Design and Development of Fish Food Pellet Machine

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Abstract **- Fish Food Pellet Machine Is Advantageous To Local Fish Farmer As It Supplies And It Is Also Economical. However, Fish Food Pelleting Equipment Are Known To Be Expensive And Unaffordable Particularly To The Local Farmer. A Prototype Of The Pelleting Machine Was Designed And Developed For Affordability. The Machine Was Also Tested To Evaluate Its Performance. The Machine Consisted Of A Piston And Cylinder, Springs, Roller, Worm And Worm Wheel, And Hopper. It Can Be Driven By An Electric Motor. The Average Specific Energy Consumption When 750 Cm3 Of Starch Binder Was Used Was 0.69 Kwh/Kg. The Density Of The Pellets Varied Between 0.7 And 1 G/Cm3. This Machine Can Be Manufactured At A Local Machine Shop For Small-Scale Local Fish Farmers In Developing Countries.**

Keywords: Development, Fish Food, Pellets, Machine.

1. INTRODUCTION

Indian current scenario of industry focuses on the high production rate with less consumption of resources. There are number of machines are available in market which is producing the fish food. But problem is that the cost of that machines are too much high and which is not affordable for local fish farmer and also small scale industries. To overcome this problems, we need to design such machine which is economical as well as highly efficient.

Fish Pelleting Machine is the one in which the material is turned into small pellets dry method. There are a wide range of applications for pelleting machine, and it is a commonly utilized industrial process all over the world, seen everywhere from plants which make animal feed to recycling facilities processing materials for reuse. This process is usually accomplished with a specialized machine called a pellet press machine, which can operate in a number of different ways, depending on the material being pelletized. Fish pelleting is dried material into small particles in the process of a machine. Where in the pellet press principle is the pressure between the piston and cylinders.

So we design such a machine with simple mechanism. Design of various parts of machine done through experimental calculations [1]. Fisheries college students also give the lots of information related with the fish food so this information help us to design a machine internal structure. Machine is very useful for those who can’t afford a costly machine for their business.

2. LITERATURE REVIEW

For many years, simple and common techniques have been used in processing fish food, which are basically cereal grains and their byproducts. They have been classified into Dry type fish feed machine and Wet type fish feed machine. The aim of designing and developing the fish food pellet machine is to affordable to local fish farmers and maintain the nutritional value. Machine produces different shapes and size of food by changing the pellets.

It has been pointed out that the mean particle size or grind of ingredient, and formulation play a major role in producing high quality pellets [2]. However, there is a limitation to the use of the fish food pelleting machine because of the high cost of the equipment for pellet processing [3 &4]. Hence, the local fish farmer, in Ratnagiri in particular, cannot afford to utilize the sophisticated fish food pelleting machine. This work aims at designing and developing a fish food pelleting machine and evaluating its performance.

3. METHODOLOGY

Tool Used

1. CATIA V5 (Design of components and structure)
2. Design data book (Design of springs)
3. Vernier caliper (Measurement of dimensions)

Experimental Procedure

1. We design various parts as per need of project and decided its dimensions after checking feasibility of model.
2. After deciding elemental parameters we move towards manufacturing of parts and its assembly.
3. This project required pit for installation of setup, so necessary of proper space selection and check the environmental conditions before installation.
4. Install the setup where performance is consistent throughout its operation.
5. Then run the setup and check the unexpected errors and modified them to improve efficiency.

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Working

Initially the motor is started, shaft of the motor giving motion to the worm and worm wheel. Reduction occurs drastically reducing the current rpm of 1400rpm to 14rpm. Output speed of the gear is input speed for the flywheel. Flywheel rotates at 14 rpm with roller, when material is fed into the cylinder through hopper that time piston moves downwards due to motion given by the roller. During downward motion, piston presses the material towards the screen. Heater is mounted on cylinder; material is some amounted heated in cylinder. The purpose of heater is to do not stick the material after passing through the screen. Screen have number of holes; the holes have same diameter as of required output. If we want large size of output then we can change the screen, which has large size of holes' diameter. After roller passes over the platform it gives motion to cutting mechanism which has number of links. Cutter is attached to link and it cuts the material which comes out of cylinder. Cutter has also number of holes equal to the screen holes. Material is cut by shearing action of cutter.

