DESIGN, ANALYSIS AND MANUFACTURING OF GARBAGE DEWATERSER

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ABSTRACT

This paper gives the idea about the Hydraulic squeezer designed to compress the wet biomass of organic MSW (municipal solid wastage). The operation is simple,using shop supplied compressed. Hydraulic pressure is supplied to perforated a plate via a flexible hydraulic hose due to which getting the dye biomass of organic MSW. Compare to traditional all squeezers, hydraulic squeezer are compact and light weight reducing operator fatigue and allowing better access to confined structural areas. The squeezer may be held symmetrically by the operator which improves operation. The units are manufactured from high dry materials. The total quantity of green waste (vegetables, fruits, etc) produced at the market places is nearly in some tones per day. And also same or more amount of waste is produced from the kitchens of hotels and homes of metro-Politian cities like Pune , Mumbai, Bangalore , Delhi, etc. Disposal of such large amount of waste is an great issue before the government. This waste is being disposed in an open land spaces. This leads to land wastage ,nuisance to people living in the surrounding and creating the hygiene problems.

Key words: hydraulic squeezer, dewateriser, analysis,

1.INTRODUCTION

The project gives us the idea of removing water from the green waste. This can be achieved by piston and cylinder arrangement.In the present state in some places biogas is produced from the waste in small area. But still large amount of the waste disposed openly.

The garbage to disposed filled in the cylinder through the opening. Pressure is applied on the garbage by using hydraulic system. There is need to apply high pressure , near about 150-200 bar This will result into removal of water from waste . The water have nutritious contents in it and it will be used as fertilizer in small scale such as nurseries or green houses. It may also be used in agriculture. The remaining waste which waste will be in the form of cake can be dried. the pallets formed will be used as a fuel in the boiler. Thus there will be 'COMPLETE DISPOSAL' of garbage.

2.DESIGN OF EXPERIEMENTATION

2.1 Proposed work:-

1] Concept
2] Drawing of model

3] Material selection of piston and cylinder
4] Mechanical design of piston and cylinder
5] Manufacturing
6] Assembly
7] Testing

2.2 WORKING

Position the squeezer is suitable orientation for operation. Attach the perforated plate to the flexible hydraulic hose and the hose to the intensifier. Ensure the hose end fittings are fluid tight. When it is desired to forward the perforated plate, press the electric control switch to actuate the unit , allowing the cylinder to stroke to full displacement until the fully formed. The release the electric control switch to remove the dry biomass piston to retract.

Technical specification of wet Biomass Squeezer for Organic MSW

1 capacity   : 60liter
2 Initial moisture : 80(%W/W)
3 Final moisture   : 25-30(%W/W)
4 Power suitable   : 1Hp

3 EXPERIMENTAL SETUP

Fig.1 Squeezer machine

4 DESIGN OF PISTON AND CYLINDER

STEP 1:- GIVEN DATA
V=60 lit.
P=200bar
Consider, L/D =1.2

STEP 2:-CALCULATION FOR LENGTH AND DIAMETER OF CYLINDER.
V= $(\Pi/4) \times L \times D^2$
$60 \times 10^{-3} = (\Pi/4) \times D^2 \times (1.2D)$
$60 \times 10^{-3} \times 4/ (1.2 \times \Pi) = D^3$
D=0.4m
D=400mm
So, L= 1.2D
L=1.2×400
L=480mm

STEP 3:-CALCULATION FOR THICKNESS OF CYLINDER.

$$t=(P_i \times D_i/2\sigma_{all})+C1$$

where, $\sigma_{all} = allowable\ tensile\ stress,$
C1 =Reboring factor

$$\sigma_{all} = \frac{S_{ut}}{N_f}$$

$$\frac{750}{3} = 250N/mm^2$$

$$t=(P_i \times D_i/ 2\sigma_{all})+C1$$

$$t=\frac{20 \times 400}{2 \times 250} + 4$$

t=20mm

But safe design take standard value of thickness.

t=25mm

STEP 4:- CALCULATION FOR CYLINDER FLANGE THICKNESS.

$$t_f = 1.2t\ to\ 1.4t$$
$$t_f = 1.2 \times 25\ to\ 1.4 \times 25$$
$$t_f = 30\ to\ 35$$
$$t_f = 32mm$$

STEP 5:- CALCULATION FOR CYLINDER THICKNESS HEAD.

$$t_{ph} = K1D \sqrt{\frac{P_{max}}{\sigma_{all}}}$$

Where, K1=cylinder head thickness constant=0.35

$$t_{ph} = 0.35 \times 400 \sqrt{\frac{20}{250}}$$

$$t_{ph} = 40mm$$

STEP 6:- CALCULATION FOR BOLT.
1] DIAMETER OF BOLT:
a)Force acting on bolt:

$$P_i = \frac{F}{A}$$
$$F = \frac{\Pi}{4} \times d_i^2 \times P_i$$
$$F = \frac{\Pi}{4} \times 400^2 \times 20$$
$$F = 2.513 \times 10^6$$

b) Calculation for core area of bolt.
$$F = n \times A_c \times \sigma_t$$
Where, n= no. Of bolts
$$A_c = core\ area\ of\ bolt$$
$$\sigma_t = allowable\ tensile\ stress$$
$$F = n \times A_c \times \sigma_t$$
$$2.513 \times 10^6 = 4 \times A_c \times 1167$$
$$A_c = \frac{\Pi}{4} \times d_c^2$$
$$Ac = 538.40 mm^2$$

c) Core diameter of bolt-

$$A_c = \frac{\Pi}{4} d_c^2$$
$$538.04 = 3.14 \times d_c^2$$
$$d_c = 26.18mm$$

2] NOMINAL DIAMETER OF BOLT:-

$$d_b = \frac{d_c}{0.87}$$
$$d_b = \frac{26.18}{0.84} = 30mm$$

Standard size, taking M30 bolt.

