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# PERFORMANCE ANALYSIS OF NOODLES MAKING PORTABLE AXIAL MACHINE

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## ABSTRACT

***Noodles are of the staple food consumed in many Asian countries. Instant noodles have become internationally recognized food and word wide consumption is one rise. Whenever, we think about noodles we remember our part experience where our mother making had been noodle (savage) by their hand in long strips and strings.***

***Now in modern era we have proposed automation and giving relief to those hand practice making noodle by taking lot of efforts .we have "Design and Fabrication of Axial noodle making machine" this machine will help us to makes noodles and its similar product like pasta ,akki savage with different diameter with greater quantity and accuracy with the underestimation of labor cost, space, time, effort and cotton of wastage.***

***The proposed Noodles making machine will forced out work through the well-shaped dice in the axial direction by the extruder which held and rotates in barrel or cylinder. Here the work will produce parallel to base of machine hence its named "Axial Noodle making machine"***

***The working of this similar to the squeezing the toothpaste from paste pack. On the bed rock on this principle the dough will be squeezed chronologically by the extruder which rotates with uniform speed. This whole mechanism will be drive by the heavy duty D.C. Motor. The main feature of the proposed model is to start drawing work by feeding 400gm of dough which is itself a proof of its compactness.***

KEY WORDS : *Extruder , selection of flour, DC motor, SMPS kit & timer belt – Pulley mechanism*.

## INTRODUCTION

The noodles are a type of food made from unlearned dough which is rolled flat and cut, stretched and extruded into long strips and strings noodles can be refrigerated for short term storage dried and stored for future used as well as long term storage.

Basically noodles appear as a handmade noodles prevail. Because they are easily prepared and can be cooked into various dishes such as Akki Noodles a specialty of Karnataka homemade noodles. Due to improving the standard of living in the cities and the rapid urbanization taking place in the rural areas, consumption of those product is widely expected to go up steadily. Besides the boom in the food service sector including fast food chain has winded the demand potential for noodles .Taking example in the carbon areas food service sector like zomato, swiggy provides wide range of fast food at home and near you resulting increasing demand. In fig. (A) graphs shows the consumption of noodles in different countries this figure represent 100 million packets plotted using data from WINA-2011 Report. According to world noodle association (WINA) 2011, Report worldwide chains rank first in the consumption of noodles followed by Indonesia, japan and Vietminh as shown in above graph.

Domestically while proposed of fabrication noodles in this form of precise product ,It is important to consider quality factor such as oxidation of dough with machine parts hence we decide to use SS346 material to avoids such problems further economic consideration compactness flexibility to produced similar product like pasta , swage by simply replacing the dice with the help of die locker mechanism ,these are the factors while a developing the model .In the tittle consideration a wrong selection machine may damage the quality and profitability of product.

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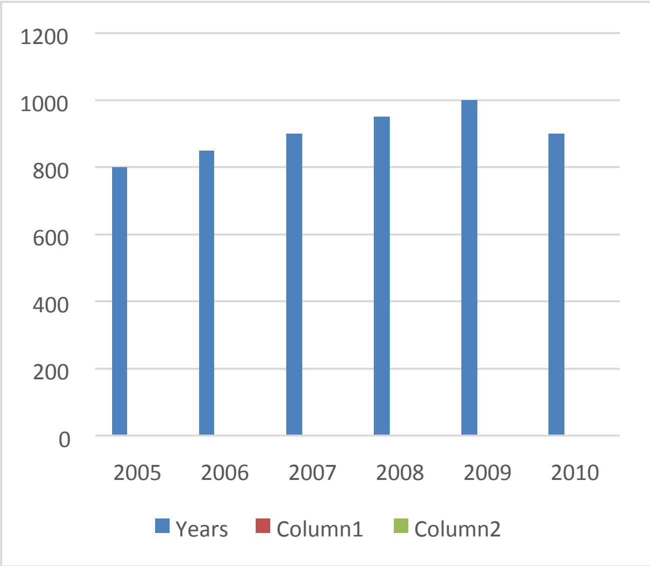
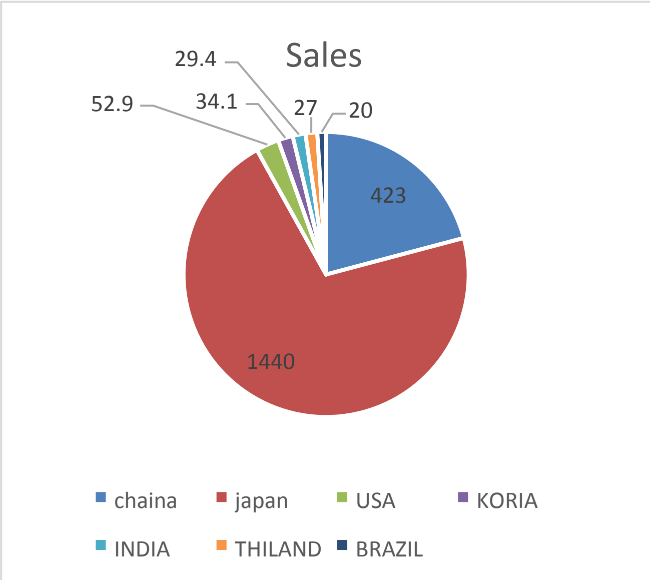
**(A)**




