less than 0.10%. These steels have a similar microstructure to carbon and low alloy steels. They are usually limited in use to relatively thin sections due to lack of toughness in welds. However, where welding is not required they offer a wide range of applications. They cannot be hardened by heat treatment. High Chromium steels with additions of Molybdenum can be used in quite aggressive conditions such as sea water. Ferritic steels are also chosen for their resistance to stress corrosion cracking. They are not as formable as austenitic stainless steels. They are magnetic.
b. Austenitic – These steels are the most common. Their microstructure is derived from the addition of Nickel, Manganese and Nitrogen. It is the same structure as occurs in ordinary steels at much higher temperatures. This structure gives these steels their characteristic combination of weldability and formability. Corrosion resistance can be enhanced by adding Chromium, Molybdenum and Nitrogen. They cannot be hardened by heat treatment but have the useful property of being able to be work hardened to high strength levels whilst retaining a useful level of ductility and toughness. Standard austenitic steels are vulnerable to stress corrosion cracking. Higher nickel austenitic steels have increased resistance to stress corrosion cracking. They are nominally non-magnetic but usually exhibit some magnetic response depending on the composition and the work hardening of the steel.
c. Martensitic – These steels are similar to ferritic steels in being based on Chromium but have higher Carbon levels up as high as 1%. This allows them to be hardened and tempered much like carbon and low-alloy steels. They are used where high strength and moderate corrosion resistance is required. They are more common in long products than in sheet and plate form. They have generally low weldability and formability. They are magnetic.
d. Duplex – These steels have a microstructure which is approximately 50% ferritic and 50% austenitic. This gives them a higher strength than either ferritic or austenitic steels. They are resistant to stress corrosion cracking. So called “lean duplex” steels are formulated to have comparable corrosion resistance to standard austenitic steels but with enhanced strength and resistance to stress corrosion cracking. “Superduplex” steels have enhanced strength and resistance to all forms of corrosion compared to standard austenitic steels. They are weldable but need care in selection of welding consumables and heat input. They have moderate formability. They are magnetic but not so much as the ferritic, martensitic and PH grades due to the 50% austenitic phase.
e. Precipitation hardening (PH) - These steels can develop very high strength by adding elements such as Copper, Niobium and Aluminium to the steel. With a suitable “aging” heat treatment, very fine particles form in the matrix of the steel which imparts strength. These steels can be machined to quite intricate shapes requiring good tolerances before the final aging treatment as there is minimal distortion from the final treatment. This is in contrast to conventional hardening and tempering in martensitic steels where distortion is more of a problem. Corrosion resistance is comparable to standard austenitic steels like 1.4301 (304).

Chemical and Mechanical Properties per ASTM A240

	Type	C	Mn	P	S	Si	Cr	Ni	N	Mo	Ti	Nb	UTS-ksi	YS - ksi	Elong - %	Hardness-RB
Austenitic	201	.15 Max	5.5-7.5	.060 Max	.030 Max	1.00 Max	16.00-18.00	3.50-5.50	.25 Max	-	-	-	75 Min	38 Min	40 Min	95 Max
	301	.15 Max	2.00 Max	.045 Max	.030 Max	1.00 Max	16.00-18.00	6.00-8.00	.10 Max	-	-	-	75 Min	30 Min	40 Min	95 Max
	304	.07 Max	2.00 Max	.045 Max	.030 Max	.75 Max	17.50-19.50	8.00-10.50	.10 Max	-	-	-	75 Min	30 Min	40 Min	92 Max
	304 DDQ	.07 Max	2.00 Max	.045 Max	.030 Max	.75 Max	17.50-19.50	8.50 Min	.10 Max	-	-	-	75 Min	30 Min	40 Min	92 Max
	304L	.03 Max	2.00 Max	.045 Max	.030 Max	.75 Max	17.50-19.50	8.00-12.00	.10 Max	-	-	-	70 Min	25 Min	40 Min	92 Max
	305	.12 Max	2.00 Max	.045 Max	.030 Max	.75 Max	17.00-19.00	10.50-13.00	-	-	-	-	70 Min	25 Min	40 Min	88 Max
	310	.08 Max	2.00 Max	.045 Max	.030 Max	1.50 Max	24.00-26.00	19.00-22.00	-	-	-	-	75 Min	30 Min	40 Min	95 Max
	316L	.03 Max	2.00 Max	.045 Max	.030 Max	.75 Max	16.00-18.00	10.00-14.00	.10 Max	2.00-3.00	-	-	70 Min	25 Min	40 Min	95 Max
	321	.08 Max	2.00 Max	.045 Max	.030 Max	.75 Max	17.00-19.00	9.00-12.00	.10 Max	-	-	-	75 Min	30 Min	40 Min	95 Max
	347	.08 Max	2.00 Max	.045 Max	.030 Max	.75 Max	17.00-19.00	9.00-13.00	-	-	-	-	75 Min	30 Min	40 Min	92 Max
Ferritic	409	.03 Max	1.00 Max	.040 Max	.020 Max	1.00 Max	10.50-11.70	.50 Max	.03 Max	-	-	-	55 Min	25 Min	20 Min	88 Max
	409 UF	.03 Max	1.00 Max	.040 Max	.020 Max	1.00 Max	10.50-11.70	.50 Max	.03 Max	-	-	-	55 Min	25 Min	20 Min	88 Max
	409 AL	.03 Max	1.00 Max	.040 Max	.020 Max	1.00 Max	10.50-11.70	.50 Max	.03 Max	-	-	-	55 Min	25 Min	20 Min	88 Max
	410	.08-.15	1.00 Max	.040 Max	.030 Max	1.00 Max	11.50-13.50	.75 Max	-	-	-	-	65 Min	30 Min	20 Min	96 Max
	430	.12 Max	1.00 Max	.040 Max	.030 Max	1.00 Max	16.00-18.00	.75 Max	-	-	-	-	65 Min	30 Min	22 Min	89 Max
	436	.12 Max	1.00 Max	.040 Max	.030 Max	1.00 Max	16.00-18.00	-	-	.75-1.25	-	-	65 Min	35 Min	22 Min	89 Max
	439	.03 Max	1.00 Max	.040 Max	.030 Max	1.00 Max	17.00-19.00	.50 Max	.03 Max	-	-	-	60 Min	30 Min	22 Min	89 Msx
	441	.03 Max	1.00 Max	.040 Max	.030 Max	1.00 Max	17.50-19.50	1.00 Max	.03 Max	-	0.10-0.50	.90 Max	65 Min	30 min	26 Min	88 Max

http://www.bssa.org.uk/faq.php?id=10

FERITIC 430:

This type of steel was available in market and we conducted test on it. This solved the problem of sticking. As previously mentioned our main problem was sticking of molten polythene bags with the combustion chamber. This there was no sticking. So the feritic 430 was the best available option for us.

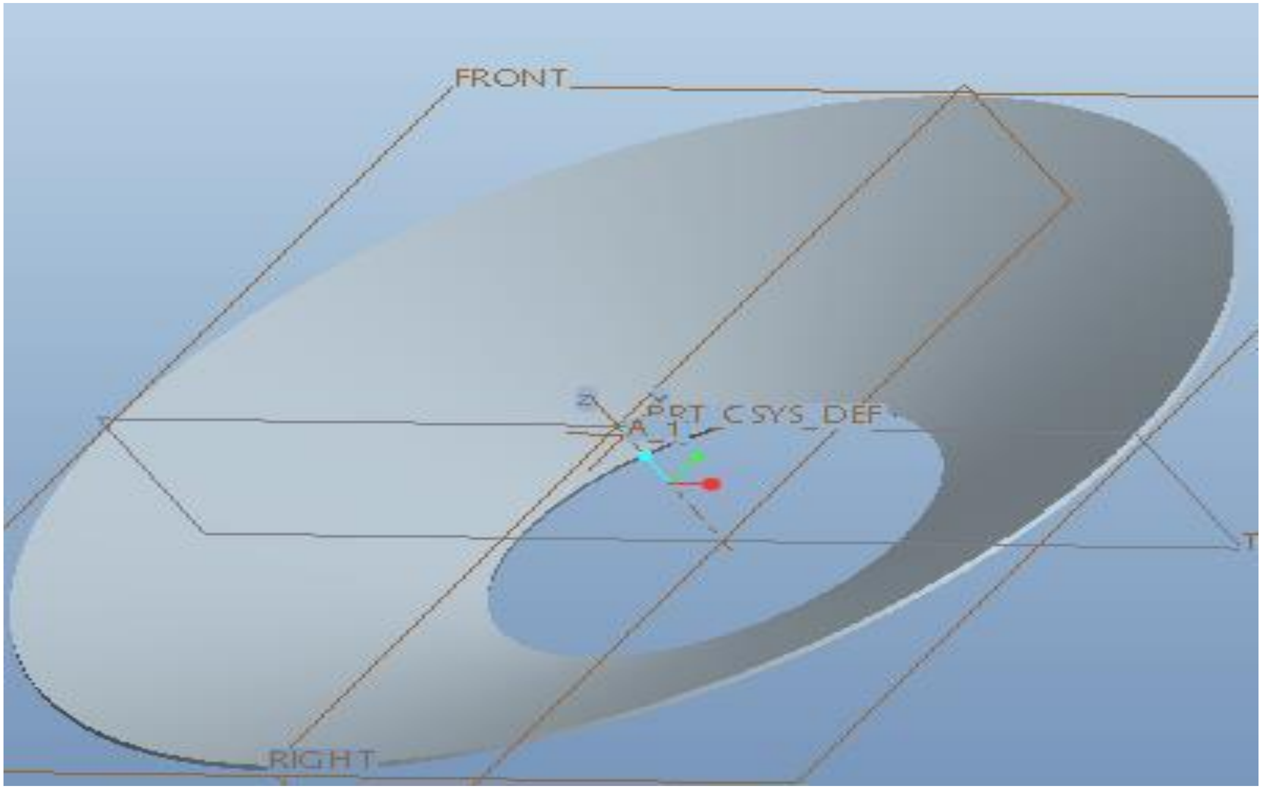
DESIGN:

PARTS:

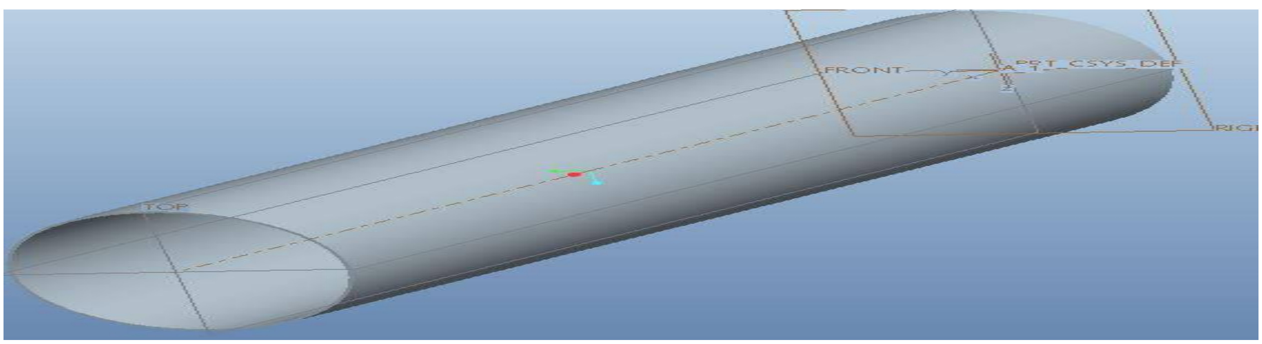
1-CONTAINER:

This is the most important and critical part of apparatus. Its components are as follows.