3] DIAMETER OF BOLT PITCH CIRCLE (D_p) and flange.
a) Diameter of stud pitch circle is-
$$D_p = D + 3d_b$$
$$D_p = 400 + (3 \times 30)$$
$$D_p = 490mm$$

b) The outside diameter of flange is-
$$D_o = D_p + 2d_b + 12$$
$$D_o = 490 + (2 \times 30) + 12$$
$$D_o = 562mm$$

STEP 7:- STRESS IN CYLINDER LINER-
1] CIRCUMFERENTIAL STRESS.

$$\sigma_C = \frac{P_{max} \times D}{2t}$$
$$\sigma_C = \frac{20 \times 400}{2 \times 25}$$
$$\sigma_C = 160 \text{N/mm}^2$$

2] LONGITUDINAL STRESS.

$$\sigma_t = \frac{P_{max} \times D}{4t}$$
$$\sigma_t = \frac{20 \times 400}{4 \times 25}$$
$$\sigma_t = 80 \text{N/mm}^2$$

3] RADIAL STRESS.

$$\sigma_r = -P_{max}$$
$$\sigma_r = -20 \text{ N/mm}^2$$

4] RESULTANT STRESS.

$$\sigma_R = (\sigma_c - v(\sigma_r + \sigma_l))$$
$$\sigma_R = (160 - (0.25980 - 20))$$
$$\sigma_R = 145 \text{ N/mm}^2$$

5 FEA ANALYSIS OF SHELL AND NOZZLE

The cylinder consists of Cylinder, piston and nozzle etc. Here we have carried out the analysis of cylinder with nozzle.
F.E.A. Analysis is necessitated to check the stress at the junction of cylinder and pressure and deflection of cylinder due to high pressure and the nozzle size is large.
The analysis objectives, assumptions and the limitations are explained below.
To calculate stresses in the following parts and compare them with the allowable stresses for the design loads.
Shell is fixed on its both of the sides.

Methodology and F.E. Idealization:

The Finite Element model included cylinder, nozzle etc.

System of Units:
The following system of units is followed for consistence throughout this analysis and results evaluation

Table 1: System of Units

S. No.	Parameter	Units	Conversion Factor used in Analysis
1.	Length	Millimetres	1.0
2.	Force	Newton	1.0
3.	Moment	N-mm	1.0
4.	Mass	Kg	1.0
5.	Pressure, Modulus of Elasticity, Stress	N / mm^2	1.0
6.	Acceleration due to gravity	M / Sec^2	1.0

ANSYS Elements Used

The complete assembly is model using ANSYS Element Types as follows:

Table 2: Element types used

Element Type No	Element	ANSYS Element	Parts Modelled
1	3-D Elastic Shell	8 node Shell 93	Cylinder and Nozzle
2	Rigid Constraint	MPC-184	Rigid Element

Material Properties

The Material Properties used for all parts are as follows.

For Design Case:-

Material: Austenitic Stainless Steel. Isotropic

Young's Modulus = 2000000 N/mm^2.

Poisson's Ratio = 0.29

Density: 8000 Kg/m^3.

Pressure: 16N/mm^2.

For Hydrostatic Test Condition Case:-

Material: Austenitic Stainless Steel. Isotropic

Young's Modulus = 2000000 N/mm^2.

Poisson's Ratio = 0.29

Density: 8000 Kg/m^3.

Pressure: 20.8N/mm^2.

Loading (Design Condition):

The Model has been analyzed for combinations one or more of the following loads

1. Internal Design pressure = 16 N/mm^2

2. External Design Pressure =(F.V.) 0.1013 N/mm^2

3. Hydrostatic Pressure = 2.54 N / mm^2

Boundary Conditions:

The boundary conditions applied on the model are as shown in the enclosed Fig.2
The model is fixed in all three directions at one end (Fx=0, Fz=0, Fy =0), and free to move horizontally at other end (Fx=0, Fz=0, Fy free to move).

FE Model Information:
Aspect ratio used for mashing is 10
Total number of elements are 3508
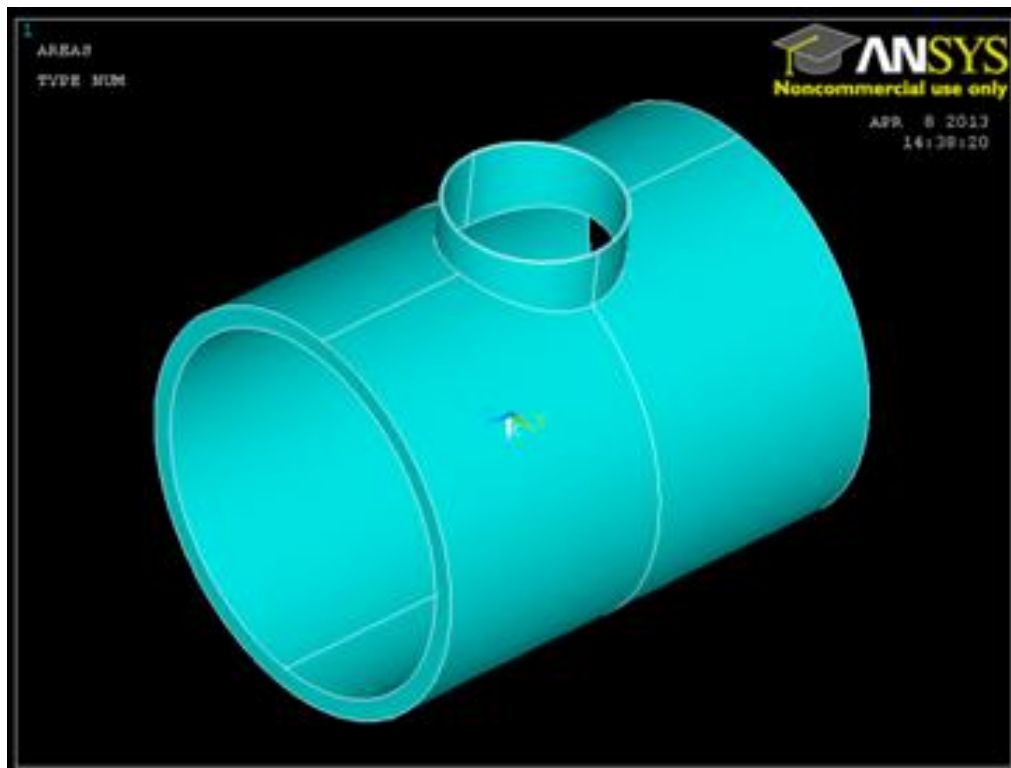Total number of nodes are 10682
Meshing has done by free meshing