## DESIGN CALCULATIONS

### 1 ) - SPEED

In this aspect to maintain the speed of extruder by reducing the base rpm of DC motor with the help of timer – pulley belt mechanism.

We have ,

Diameter of Smaller pulley (d) = 50 mm

Diameter of main pulley (D). = 150 mm DC motor RPM (N). = 100 RPM Main / extruder pulley Rpm (n) = ?

Putting in std. Formula: $\mathbf{N \times d = n \times D}$

$\mathbf{100 \times 50 = n \times 150 \quad (100 \times 50) \div 150 = n \quad n = 33.33 \approx 34\ RPM}$

From the above calculation speed of extruder is 34 rpm but practically it reduces due to inertia force develop by the dough inside the cylinder.

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**2 ) - FEED ZONE**

The geometry of the feed zone of the screw is given by the following data:

Barrel diameter ($D_b$} = 75 mm = 0.075 m

Screw lead (5) = 36.5 mm = 0.036 m

Number of flights (V) =1

Flight width ($W_{FLT}$) –3 mm = 0.003 m

Channel width ($W_c$) = 37.5 mm = 0.0375 m

Depth of feed zone ($H_{fz}$) = 18.5 mm = 0.0185 m

Conveying efficiency ($^n{}_f$) = 0.35

Screw speed $N_2$ = 33 r. p. m.

Bulk density of the polymer ($P_0$} = 600 Kg/$m^3$

Helix angle (Ψ) =12°

The solids conveying rate in the feed zone of the extruder can be calculated as,

$$G = 60 \text{ x } P_o \text{ x } N_2 \text{ x } n_f \text{ x } \pi^2 \text{ x } H_{fs} \text{ x } D_b(D_b - H_{fs}) \frac{w_e}{w_e + w_{flt}} \text{ x } \sin\varphi \text{ x } \cos\varphi \text{ . (26)}$$

Therefore,

G = 60 × 600 × 33 × 0.35 × ( 3.142)² × 0.0185 × ( 0.075 – 0.0185)

× 0.0375/ 0.0375 + 0.003 × sin(12 ) x cos (12 )

**G = 36. 3570 kg/h**

## 3 ) - ANALYSIS OF FLOW

**1 . Drag Flow** ($Q_d$)

$$Q_d = \frac{1}{2} \text{ x } \pi^2 \text{ x } D_s^2 \text{ x } N_1 \text{ x } H_{cd} \text{ x} \sin\varphi \text{ x } \cos\varphi \text{ .} \qquad (27)$$

Where,

Screw diameter ($D_s$) = 74 mm = 0.074 m

Screw Speed ($N_2$) = 33r.p.m

Channel Depth ($H_{cd}$) = 18.5 mm = 0.0185 m

Helix angle (φ) = $12^0$

Therefore

Qd = 1/2 x (13.142)² x (0.074)² x 33 x 0.0185

X sin(12 ) x cos(12 )

Qd = 0.067118/ 2

Qd = 0.0335 m³/s

**2. Pressure**

**Flow ($Q_p$)**

$$\text{Pressure Flow } (Q_p) = \frac{\pi D_s H_{cd}{}^3 \sin 2\varphi}{12^n} \text{ x } \frac{P_a}{L_{es1}}.$$