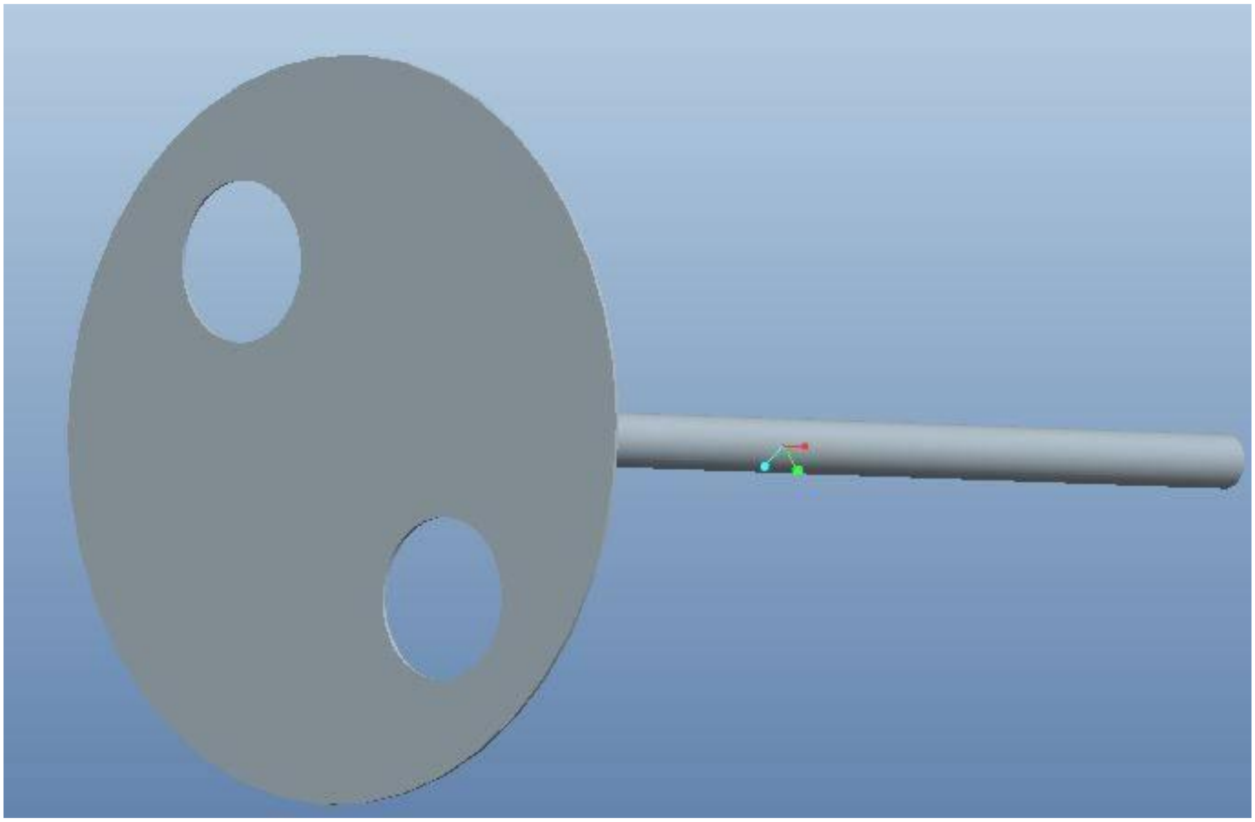
Cone

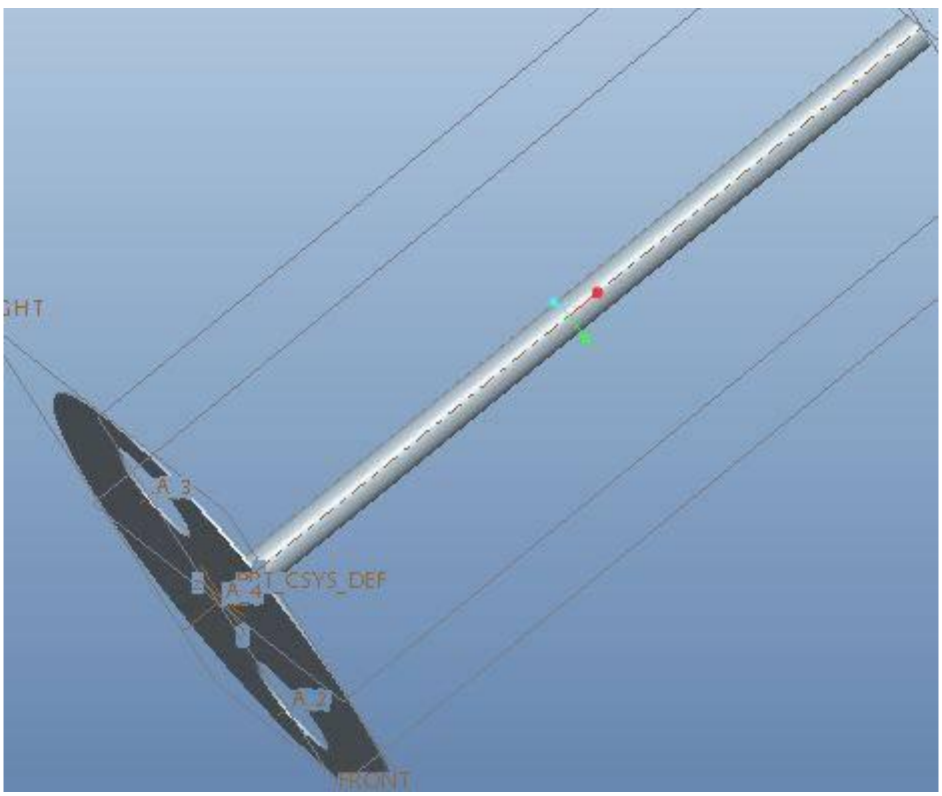


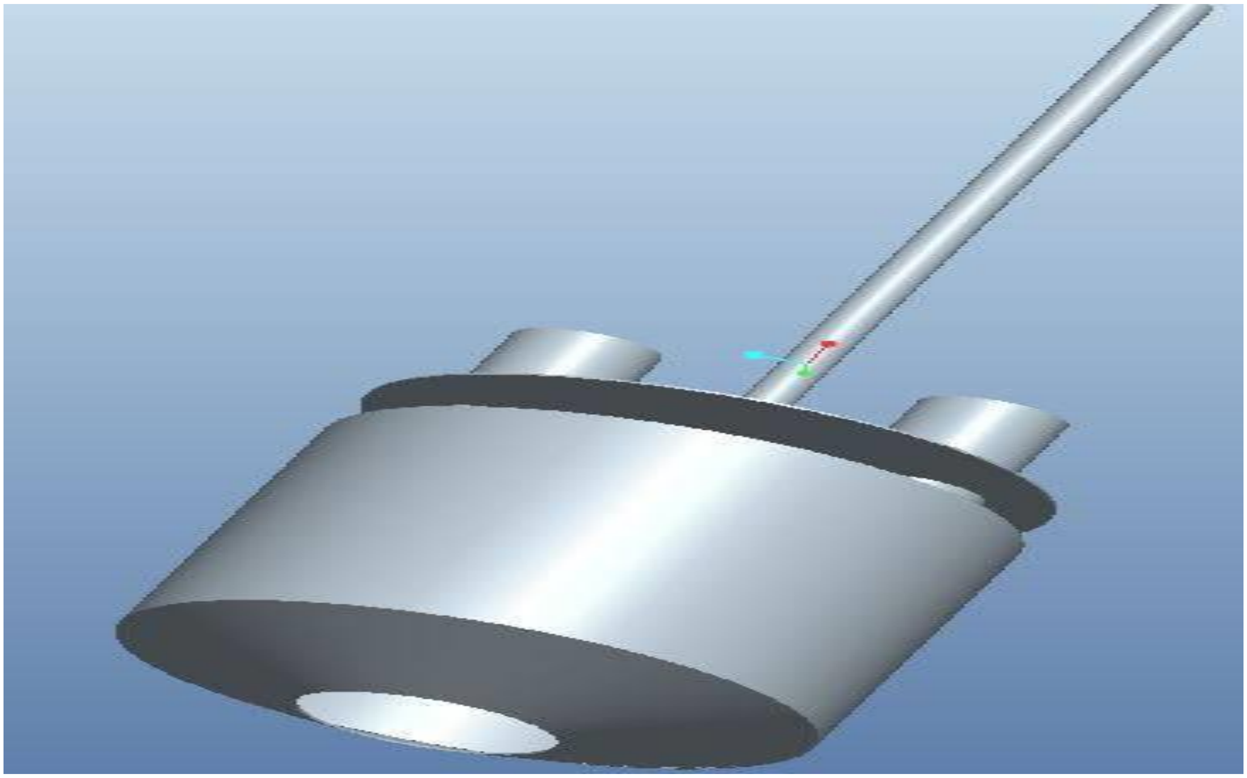
Burner

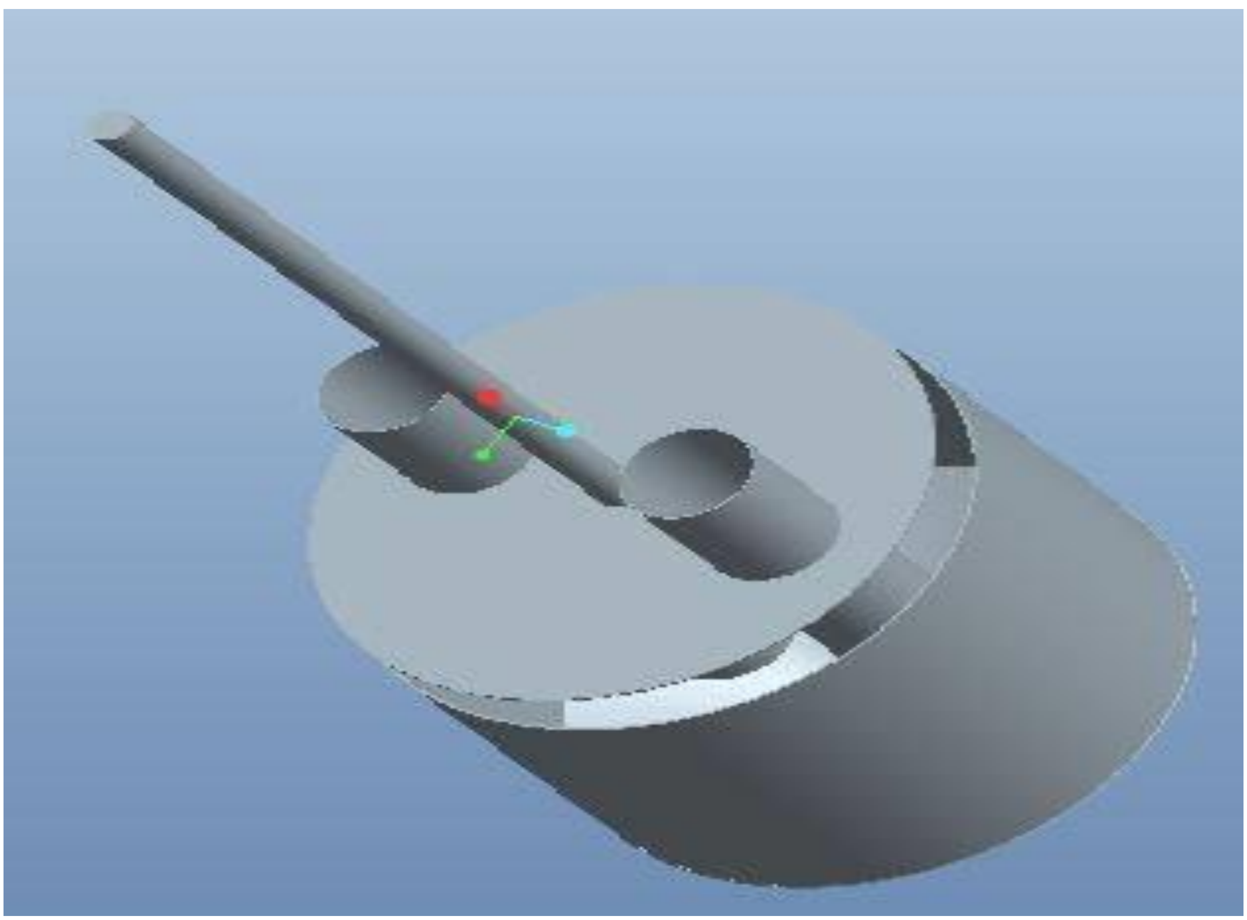


Piston:



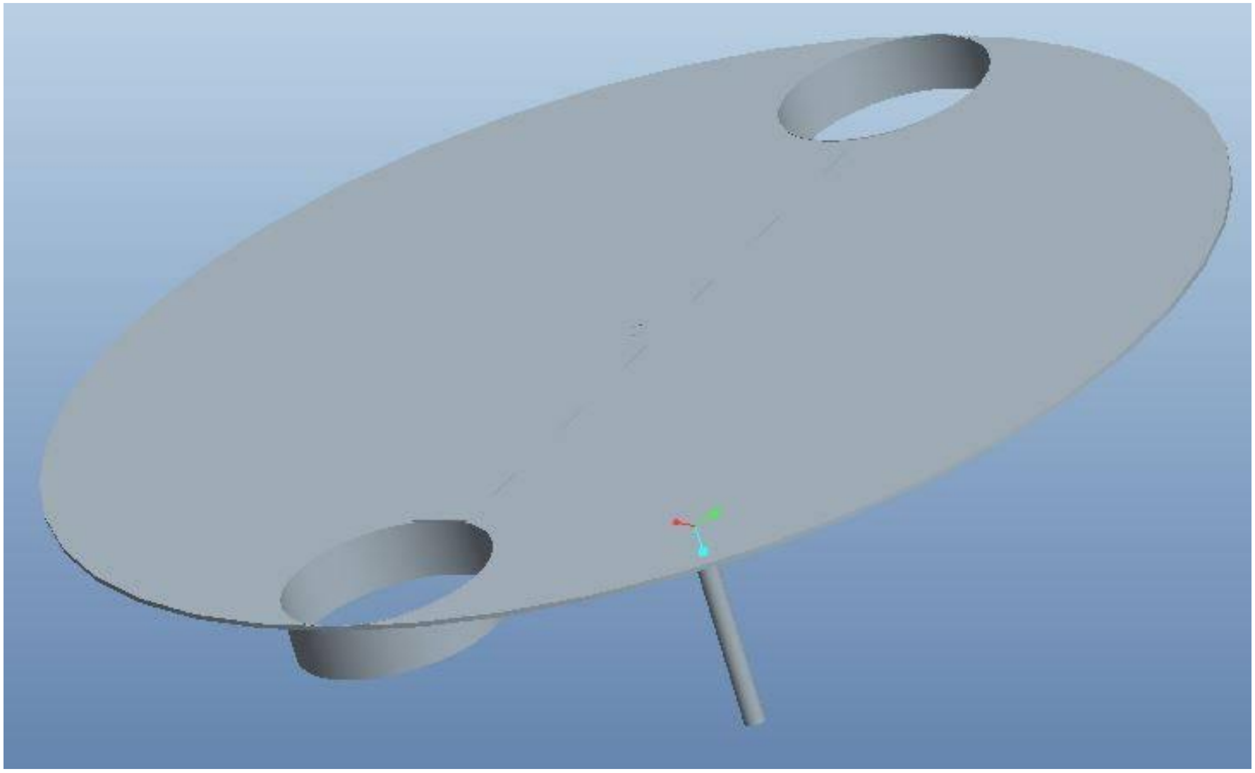

GHT
A_3
PRT_CSYS_DEF
A_4
A_2
FRONT



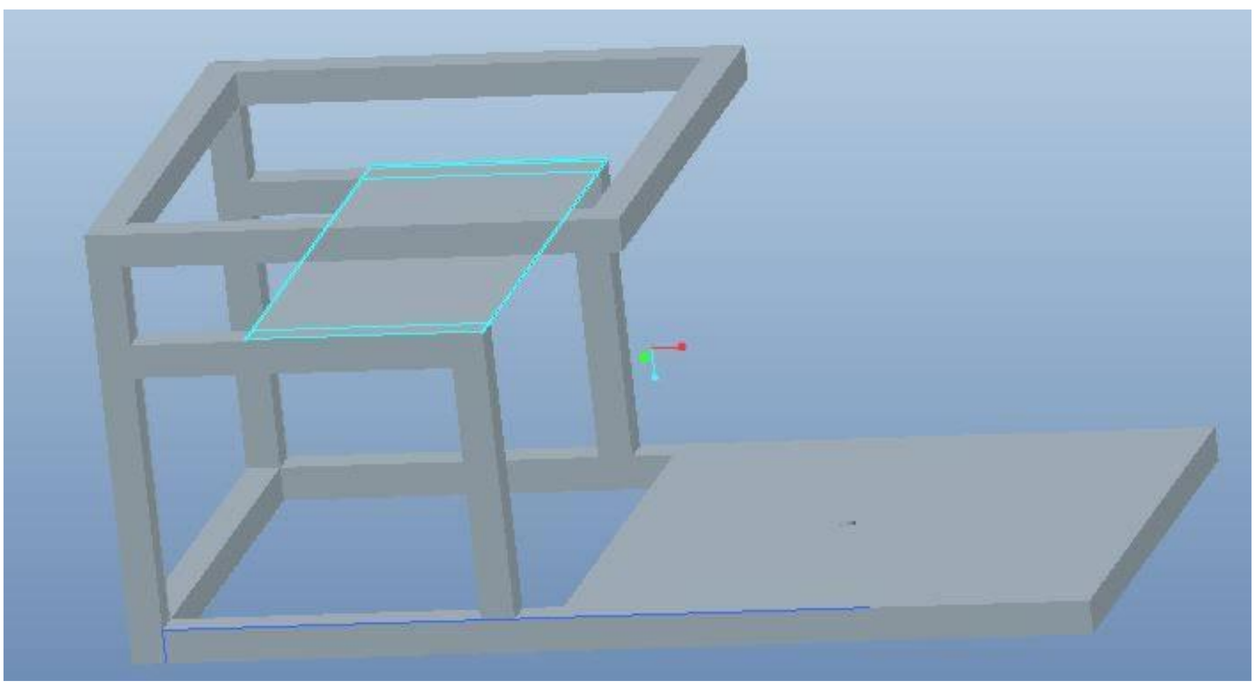


2-DYE:

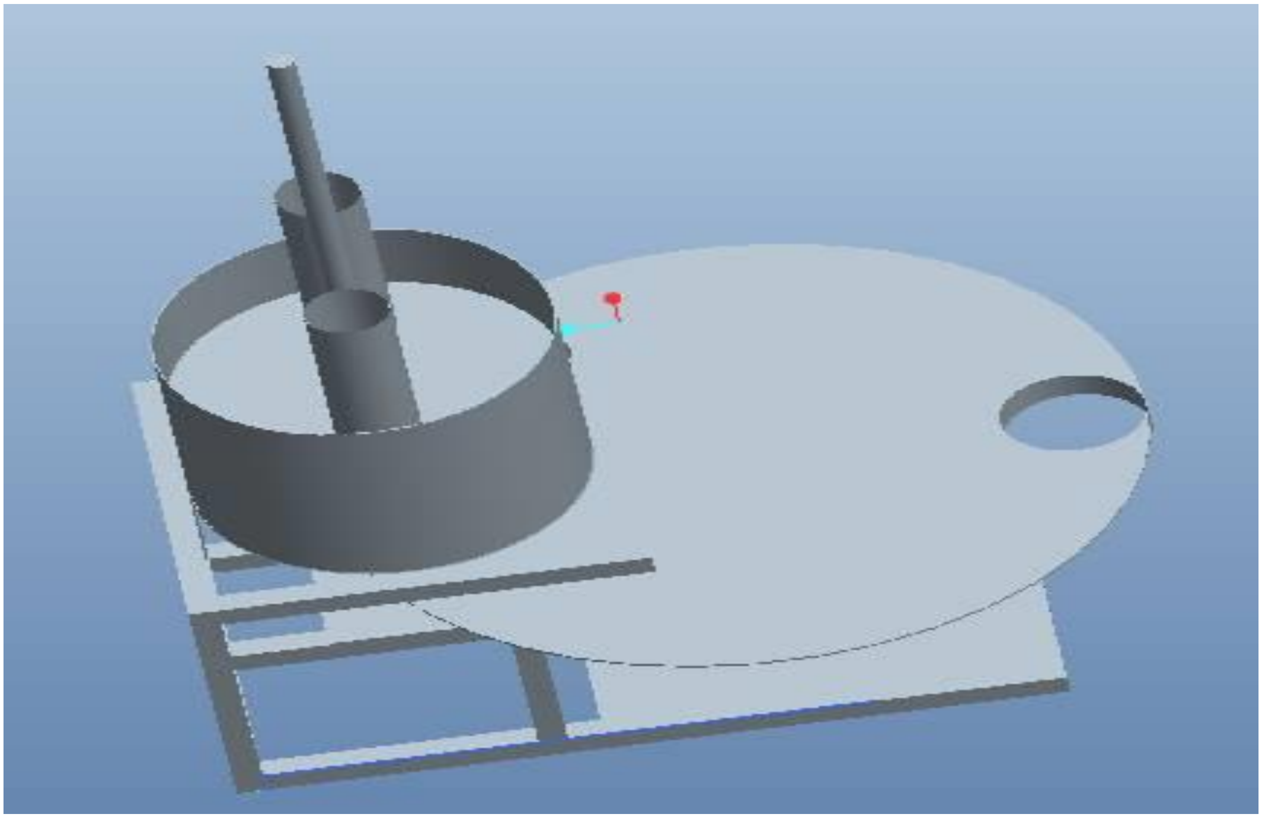
It is made up of stainless steel to avoid sticking. Semi-solid material is poured into the dye mold. This part is designed in such a manner that it is self-stopping. A sheet of mild steel is used to avoid sticking.