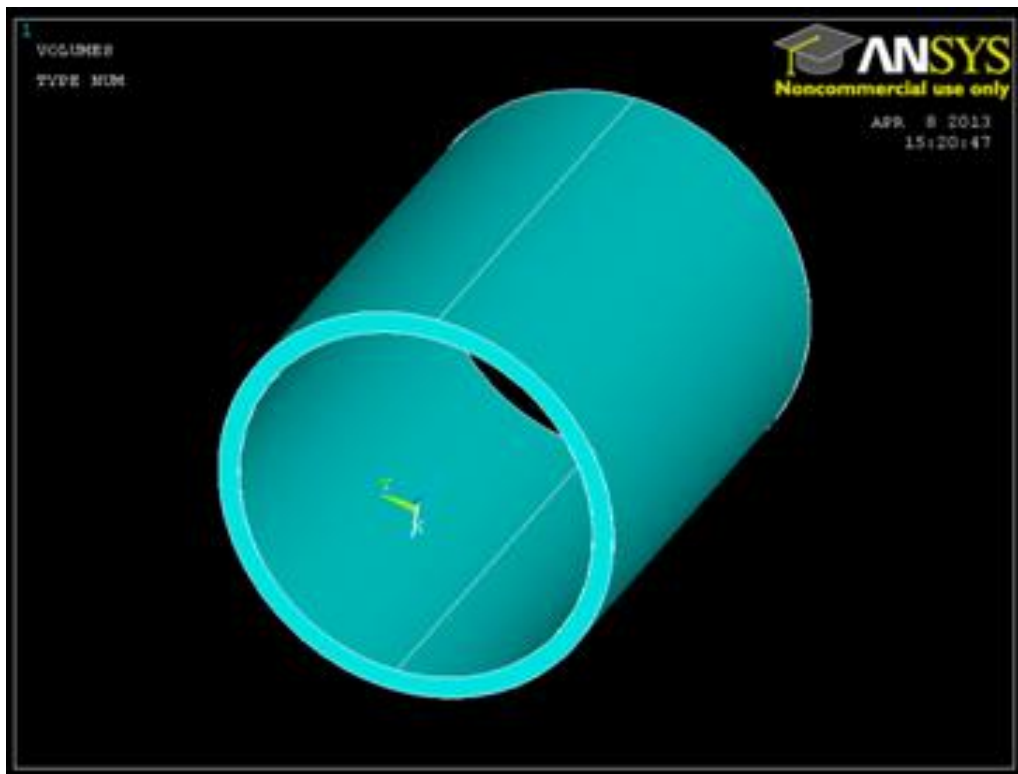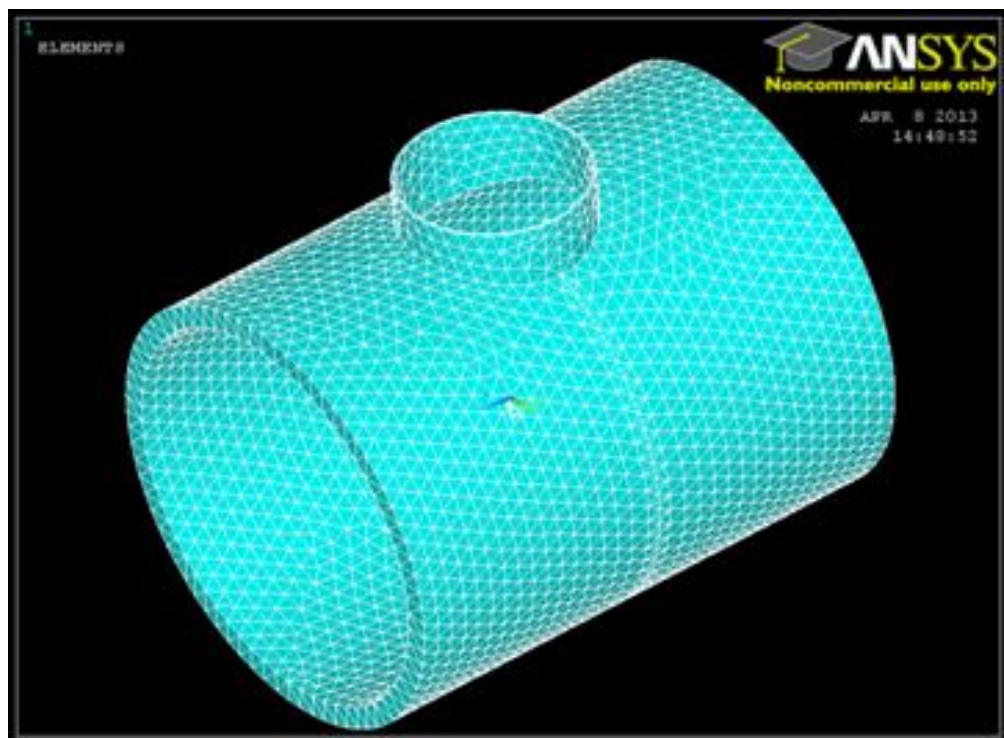
Fig2.Part Model Cylinder with Nozzle