Where,

Screw diameter ($D_s$) – 74 mm = 0.74 m

Channel depth *($H_{cd}$)* =18.5 mm = 0.0185 m

Helix angle *(φ)* = 12°

Fluid viscosity (η) = 0.373 at $20^0$

*Operation Pressure ($P_a$) =?*

*Effective screw length ($L_{esl}$) = 300mm* — 0.300 m

But

The pressure distribution of the flow in the extruder is the total output obtained from the drag flow, back pressure flow and leakage. Assuming that there is no leakage

$$Q_d = \frac{1}{2} \text{ x } \pi^2 \text{ x } D_s^2 \text{ x } N_2 \text{ x } H_{cd} \sin\varphi \ \cos\varphi - \frac{\pi D_s H_{cd}{}^2 \sin^2\varphi}{12} \frac{P_a}{L_{esl}} = Q_d - Q_P$$ (Crawford, 1998)

When there is no pressure build up at the end of the extruder, any flow is due to drag and maximum flow rate $Q_{max}$ can be obtained. The equation then can be reduced to only the drag term as follows.

$$Q = Q_{max} = \frac{1}{2}\pi^2 D_s^2 N_2 H_{cd} \sin\varphi \ \cos\varphi$$

Therefore,

Q = Q ( max) = ½ × ( 3.142)² × (0.074)² × 33 × 0.0185

× sin (12) × cos (12)

= ½ × 9.87 × 5.476 × 10 ⁻³ × 33 × 0.0185

Sin (12) × cos (12)

Q = Q (max) = 0.0671/2

= 0.03355 m³/s

Similarly, when there is a high pressure drop at the end of the extruder the output of the extruder, Q becomes equal to zero (Q=0) and the maximum pressure is obtained from the equation.

$$\frac{1}{2}\pi^2 \text{ x } D_s^2 \text{ x } N_2 \text{ x } H_{cd} \sin\varphi \ \cos\varphi = \frac{\pi D_s H_{cd}{}^2 \sin^2\varphi}{12^n} \frac{P_a}{L_{esl}} . (30)$$

$$P_a = \frac{12^n L_{esl} \pi^2 D_s{}^2 H_{cd} \sin\varphi\cos\varphi}{2\pi D_s H_{cd}{}^3 \sin^2\varphi}$$

$$P_a = \frac{6^n L_{esl} D_2 N_2 \cos\varphi}{H_{cd}{}^2 \sin\varphi}$$

$$Recall, tan\varphi = \frac{\sin\varphi}{\cos\varphi} \therefore \frac{1}{\tan\varphi} = \frac{\cos\varphi}{\sin\varphi}$$

Hence,

$$P_a = \frac{6\pi L_{esl} D_2 N_2{}^n}{H_{cd}{}^2 \tan\varphi}$$

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But

$$\eta = m(T^{0}C)\Upsilon^{\eta-1}$$

Where, m = consistency index = 2.00 x $10^4$ n = power law index = 0.41

The power law is usually represented as $\eta = my^{n}$-$^{1}$, where m is sometimes replaced by 'k' or other letter (Michaeli, 2003). The consistency index is said to include the temperature dependence of the viscosity whilst the power law index represents the shear thinning behavior of the polymer melt. "The limits of thelaware zero (0) and infinity" (Osswald, 2009) Therefore,

$$\eta = m\Upsilon^{\eta-1}$$

But,

Shear rate for a quadratic cross section is given by

Y = 6 Q / W ( flt) $H^2$ S (flt)

Y = 6× 0.03355/ 0.02 × ( $0.0185)^2$

Y = 0.2013 / 0.02 × ( 0.0185 ) $^2$

Y = 29408 . $32^{\alpha-1}$

Therefore,

h = ( 2.00× $10^4$) ( 29408) $^{0,41-1}$

h = 46.19 pa.s

Therefore ,

Pa = 6 × 3.142 × 0.74 × 0.300 × 33 × 46.19 / $0.0185^2$ × tan (12)

Pa = 637.9289 / $0.0185^2$ × tan (12)

Pa = 0.8 Gpa

Therefore,

$$\text{Pressure flow } (Q_p) = \frac{\pi D_s H_{cd}{}^3 \sin 2\varphi}{12\eta} \text{ x } \frac{P_a}{L_{esl}}$$

= 3.142 × 0.74 × $0.0185^2$ × sin $^2$ (12) × 8 × $10^{12}$ / 12 × 46.19 ; 8 × $10^7$ / 0.300

**Qp = 0.3061**

## 4) – CALCULATION FOR COMPRESSION RATIO

$$CR = \frac{\text{Channel depth in feed section}}{\text{Channel depth in metering section}}$$