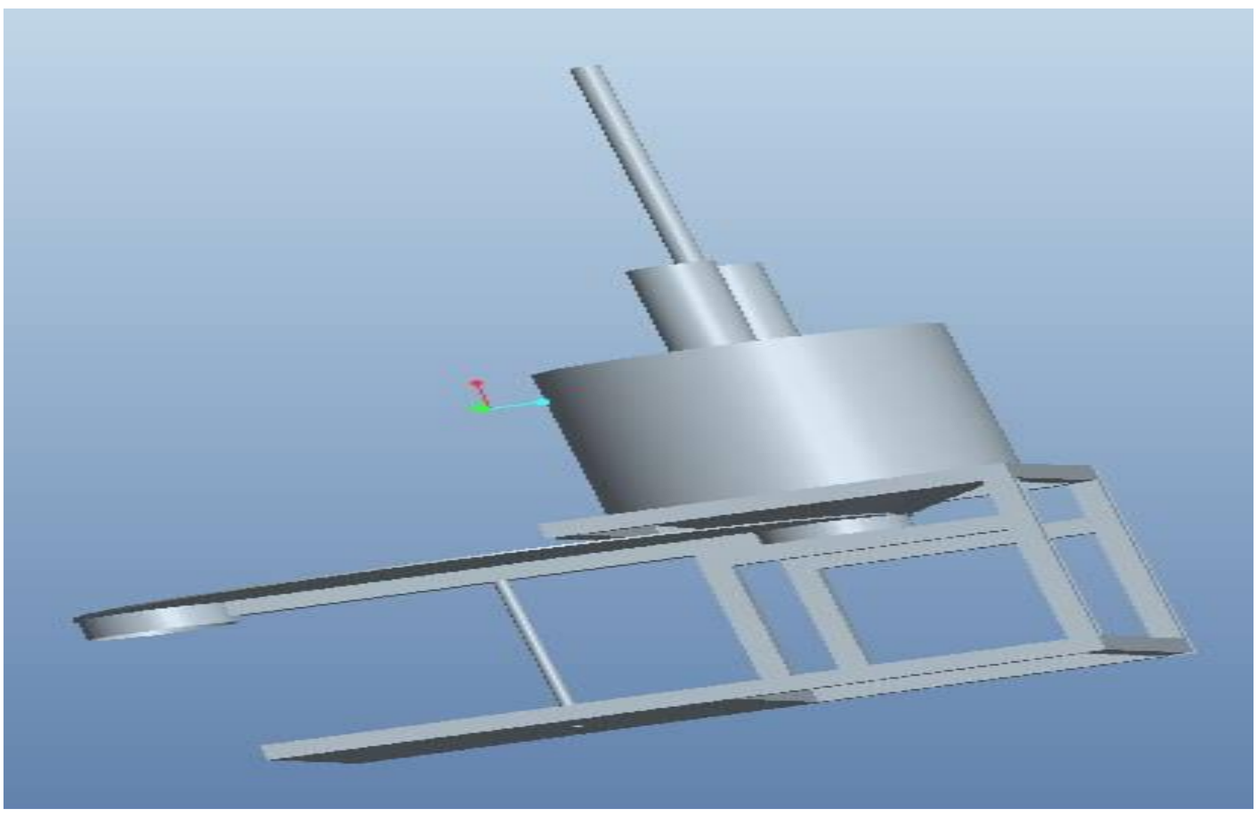


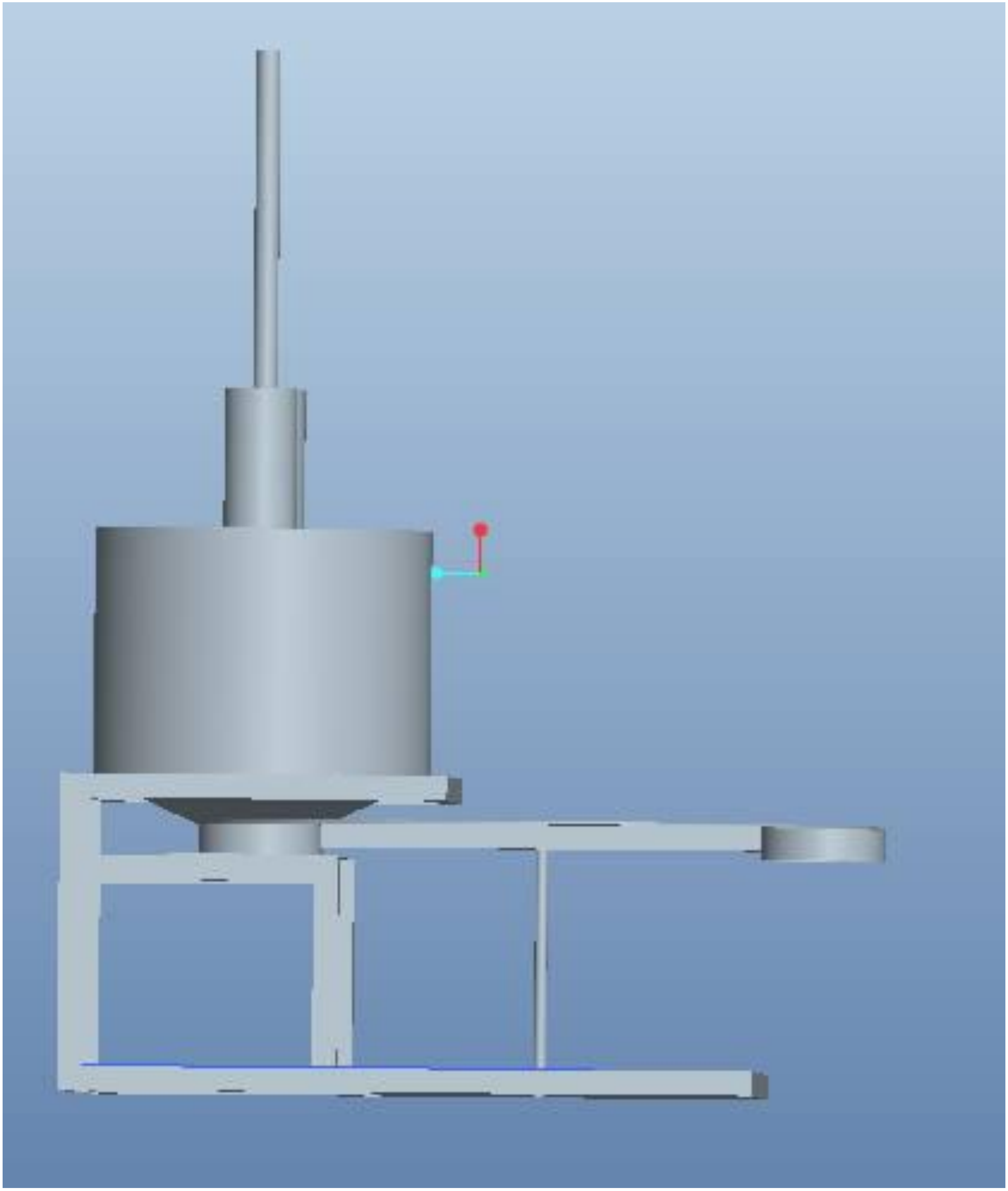
3-STAND:



COMPLETE ASSEMBLY:







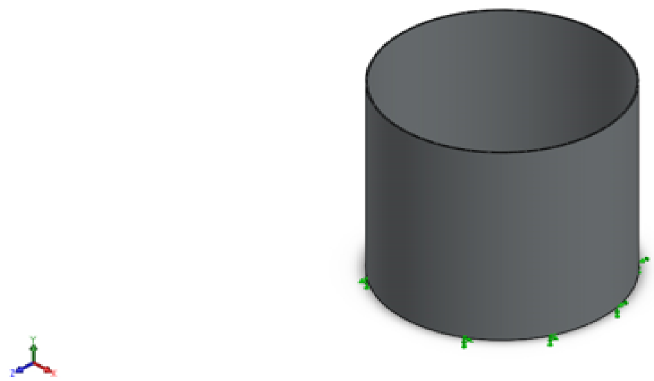
FINITE ELEMENT ANALYSIS:

Following were the analysis performed on polythene bricks manufacturing plant.

1) Static analysis

2) Thermal analysis

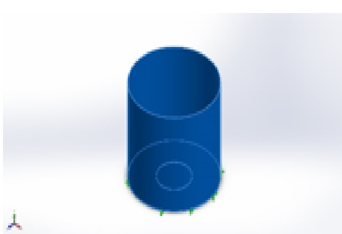
PROPERTIES OF SOLID BODY OR CONTAINER:



Model name: Part1
Current Configuration: Default

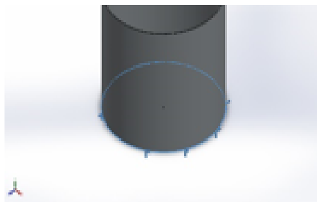
Solid Bodies			
Document Name and Reference	**Treated As**	**Volumetric Properties**	
Cut-Extrude2 	Solid Body	**Mass:6.00568 kg** **Volume:0.000769959 m^3** **Density:7800 kg/m^3** **Weight:58.8557 N**	

MATERIAL PROPERTIES:

Model Reference	Properties	Components
	Name: Chrome Stainless Steel Model type: Linear Elastic Isotropic Default failure criterion: Unknown Yield strength: 1.72339e+008 N/m^2 Tensile strength: 4.13613e+008 N/m^2 Elastic modulus: 2e+011 N/m^2 Poisson's ratio: 0.28 Mass density: 7800 kg/m^3 Shear modulus: 7.7e+010 N/m^2 Thermal expansion coefficient: 1.1e-005 /Kelvin	SolidBody 1(Cut-Extrude2)(Part1)

STATIC ANALYSIS:

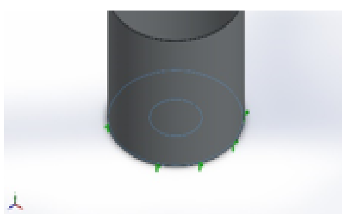
LOAD AND FIXTURES:

Fixture name	Fixture Image	Fixture Details
Fixed-1		Entities: 1 edge(s) Type: Fixed Geometry

Resultant Forces

Components	X	Y	Z	Resultant
Reaction force(N)	0.15893	30.028	0.188255	30.029
Reaction Moment(N.m)	0	0	0	0

LOAD:

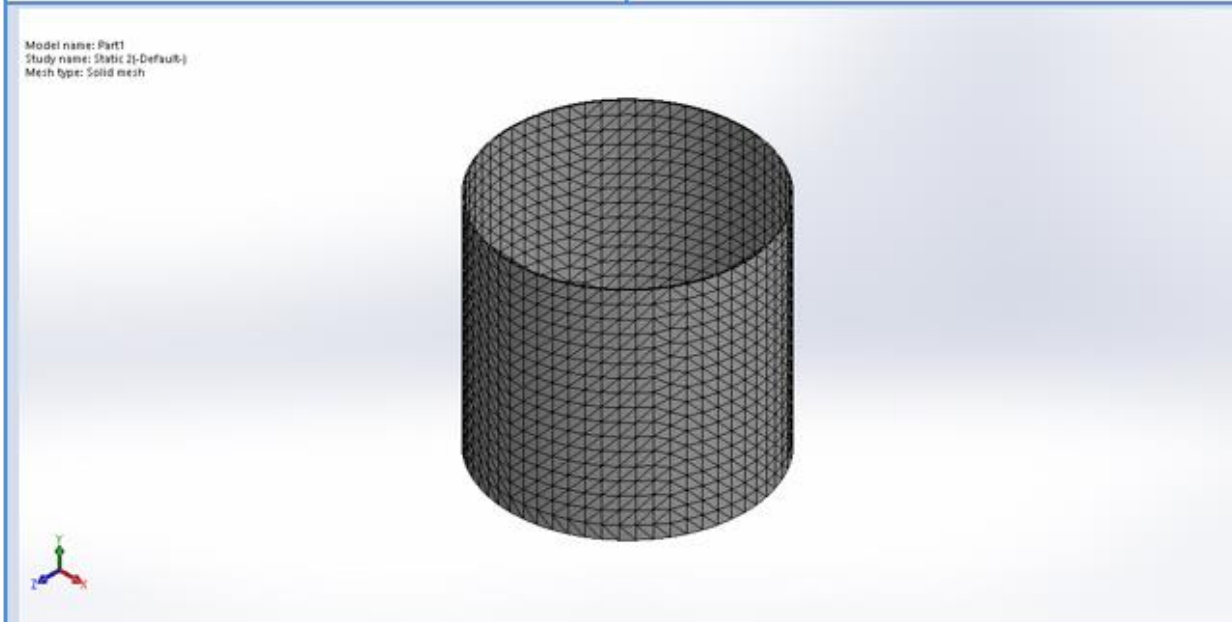
Load name	Load Image	Load Details
Force-1		Entities: 1 face(s) Type: Apply normal force Value: 30 N

MESH INFORMATION:

Mesh type	Solid Mesh
Mesher Used:	Curvature based mesh
Jacobian points	4 Points
Maximum element size	0 in
Minimum element size	0 in
Mesh Quality	High

Mesh Information - Details

Total Nodes	20832
Total Elements	11582
Maximum Aspect Ratio	57.645
% of elements with Aspect Ratio < 3	0
% of elements with Aspect Ratio > 10	57.3
% of distorted elements(Jacobian)	0
Time to complete mesh(hh;mm;ss):	00:00:05
Computer name:	ADNAN



RESULTANT FORCES:

Reaction Forces

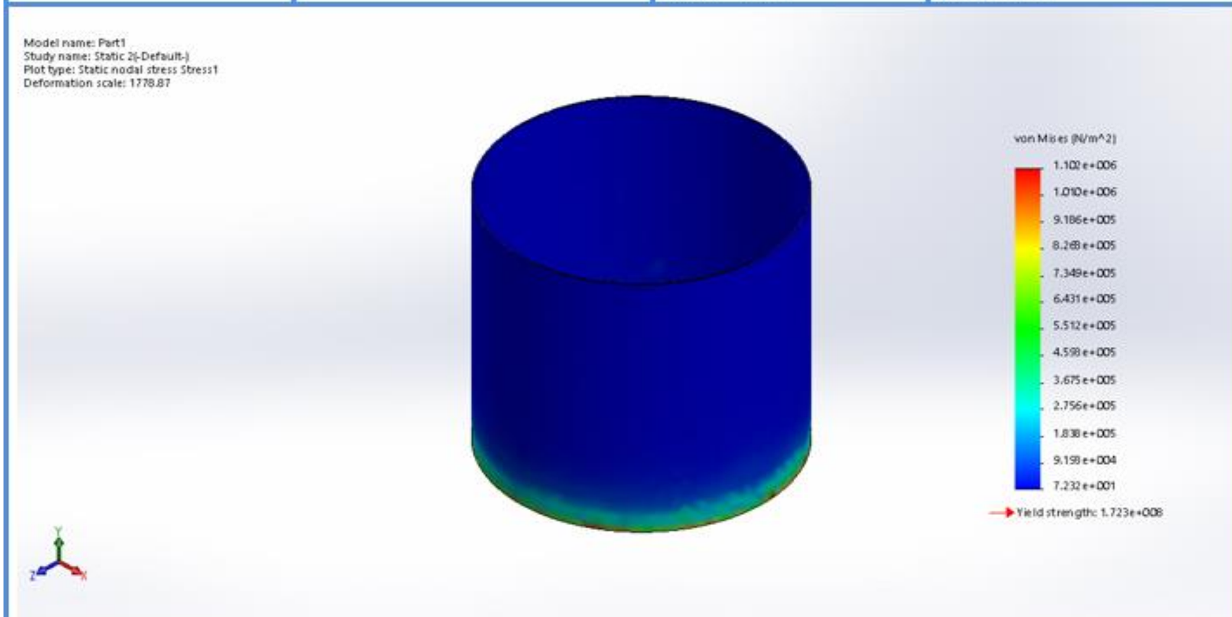
Selection set	Units	Sum X	Sum Y	Sum Z	Resultant
Entire Model	N	0.15893	30.028	0.188255	30.029

Reaction Moments

Selection set	Units	Sum X	Sum Y	Sum Z	Resultant
Entire Model	N.m	0	0	0	0

VON MISES STRESS:

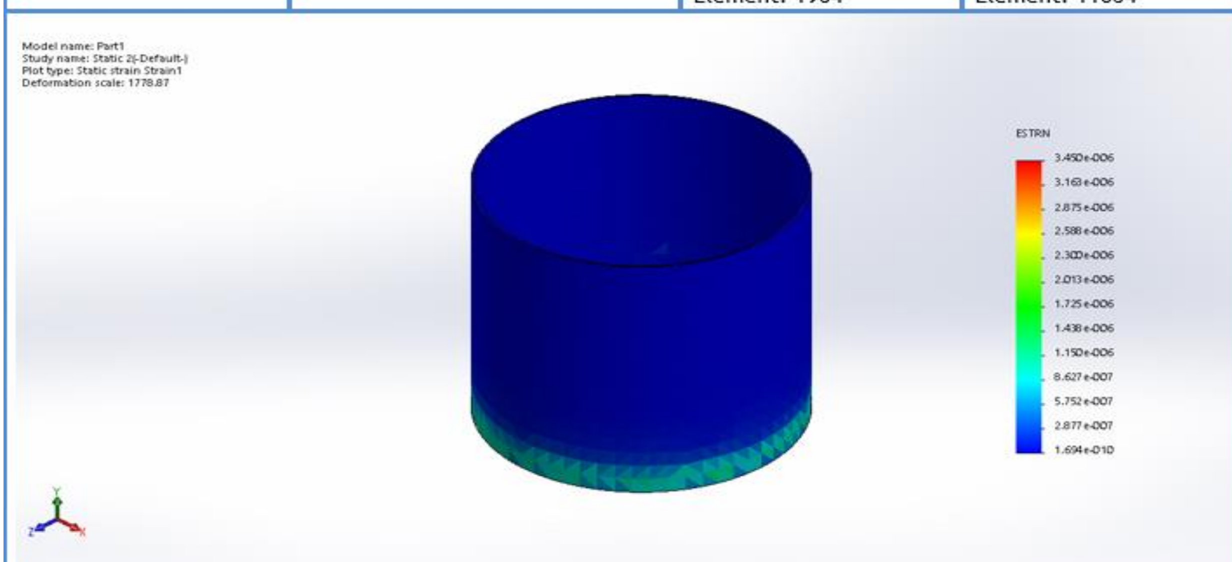
Name	Type	Min	Max
Stress1	VON: von Mises Stress	72.3216 N/m^2 Node: 18044	1.10232e+006 N/m^2 Node: 1569



Part1-Static 2-Stress-Stress1

STRAIN:

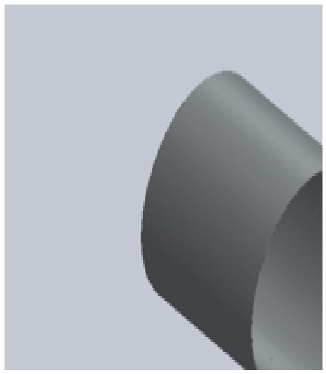
Name	Type	Min	Max
Strain1	ESTRN: Equivalent Strain	1.6943e-010 Element: 1964	3.45048e-006 Element: 11034



Part1-Static 2-Strain-Strain1

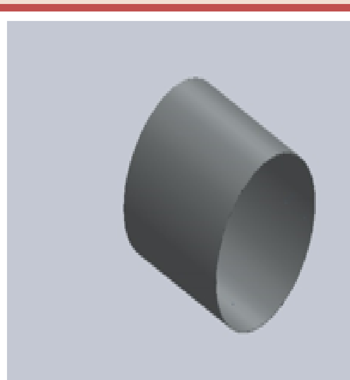
THERMAL ANALYSIS:

LOAD AND FIXTURES:

Fixture name	Fixture Image	Fixture Details
Fixed-1		Entities: 1 face(s) Type: Fixed Geometry

Resultant Forces

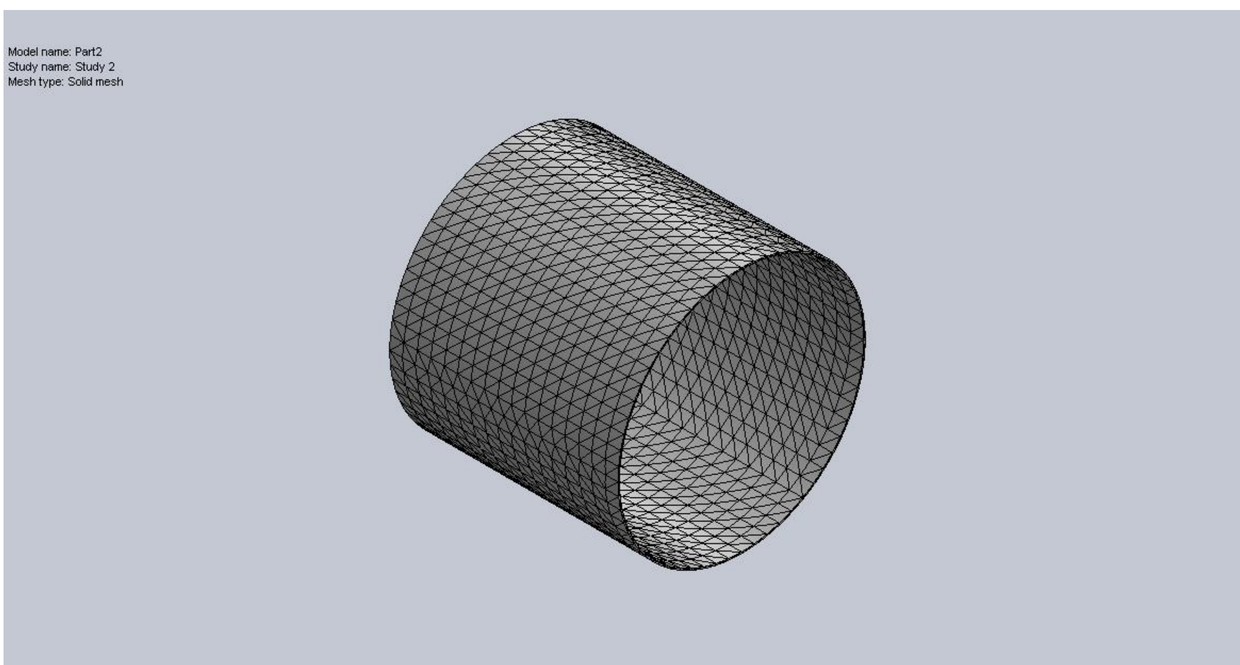
Components	X	Y	Z	Resultant
Reaction force(N)	0.0547485	-0.057373	-0.327881	0.337335
Reaction Moment(N·m)	0	0	0	0

Load name	Load Image	Load Details
Temperature-1		Entities: 2 face(s) Temperature: 220 Celsius

MESH INFORMATION:

Mesh type	Solid Mesh
Mesher Used:	Standard mesh
Automatic Transition:	Off
Include Mesh Auto Loops:	Off
Jacobian points	4 Points
Element Size	0.703286 in
Tolerance	0.0351643 in
Mesh Quality	High