Fig.3 Part Model
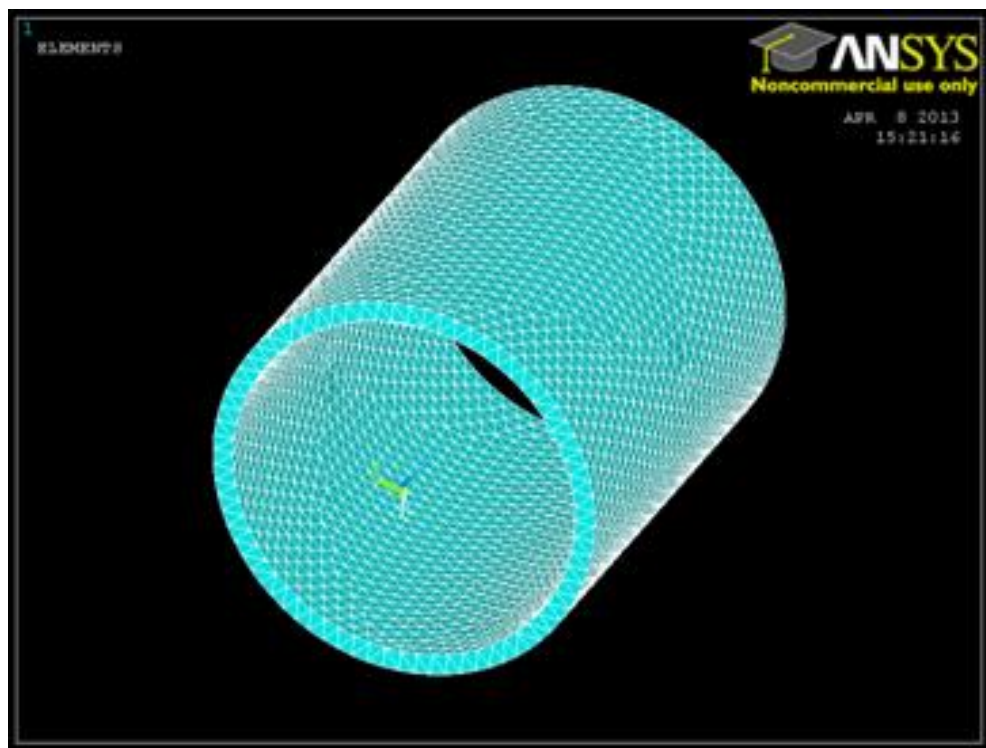

Fig.4 Meshing of Cylinder with Nozzle
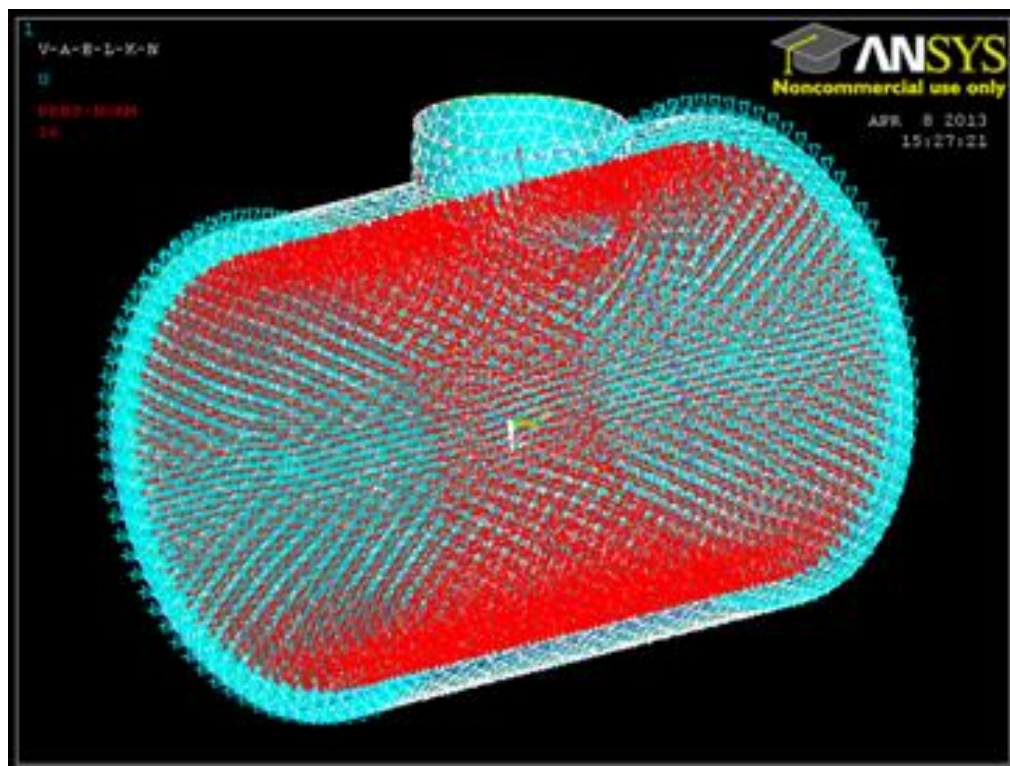
Fig.5 Meshing of Cylinder