Figure 1: Fish Food Pellet machine.

Output from the machine:

for 1mm floating feed pellets

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for 2mm floating feed pellets

4. DESIGN AND MANUFACTURING [7]

- PISTON AND CYLINDER ARRANGEMENT:
- A piston cylinder arrangement is the main acting part in our device as said earlier we are pressing the dough and form the pallet.
- Cylinder of this arrangement consists of one inlet for dough feeding and screen having number of holes as an outlet. Screen is fitted with cylinder by means of Allen screw.
- SPRINGS [1]:
  Springs play a crucial role in complete mechanism and help to generate the vertical movement that is the return stroke of piston. Type of spring use here helical springs. The main function of the springs is to store energy due to the application of load by motor and is to release energy when the roller crosses over the platform. This forces the platform to get back to its original position.
- ROLLER [1]:
  Roller plays major role in movement of piston. When roller rolls on platform, piston moves up and down. Roller also gives movement to the cutting mechanism.
- WORM AND WORM WHEEL [1]:
  The main purpose of using the Worm & Worm Wheel gear is to reduce the speed. Reduction ratio of this gear is 100:1.

5. CALCULATIONS [1 & 5]:

Motor Selection [1]:-

$P = \frac{2\pi NT}{60}$

P = 0.1649 kw

[P] = 0.1804 kw

That is 0.25 HP = 0.1865 kw [5]

Worm & Worm Wheel Design:-

Ni = 1400rpm

P = 0.25HP = 0.1865kw

- Design Power:-
  [P] = P*S. F [1]
  S.F = 1.2 [5]
  [P] = 0.155*1.2
  =0.1865kw
- General Assumption [1]:-
  1) Helix on worm & worm wheel
  2) Tooth profile = Involute helicoids
  3) Pressure angle = 20^0
  4) Gear grade = Grade 3 & 4, Precision gear cuts
  5) Throating = Single throating

6) No. of starts & no. of teeth on worm & worm wheel [6]

$$Z = \frac{40}{i+1}$$

Z = 0.396

Therefore, Z= 1 {no. of starts}

$$i = \frac{z}{Z}$$

z = 100 {no. of teeth}

7) Selection of diameter factor [5]:

q = 11

8) Helix angle [5]

$\lambda = tan^{-1} \frac{100}{11}$

$\lambda = 5.19$

$\theta_s = \lambda + \beta_w$

$\theta_s = 90$

$\beta_w = 84.81^0$

$\beta_1 = \beta_{worm} = 84.81^0$

$\beta_2 = \beta_{worm\ wheel} = 5.19^0$

9) Virtual no. of teeth [5]

$$Z_x = \frac{z}{\cos^3\beta}$$

$B_1 = 84.81^0$ Z= 1 $Z_{v1} = 1350.977$

$B_2 = 5.19^0$ z = 100 $Z_{v2} = 101.24$

10) Lewis form factor [5]

$$Y_v = \pi[0.154 - \frac{0.912}{Z_v}]$$

$Y_{v1} = 0.48168$

$Y_{v2} = 0.45$

11) Determination of weaker element [5]

$F = [\sigma_b] * Y_v$

$F_1 = 65.0268$ N

$F_2 = 50.105$ N

Hence $F_1 > F_2$

Gear Wheel is weaker.

12) Module estimation [5]

$$a = \left(\frac{z}{q} + 1\right) * \sqrt[3]{\left[\frac{540}{\frac{z}{q}[\sigma_c]}\right]^2 * [M_t]}$$

$a_{exact} = 166.5$ mm

13) Check for bending failure [1]

$$\sigma_b = \frac{1.9[M_t]}{M_{x3} q Y_v Z}$$

$\sigma_b = 0.17866$ kgf/cm^2

$= 17.866$ N/mm^2 $\sigma_b < [\sigma_b]$

Hence design is safe against bending failure.