Mesh type	Solid Mesh
Mesher Used:	Standard mesh
Automatic Transition:	Off
Include Mesh Auto Loops:	Off
Jacobian points	4 Points
Element Size	0.703286 in
Tolerance	0.0351643 in
Mesh Quality	High



RESULTANT FORCES:

Reaction Forces

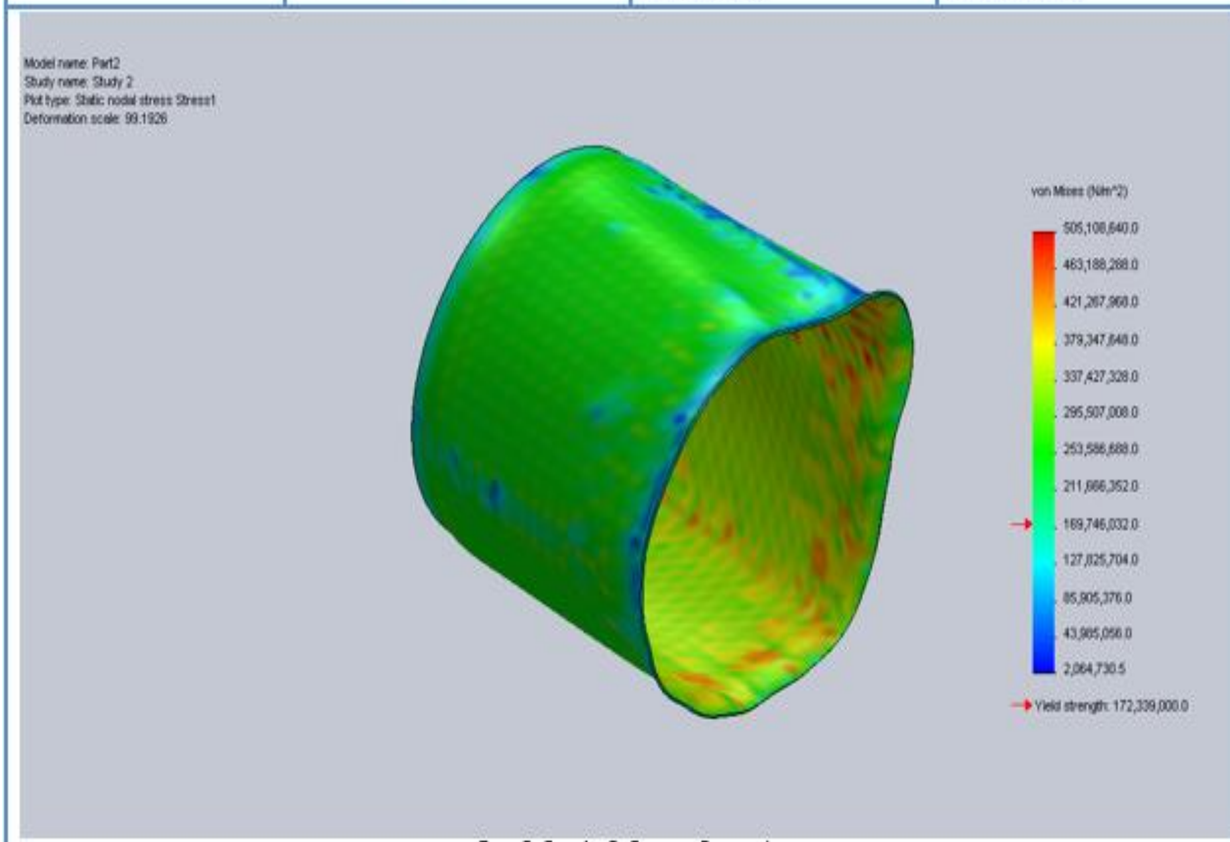
Selection set	Units	Sum X	Sum Y	Sum Z	Resultant
Entire Model	N	0.0547485	-0.057373	-0.327881	0.337335

Reaction Moments

Selection set	Units	Sum X	Sum Y	Sum Z	Resultant
Entire Model	N·m	0	0	0	0

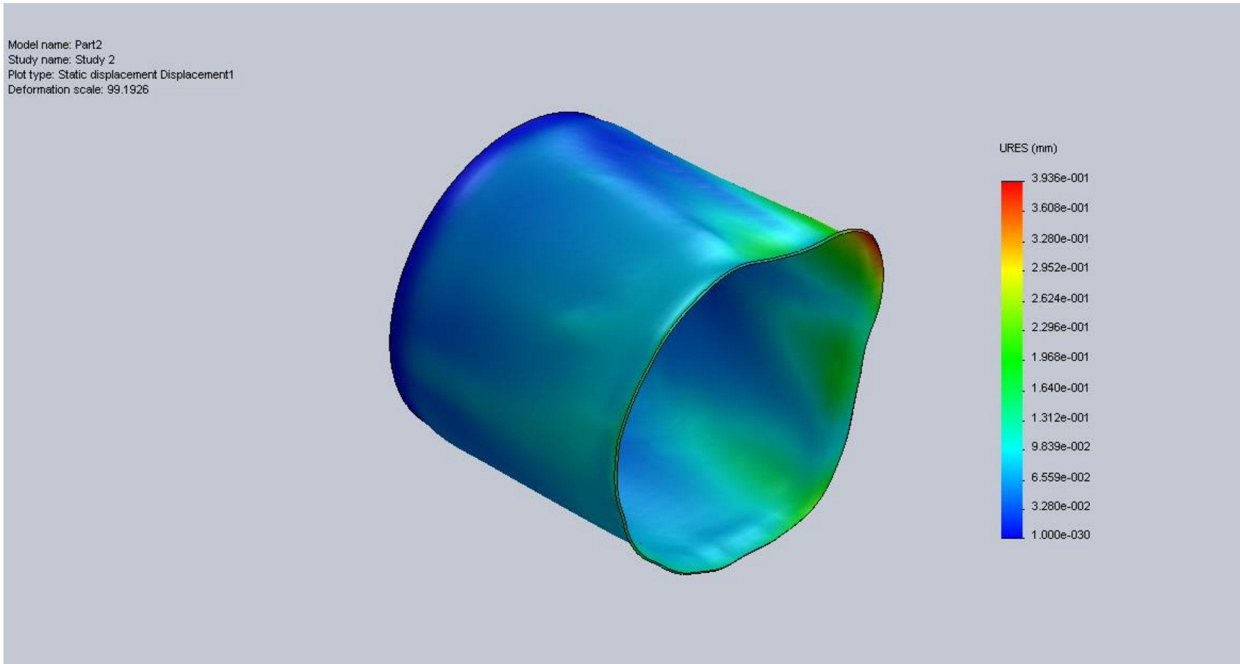
STRESS:

Name	Type	Min	Max
Stress1	VON: von Mises Stress	2.06473e+006 N/m^2 Node: 6148	5.05109e+008 N/m^2 Node: 13995