Where

Channel depth in feed section = 18.5 mm

Channel depth in metering section = 18.5 mm

CR = 18.5 / 18.5

CR = 1:1

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### 5) - CALCULATION FOR LENGTH/DIAMETER (L/D) RATIO

$$L/D = \frac{\text{Screw flighted length}}{\text{Screw outside diameter}}$$

Where

Screw Flighted length = 300 mm

Screw Outside diameter = 74 mm

L/D = 300/74

L/D = 4:1

### 6) - DESIGN OF SCREW SHAFT

W = 0.40 KN

= 0.40 x $10^3$ N,

L = 30 mm,

x = 240 mm,

T = *12.17 N/m = 1270 N/mm,*

$d_{ss}$ = 74 mm

A little consideration will show that the maximum bending moment acts on the shaft at both end of the shaft .Therefore maximum bending moment,

M = 0.40 x $10^3$ x 1.80 x $10^4$

M = 720000

M = 7.2 x $10^5$ *N -mm*

### 7) - CALCULATING FOR SHAFT SUBJECTED TO COMBINED TWISTING MOMENT AND BENDING MOMENT

Let, T = Shear stress induced due to twisting moment, and $\sigma b$ = Bending stress (tensile or compressive) induced due to bending moment.

According to maximum shear stress theory, the maximum shear stress in the shaft,

$$\tau_{max} = \frac{1}{2}\sqrt{(\sigma_h)^2 + 4\tau^2}.$$

Where

$$\tau = \frac{16T}{\pi d^3} \text{ and } \sigma_h = \frac{32M}{\pi d^3}$$

Substituting values of $\tau$ and $\sigma_b$ into above equation

$$\tau_{max} = \frac{1}{2}\sqrt{\left(\frac{32M}{\pi d^3}\right)^2 + 4\left(\frac{16T}{\pi d^3}\right)^2} = \frac{16}{\pi d^3}\sqrt{M^2 + T^2}$$

$$\frac{\pi}{16} \text{ x } \tau_{max} \text{ x } d^3\sqrt{M^2 + T^2}$$

Therefore

= 16/ 3.142 × $38^3$ √ ( 7.2 × $10^5$)$^2$ + ( 12.17 )$^2$

$\tau_{max}$ = 66.81 N/mm

The expression $\sqrt{M2 + T2}$ is known as equivalent twisting moment and is denoted by $T_e$. The equivalent twisting moment may be defined as that twisting moment, which when acting alone, produces the same shear stress (T) as the actual twisting moment. By limiting the maximum shear stress {$T_{max}$} equal to the allowable shear stress (T) for the material, the equation (7) may be written as

$$T_e = \sqrt{M^2 + T^2 = \frac{\pi}{16} \times \tau \times D_{ss}^3}.$$ Therefore,

Té = $\sqrt{M^2 + T^2}$ $\sqrt{(7.2)^2 + (12.17)^2}$

Té= $14.14 \times 10^5$ N/ mm²

Now, according to maximum normal stress theory, the maximum normal stress in the shaft,

$$\sigma_{b(max)} = \frac{1}{2}\sigma_b + \frac{1}{2}\sqrt{(\sigma_b)^2 + 4\tau^2}.$$

$$\sigma_{b(max)} = \frac{1}{2} \times \frac{32M}{\pi D_{ss}^3} + \frac{1}{2}\sqrt{\left(\frac{32M}{\pi D_{ss}^3}\right)^2 + 4\left(\frac{16T}{\pi D_{ss}^3}\right)^2}$$

$$\sigma_{b(max)} = \frac{32}{\pi D_{ss}^3}\left[\frac{1}{2}\left(M + \sqrt{M^2 + T^2}\right)\right]$$

$$\frac{\pi}{32} \times \sigma_{b(max)} \times D_{ss}^3 = \frac{1}{2}\left[M + \sqrt{M^2 + T^2}\right].$$

The expression $\frac{1}{2}\left[M + \sqrt{(M^2 + T^2)}\right]$ is known as equivalent bending moment and is denoted by $M_e$. The equivalent bending moment may be defined as that moment which when acting alone produces the same tensile or compressive stress ($a_b$) as the actual bending moment. By limiting the maximum normal stress [ab(max)] equal to the allowable bending stress ($a_b$); then the equation (iv) may be written as

$$M_e = \frac{1}{2}\left[M + \sqrt{M^2 + T^2}\right] = \frac{\pi}{32} \times \sigma_{b(max)} \times D_{ss}^3 . (17)$$