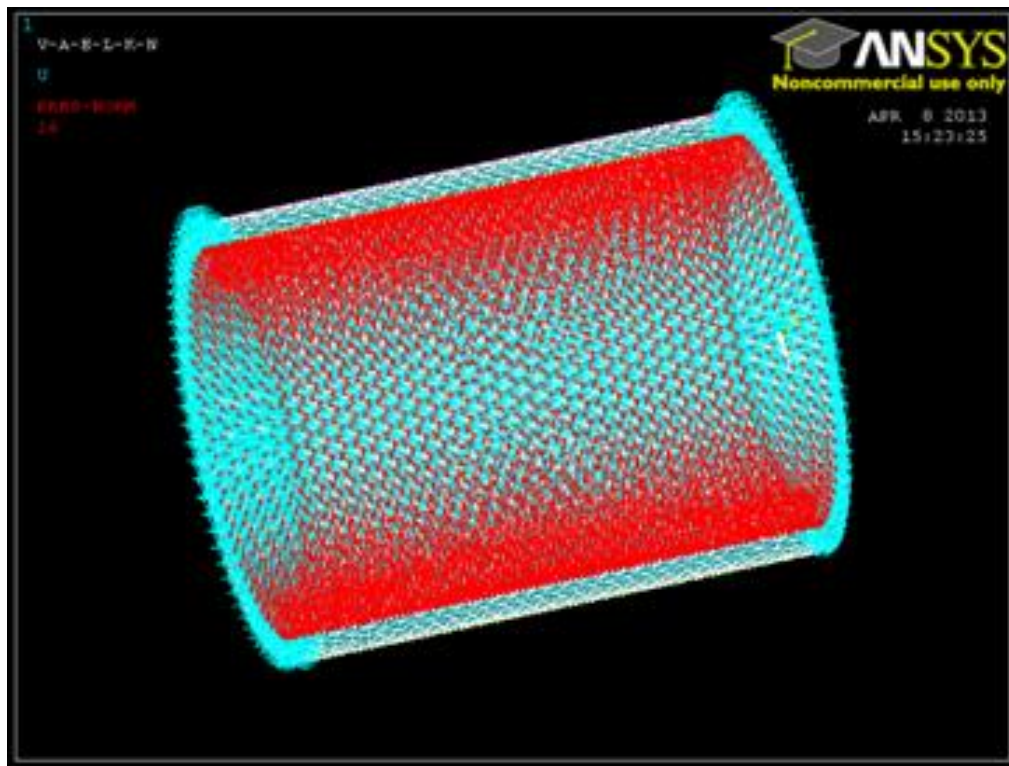**Fig.6 Loading Condition Of Cylinder with Nozzle**

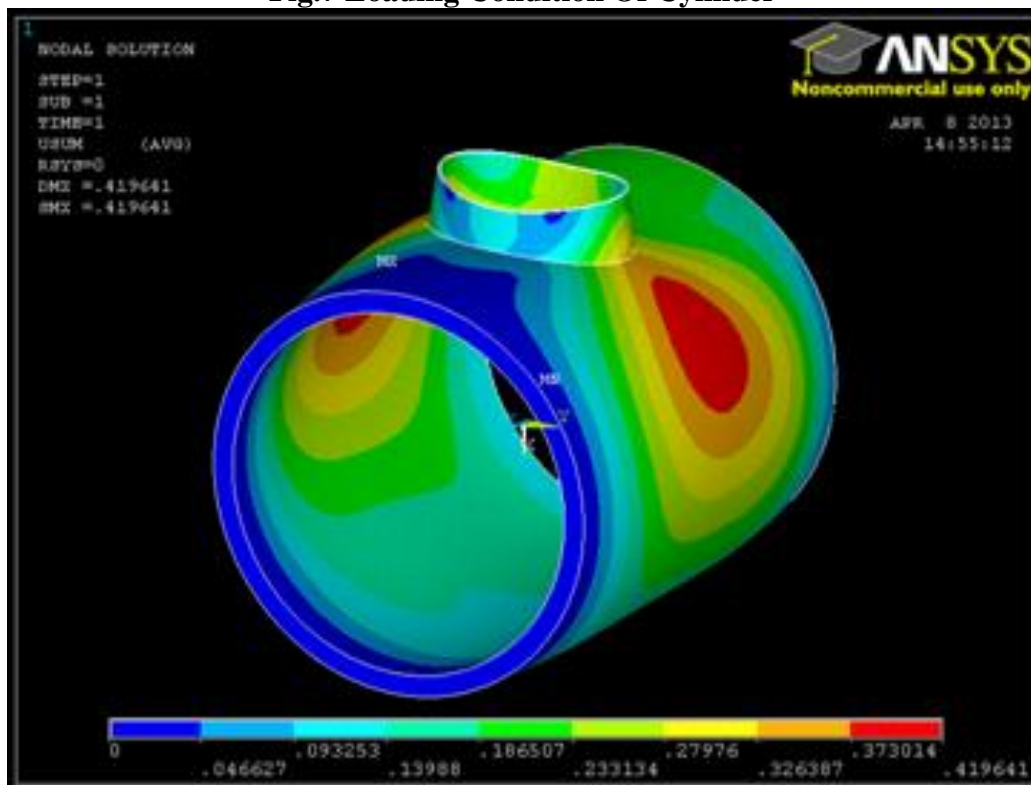**Fig.7 Loading Condition Of Cylinder**
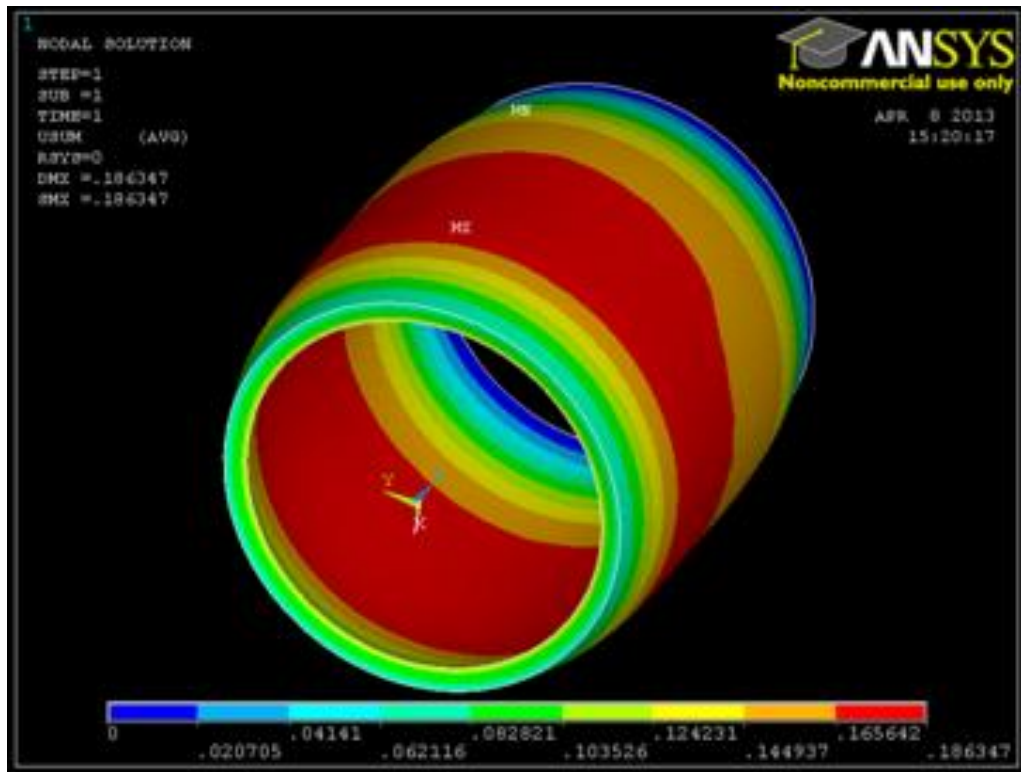