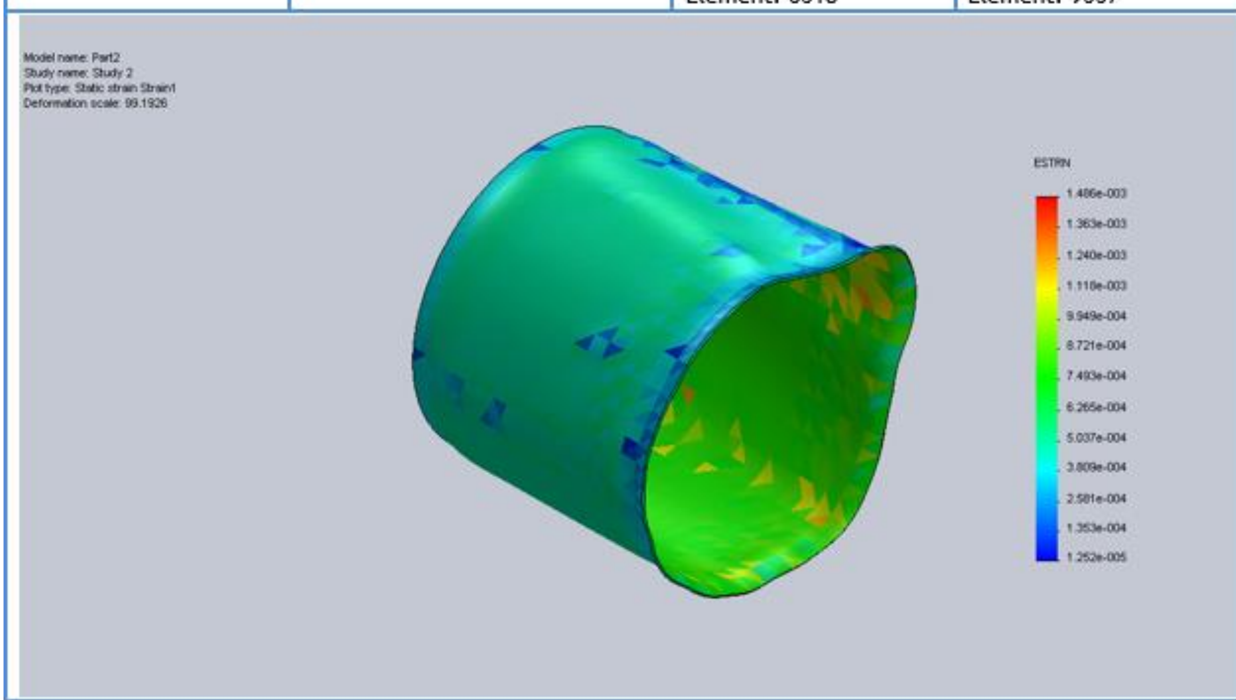
Part2-Study 2-Stress-Stress1

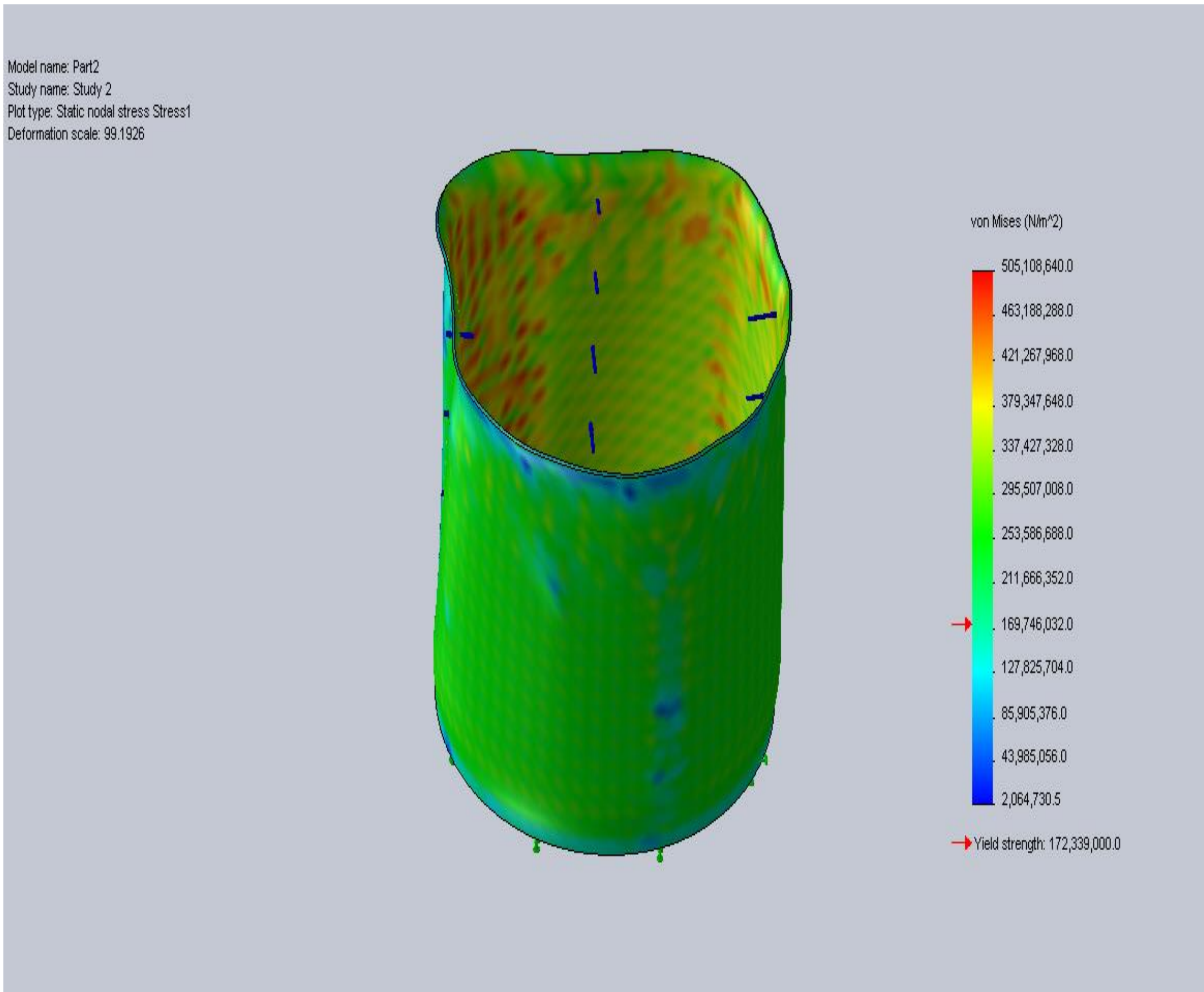
Name	Type	Min	Max
Displacement1	URES: Resultant Displacement	0 mm Node: 767	0.39357 mm Node: 15563



STRAIN:

Name	Type	Min	Max
Strain1	ESTRN: Equivalent Strain	1.25162e-005 Element: 6318	0.00148602 Element: 9557




Model name: Part2
Study name: Study 2
Plot type: Static nodal stress Stress1
Deformation scale: 99.1926
von Mises (N/m^2)
505,108,640.0
463,188,288.0
421,267,968.0
379,347,648.0
337,427,328.0
295,507,008.0
253,586,688.0
211,666,352.0
169,746,032.0
127,825,704.0
85,905,376.0
43,985,056.0
2,064,730.5
Yield strength: 172,339,000.0

CALCULATIONS:

NUMBER OF BRICKS:

Volume of container=$\pi r^2 h = 23825.8cm^3$
Volume of pipes=$1181017cm^3$
Volume of frustum=$\frac{\pi h(R^2+r^2+Rr)}{3} = 1189.4cm^3$
Total volume of container=$22652.9cm^3$
Volume of brick=$443.54cm^3$
As 80% reduction in volume of polythene bags occurs after burning so container tightly filled with polythene bags can produce 10.2 bricks.

WEIGHT OF BRICK:

THEORETICAL WEIGHT:

$\rho = 0.940gcm^{-3}\ at\ 200℃$
m=ρV=0.940$\times$ $443.54grams = 416.9grams$

ACTUAL WEIGHT:

m=342$grams$

ENERGY PER BRICK:

THEORETICAL:

LHV=$43MJkg^{-1}$
Energy per brick=$43 \times 0.415MJ = 17.8MJ$

ACTUAL:

Energy per brick=$43 \times 0.342MJ = 14.7MJ$

COMPARISON WITH DIESEL AND PETROL IN TERMS OF ENERGY AND NUMBER OF BRICKS:

Diesel LHV=43.400$MJkg^{-1}$
Diesel LHV=44.00$MJkg^{-1}$
Diesel LHV per liter=35.8$MJ/liter$
Petrol LHV per liter=32.4$MJ/liter$
One liter petrol=1.82 bricks
One liter diesel=2 bricks

MELTING TIME REQUIRED FOR FULLY FILLED CONTAINER:

Melting time for fully filled container=54 minutes

HEAT INPUT:

$T_{melting} = 220℃$
$Q = mC_P\Delta T = 4150 \times 2.56 \times 195 = 2.071MJ$
So for one brick $Q_{One\ brick} = 0.207MJ$

EFFICIENCY OF BURNER:

Burner at full valve open uses LPG= $0.86 liter/hour$ at 0.39psi
Density of LPG= $495 kg/m^3$
Mass flowrate at full valve open= $0.424 kg/hour$
Mass flowrate of valve position used= $0.105 kg/hour$
LHV of LPG= $50 MJ/kg$
Energy flow at stove= $50 \times 0.105 kJ/hour = 5.25 kJ/hour$
As time for 10 bricks material= $54 minutes$
Energy input for 10 bricks= $4.72 MJ$
Efficiency of burner= $\frac{2.07}{4.72} = 0.43 \text{ or } 43\%$

LPG Conversion Value Table

KG	Litres (Liquid)	Mega Joules (MJ)	Kilowatt Hours (kWh)	Gas Volume (M^3)	Diameter* (mm)	Height* (mm)	Tare Weight* (KG)
0.51	1	25	6.9	0.27	na	na	na
1	1.96	49	13.6	0.54	na	na	na
3.7	7.25	181	50	2.0	265	340	5.5
8.5	16.6	417	116	4.6	310	460	9
15**	29	735	204	8	305	734	10
18	35	882	245	10	310	826	18
45	88	2205	612	24	375	1250	33
90	176	4410	1225	48	510	1380	65
210	411	10290	2858	113	760	1450	140

*Dimensions and tare weights can vary by cylinder manufacturer
**Data for aluminium forklift cylinder
NOTE: Some numbers have been rounded

COMPARISON WITH LPG IN TERMS OF ENERGY AND NUMBER OF BRICKS:

LHV of LPG= $43MJ/kg$
1kg of LPG= $2.4\ bricks$
LHV of natural gas= $48.6MJ/kg$
1kg of natural gas = $2.73\ bricks$

PROBLEMS FACED:

Following were the problems faced while designing and fabricating.

- The upper part of apparatus was difficult to make.
- Uniformity of cylinder was critical to maintain as the piston was needed to move smoothly throughout to move the molten material down. This took a lot of time. We had to conduct a thorough survey for required and suitable equipment.
- Stainless sheet used for cylinder was quite difficult to round and maintain uniformity as its thickness and strength was quite problem. This problem was solved carefully rolling the sheet using roller.
- The problem with using stainless steel was that we were required to use special tools at some stages. More robust tools were required because of strength of steel.
- Stopping material in combustion was another design problem. Stopper was required which was quite difficult to put into the structure. This problem was solved by changing the structure of lower part. This lower part design changing made the structure self-stopping.
- One of the main concerns was exhaust identification. Main problem was the availability of proper apparatus. So we have to with available apparatus and also studied exhaust related research papers.

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- Comparative evaluation of RDF and MSW incineration Ying-Hsi Chang, W.C. Chen, Ni-Bin Chang doi:10.1016/S0304-3894(97)00118-0
- Fuel gases from pyrolysis of waste Polyethylene sachets ADEMILUYI, T; 2ADEBAYO, T A Department of Chemical/ petrochemical Engineering, Rivers State University of Science and Technology, Port Harcourt. 2Department of Petroleum Engineering, Rivers State University of Science and Technology, Port Harcourt.
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