Therefore ,

Mé = ½ ( $7.2 \times 10^5$) + √ ( $7.2 \times 10^5$)² + (12.17)²

Mé = ½ ( $7.2 \times 10^5$) + √ $5.184 \times 10^{11}$

Mé= 720000 N/mm

Mé = $7.2 \times 10^5$ N/mm

## 8) - CALCULATING FOR THE AVERAGE VELOCITY (V)

$$V = \frac{\pi DN}{60} = \frac{\tau \emptyset N}{60}$$

Average velocity of smaller sprocket ($V_1$)

$V_1 = \pi D_1 N_1 / 60 = 3.142 \times 0.05 \times 100 / 60$

$V_1 = 3.184 / 60$

$V_1 = 0.2618$ m/s

Average velocity of bigger sprocket ($V_2$)

$V_2 = \pi D_2 N_2 / 60 = 3.142 \times 0.15 \times 33 / 60$

$V_2 = 15.5529 / 60$

$V_2 = 0.2592$ m/s

## 9) - DESIGN CALCULATION FOR BARREL

Calculating for the circumferential or hoop stress

Where $p_b$ = Intensity of internal pressure = 2GPa.

Internal diameter of the cylindrical shell {$d_{cs}$) = 75 mm

Length of the cylindrical shell ($L_{cs}$) = 300 mm

Thickness of the cylindrical shell ($t_{cs}$) = 3mm

$\sigma t1$ = Circumferential or hoop stress for the material of the cylindrical shell,

*total force acting on a longitudinal section of the shell

= Intensity of pressure x projected area

$= p_b{}^x d_{cs} \times L_{cs}$.

The total resisting force acting on the cylinder walls

$= \sigma_{t1} \times 2t_{cs} \times L_{cs}$. (therefore of two sections). From equation (12) , we have

$\sigma_{t1} \times 2t_{cs} \times L_{cs} = p_b \times d_{cs} \times L_{cs}$ or $\sigma_{t1} = \frac{p_b \times d_{cs}}{2t_{cs}}$ or $t_{cs}$ $\frac{p_b \times d_{cs}}{2\sigma_{cs}}$

Therefore,

$\emptyset\square_1 = 2 \times 10^9 \times 75 / 2 \times 3$

$= 1.5 \times 10^5 / 6$

$\emptyset\square_1 = 2.5 \times 10^{10}$ mpa

## 10 )- POWER REQUIREMENT

Power can be expressed as

Power (p) = torque resistance × angular speed

$P = TW$

But, $W = 2\pi N_1 / 60$

Where ,

T = torsional stress

W = angular speed

$N_1$ = speed in revolution per minute

We have $N_1 = 33$ rpm

$W = 2\pi N_1 / 60$

$= 2\pi \times 33 / 60$

$W = 3.45$ rad / sec

**For the electric motor :**

$P = v \times I$

$= 12 \times 3.5$

$P = 42$ watt

Here , P = TW from the above equation , we have ,

$P = TW$

$T = P / W$

$= 42 / 3.45$

**T = 12.17 N/ M .**

## 1 ) – DC MOTOR

DC motor is the most important element of the ANMM . It drives the extruder through the timer belt Pulley mechanism. the driving mechanism contains motor , Pulley arrangement through the timer belt to drive the extruder rod which rotating inside the cylinder. Here, the motor DC motor is used which is capable enough to take load as per the Calculation and drives the extruder. In the proposed model the square gearbox type DC motor is used which is capable to produce and lift 85 kg - cm pressure. This motor contains an inbuilt gearbox which is capable to reduce its base RPM which is 2300 RPM to the 100 RPM. As per the calculation 12.17 N – M force will require to forced out the dough.

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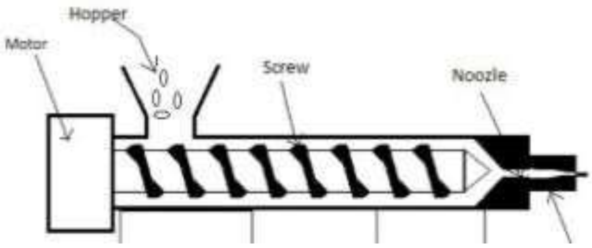
## FABRICATION OF ANMM

Fabrication of ANMM includes the following major areas :

**2) - EXTRUDER**




It acts as the heart of the machine it rotate with calculated speed that is 34rpm and forced out the work through dice it is fully made up of SS-346 material to avoid oxidation problem with dough and has length 300mm with extended end till the driven pulley and diameter 74mm to maintain allowances of ½ mm between extruder and cylinder wall resulting to not bypass pressure in backward direction.