Fig.8 Deflection Of Cylinder with Nozzle

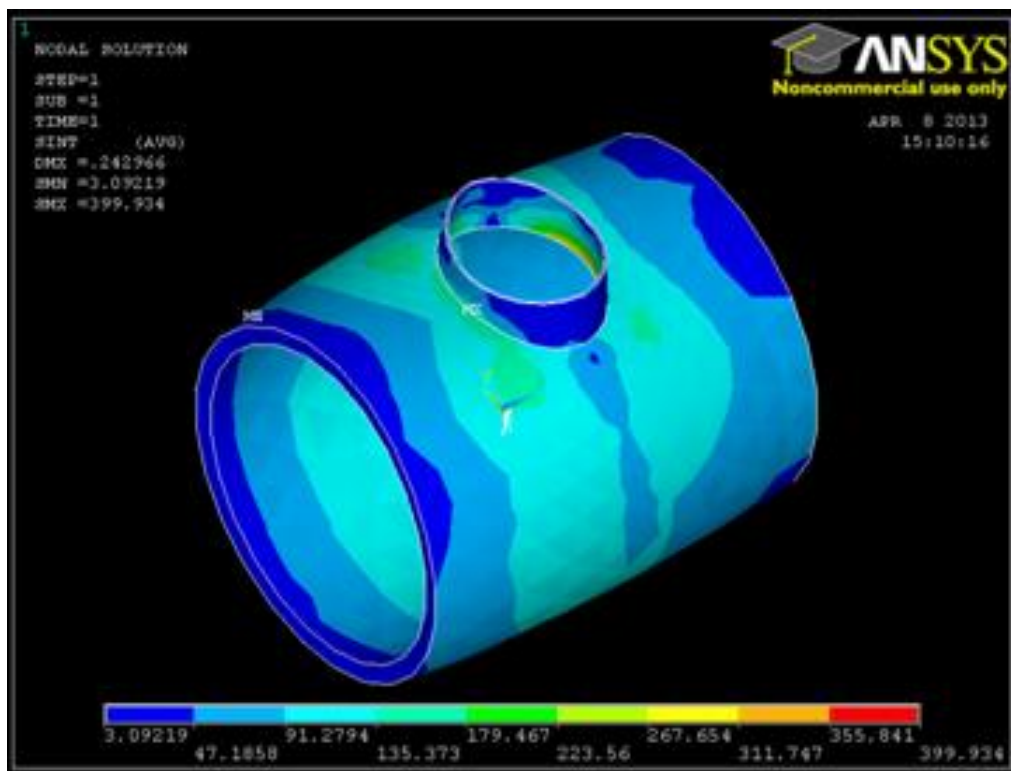**Fig.9 Deflection Of Cylinder**

Fig.10 Stress In Cylinder and Nozzle
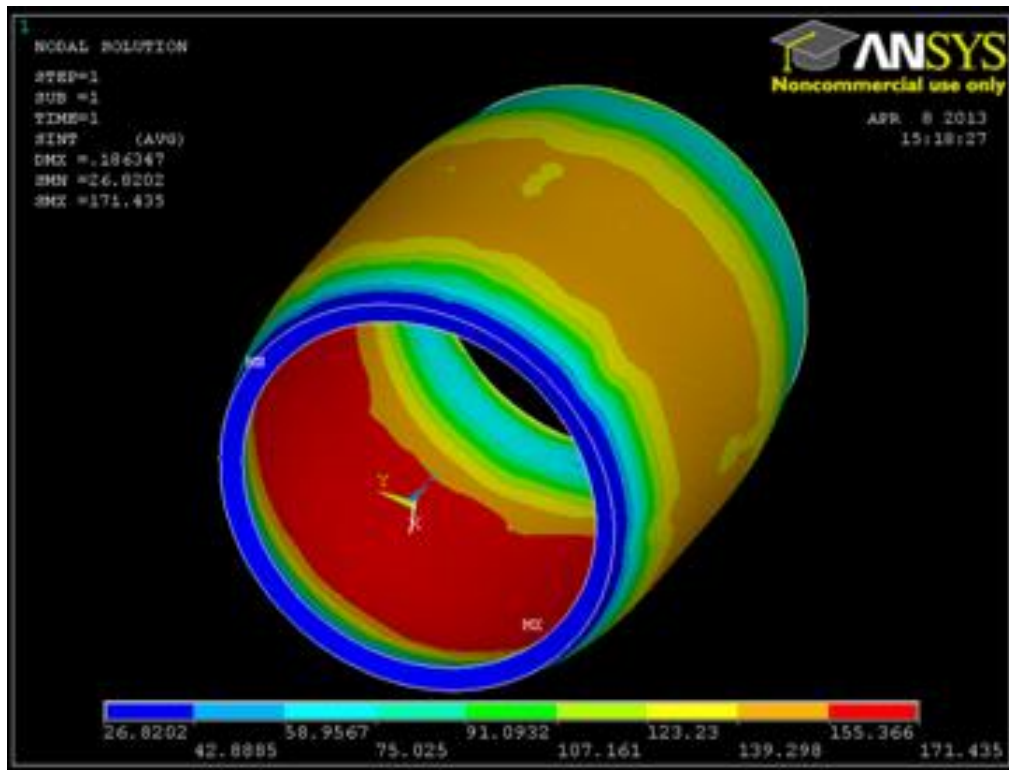
Fig.11 Stress in Cylinder

Results Interpretation and Code Checking:

The stresses for the above mentioned load combinations are summarized and compared with code allowable limits for all critical parts in the following Tables. The stress plots are also enclosed and referred.

Table 3 : Summary of FEA Stresses (Stress Intensity) For Design Condition				
Stress Value \ Member			Cylinder	Cylinder with nozzle
Primary Membrane	Middle Layer	Maximum Stress Intensity (N/mm2)	171.44	399.93
	Stress Limit	Allowable Stress (N/mm2)	500	500

Table 4 : Summary of FEA Stresses (Stress Intensity) For Hydro test Condition

Stress Value \ Member			Cylinder	Cylinder with nozzle
Primary Membrane	Middle Layer	Maximum Stress Intensity (N/mm2)	250	220
	Stress Limit	Allowable Stress (N/mm2) $(0.95*S_{yt})$	712.5	712.5

6 MANUFACTURING

6.1 CYLINDER MATERIAL IDENTIFICATION
During fabrication the following check are carried out to ensure that right quality of material and consumables are going into final product.
1. IT is insure that material of right specification is issued. The material identification reports are made at this stage.
2. Visual inspection is carried out at this stage to conform that no damage has occurred on the material during storage and handling.

6.2 FABRICATION OF CYLINDER
1**. Marking**: The plate is marked to rectangle from with following dimensions
Length = $\prod *D$
Breadth= L.
Where D= diameter of shell.
L=Length of the shell.
Inspection for shell length, width, and diagonals for perpendicularity is done
2. Pinching: The punching is done along with marking .this guides the cutter or plasma cutting to cut with proper dimensions