**3)- HOPPER**


The first stage of noodle making where the dough is primarily feed to the extruder then after it will be pushes towards the shaping dice. Hopper is the important component of the which allows the primary feeding to the whole mechanism. It is the pipe shape metallic arrangement having different diameter on both end , one of which reduces chronologically from other.

It is made up of stainless steel (ss-346) material & mounted on the cylinder at the starting extruder in such a way that it would capable to supply raw material to the whole area of extruder.

**4)- TIMER BELT & PULLEY**

The whole mechanism drives by the DC motor through the timer – pulley – belt power transmission mechanism. Here , the main purpose of timer belt is to reduce/prevent the slippage phenomenon , whereas pulleys with different diameter used to reduce RPM from 100 to 34 . Smaller pulley engaged with the motor output shaft & bigger one is engaged with the extruder & drives the extruder to forced out the product through the well shaped dice.

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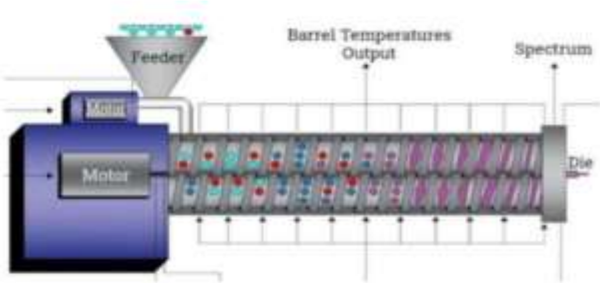
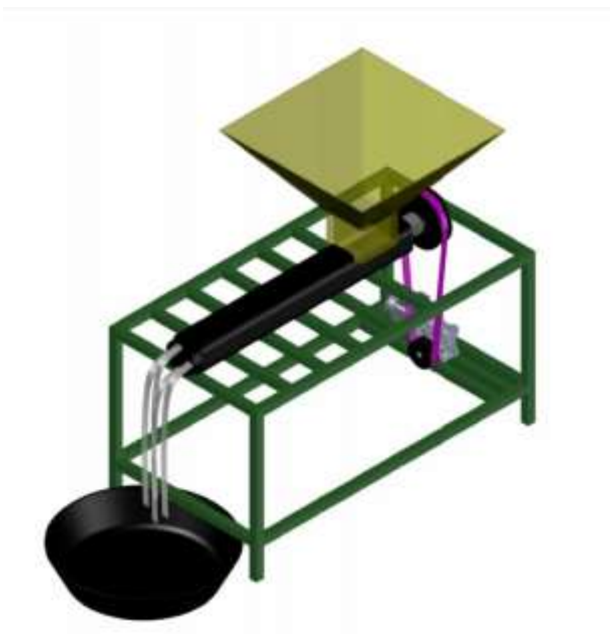
**5) – CYLINDER / BARREL**




It is the simple type of cylinder which is closed at one end and contains external thread on the other end to Mount the well shaped dice with die – locker. It is made up of stainless Steel (SS 346 ) which is a strong enough to withstand the load and non corrosive in nature.

The extruder rotates inside the cylinder in such a manner that both (cylinder and extruder) having clearances as minimum as between them two not bypass the pressure developed inside the cylinder.

**3D- MODEL DESIGN :**



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**SCOPE FOR FUTURE WORK**

The proposed model of axial noodle making machine not only limited to produce one product but it will be capable to produce similar product like pasta with various shape and other products. A lot of future work can be done to increase the functionality of the base machine by researching the decreasing serving time and decreasing the size and weight of machine. The machine will undergoes to produce similar varieties by undergoing the small modification by investigating certain issues related to base machine and demand accordingly. Adding a new flavors to the also proposed addition, as well as introducing a more user friendly interface the user and machine.

## CONCLUSION

The present study revealed that noodle could be made using different wheat milled product which are economically and also have beneficial national application and more consumption through a urban as well as the rural areas demands the machine that satisfied the requirement such as the compact designed, portable and operated by single person is need of hour now a days as domestic appliance in the market. There are different types of manual operated semi-automatic and automatic noodle making machine are available in the market .All the machine have its advantages and disadvantages to each other .manual operated machine need higher pressure and multiple people to handle machine.

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