3. Cutting: For cutting plasma arc welding process is used. This process is more suitable for stainless steel cutting than any other process.
4. Grinding: The cut portion has burr on its cut surface. This is removed by grinding process the of exact dimensions are attained by this process
5. Edge Preparation: The edges to be welded are initially prepared the edges are beveled and required root face is maintained as per welding details given drawings.
6. Pre-pinching: while rolling of plate the adjoining edges of longitudinal joints are first shaped to proper curvature by preliminary rolling in order to avoid having objectionable flat spots along the completed joints. This process is known as per pinching.

7. Rolling and L-seam fit-up: Rolling is used to shape the given plate into cylinder of required diameter this process involves trials and the plate is passed no. Of times to acquire exact dimensions finally.

After rolling of shell to be worked as matched as per the weld design root gap is properly maintained. Inspection of circumference of shell OD, ID template matching and ovality is done.

Fig.12 Rolling Machine

8. L-Seam Welding: L-seam welding is performed by GTAW process with complete penetration and full fusion. Initially root-run is performed and then final runs are performed. The filler material used is 316L as plate material is 316L.

9. Rerolling

10. Radiography Examination: Radiography examination of weld joint is performed. Weld defects are inspected on radiographic film marked on respective position on joints these repairs are then grinded thoroughly and welding is done.

11 Fabrication Of Nozzle

1. Material identification for shell with respect to specification Grade Size Heat no etc against mill test certificate or check test certificate.

2**. Marking**: The plate is marked to curvature form as per the shape of conical shape.
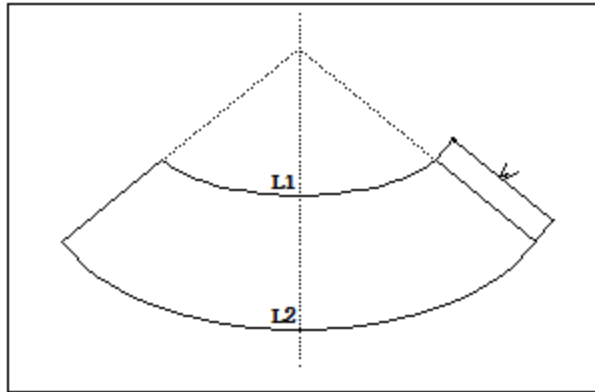
L1= perimeter of small dia.= $\prod*d$
L2= perimeter of large dia.= $\prod*D$
Breadth= W.
Where D= diameter of large end of conical shell.
d= diameter of small end of conical shell

3. Pinching: The punching is done along with marking .this guides the cutter or plasma cutting to cut with proper dimensions

4. Cutting: For cutting plasma arc welding process is used. This process is more suitable for stainless steel cutting than any other process.

5. Grinding: The cut portion has burr on its cut surface. This is removed by grinding process the of exact dimensions are attained by this process

6. Edge Preparation: the edges to be welded are initially prepared the edges are bevelled and required root face is maintained as per welding details given drawings.

7. Pre-pinching: while rolling of plate the adjoining edges of longitudinal joints are first shaped to proper curvature by preliminary rolling in order to avoid having objectionable flat spots along the completed joints. This process is known as per pinching.

8. Rolling and L-seam fit-up: Rolling is used to shape the given plate into cylinder of required diameter this process involves trials and the plate is passed no. Of times to acquire exact dimensions finally.

9. L-Seam Welding: L-seam welding is performed by GTAW process with complete penetration and full fusion. Initially root-run is performed and then final runs are performed. The filler material used is 316L as plate material is 316L.

10. Rerolling

11. Back Chipping: after L-seam and C-seam welding, the grinding on reverse side of weld is done up to sound material .this process is known as back chipping.
        The Die Penetration (D.P.) test is performed on back chipped portion to find out surface defects like cracks, porosities etc. The portion having the defects is again grinded and D.P. test is performed. This process is repeated until there are no defects.Cone portion of shell.

12. Radiography Examination: Radiography examination of weld joint is performed.
Weld defects are inspected on radiographic film marked on respective position on joints these repairs are then grinded thoroughly and welding is done
Re-radiography of repair is performed until there are no defects in radiography examination .same procedure carried out for the channel shell as per drawing requirement.

Nozzle Pipe To Cylinder Fit up

1. Marking: First marking of all the nozzles as per orientation is done on shell according to the nozzle sizes (NB) as per drawing requirement.

2. According to the nozzle sizes pipe of required schedule are selected, if the pipe of required schedule is not available or of large nozzle dia. Then they are made by plate same as rolling of shell but of sch. Diameter for cost reduction

3. According to the pipe schedule required size, material, type, and rating of flange is selected for this we have selected integral type flanges having raised face are selected.

4. Profile Marking: After nozzle pipe preparation profile marking has been done on the pipe by inserting pipe inside shell or by marking highest and lowest point on pipe from shell and according to these points marking has been done and profile shape has been cut with plasma cutting m/c grinding is done on it.

5. After all these marking and selection of pipes, flange fit up is carried out with the help of *TIG* welding for which 316L filler material is used.

6. This nozzle is fitted to shell as per orientation for which first tack weld is carried out and inspected by quality inspector. If it is ok for nozzles then *TIG* welding is carried out.
Inspection of fit up for following point carried out.

        a.   elevation front line
        b.   projection and alignment
        c.   off centre

Back chipping from inside from inside in done and penetrate test is carried out.

7. TEST REPORT

Hydrostatic Test

Scope

        According to the code of conduct the hydrostatic test is carried out at the end of the fabrication process. This test is implemented to ensure that test pressure is found within working limits with leakages under prescribed limits. These leakages when identified over prescribed limits, corrective measures are taken.

Procedure
Step 1
1. Mount test flanges on side 1. Inlet and outlet locations are written in the work order.
2. Check that the manometer/pressure gauge is calibrated within the last 3 months.
3. Fill the heat exchanger with fresh water (less than 30 ppm chloride content) with a temperature of min 10ºC.
4. Close the air venting valve when all the air is evacuated.
5. Raise the pressure to correct test pressure according to the work order and/or general arrangement drawing and close the valve.
6. During the time that the heat exchanger is under pressure, it is to be inspected for leakage. Check the manometer to see that there is no pressure drop below the stated test pressure. No leakage or residual deformation is permissible.

Step 2

Perform pressure test on the second side as per above stated procedure.
Step 3
1. Drain the unit after successful pressure test.
2. Sign the final inspection report that the unit is successfully pressure tested.

3. Time schedule for pressure tests
 ASME VIII, Div 1. HE shall be pressure tested 30 minutes on each side.

4. Pressure gauge range
Pressure tests between Use gauge
0-20 bar 0-25 bar
10-35 bar 0-40 bar
30-55 bar 0-60 bar
Pneumatic test:
Subject to the provisions of UG-99(a)(1) and (a)(2), a pneumatic test prescribed in this paragraph
may be used in lieu of the standard hydrostatic test prescribed in UG-99.
(1) These are used when vessels are so designed and/or supported that they cannot safely be
filled with water.
(2) Also when vessels, are to be used in services where traces of the testing liquid cannot be
tolerated and the parts of which have, where possible, been previously tested by hydrostatic
pressure to the pressure required in UG-99.
Pneumatic test pressure a every point in the vessel shall be at least equal to 1.1 times of
maximum allowable working pressure multiplied by the lowest stress ration for the material of
which the vessel is constructed.
 8. RESULTS
 We have design and analysed the garbage dewateriser succefully with help of ANSYS.
 Manufacturing is done with various operating conditions and processes. Results of the tests
 are satisfactory. Product is being running successfully and removing water from the green
 waste, which reduces the issue of garbage disposal.

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10. ACKNOWLEDGEMENT