14) Determination of beam strength [1]

$F_b = \frac{[\sigma_b]\times b\times Y}{Pd_n}$

$F_b = M_n \times[\sigma_b]\times b\times Y$

$b = 0.75d_1$[5]

Therefore, $F_b = F_s = 3705.043$

15) Wear strength [5]

$F_w = d_2\times b\times k_w$

$F_w = 6534$ N

16) Dynamic load [5]

$F_d = \left[\frac{6+V_m}{6}\right]\times F_t$

$F_d = 14141.77$ N

$F_s = 14820.175$ N

17) Wear strength [1]

$F_w = d_2\times b\times k_w$

$F_w = 26136$ N

$F_d = \left[\frac{6+V_m}{6}\right]\times Ft$

$F_d = 7383.2057$ N

$F_s > F_d$ & $F_w > F_d$[5]

Design is safe against dynamic load.

18) Length of worm [5]

For $x = 0$, $Z=1$

$L \geq 68.16$ mm

Corrected length L_1[5]

$L_1 = L + 25$ mm for $M_x = 10$ to 16

$L_1 = 68.40 + 25$

$L_1 = 93.16$ mm

Spring Design [5]:

Force= 5Kg = 49.95N ≈ 50N

$K=\frac{p}{\delta}$

$\underline{\delta}= 0.018227\tau\tau$

1) Selection of Material [5]:
   a. For general purpose use SW spring steel oil hardened & tempered.
   b. So selecting

      $\tau = 760\ N/mm^2$
2) Spring Index [5]:

   Assume suitable value for spring index (c). For industrial application- spring index varies from 8 to 10. 9 is considered as a good value.
3) Wahl factor [5]:

   $K=\frac{4C-1}{4c-4}+\frac{0.615}{C}$

   K= 1.14

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4) Determine wire diameter (d) [5]:-

$\tau = K\left(\frac{8pc}{\pi d^2}\right)$

d = 1.38mm

$C = \left(\frac{D}{d}\right)$

D = 27mm

5) Determine number of active coil [5]:

$\delta = \left(\frac{8PD^3N}{Gdd^4}\right)$

N = 6.33

N = 7 coils

6) Solid Length [1]:

Solid Length = Nt x d

= 22.5 mm

7) Actual Deflection of spring [1]:

$\delta = \left(\frac{8PD^3N}{Gd^4}\right)$

δ = 13.76 mm

8) Free Length [5]:

Total axial gap = $(Nt - 1)$ x 1

= 8 mm

Free length: solid Length + Total axial gap + δ

= 44.46 mm

Bearing No 1 [1]:

F_r = 50 N, D = 24 mm

L_{10h} = 15000 hrs., N = 1400 rpm

1) Bearing Life (L_{10}) [1]

$L_{10} = \frac{60NL_{10h}}{10^6}$

= 1260 million rev.

2) Dynamic Load Capacity [1]

P = F_r = 50 N

C = P $(L_{10})^{1/3}$

C =540.04 N

Selecting Bearing no. as SKF6305 and d = 25 mm [5]

Selection of bearing No 2 [1]:

$L_{10} = \frac{60 \times N \times L_{10h}}{10^6}$

$C = P \times (L_{10})^{1/3}$

C = 10000 N

Selecting bearing as SKF 6204 and d = 24 mm [5]

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6. RESULTS AND CONCLUSION

Experimental data:

Sr. No	Input (kg)	Actual output (kg)	Required Time (min)	Production rate (kg/min)
1	0.05	0.035	2	0.025
2	0.1	0.07	4	0.025
3	0.2	0.14	8	0.025
4	0.3	0.21	12	0.025
5	0.4	0.28	16	0.025
6	0.5	0.35	20	0.025
7	1	0.7	40	0.025

Table 5.1 Experimental data

Advantages

The fish food pallet machines with simple mechanism benefits which makes it highly preferable than its conventional machines. The following are the advantages of our device.

- The biggest and most rewarding advantage is the simplicity of mechanism. We design a machine which is user friendly.
- The machine is portable and light in weight.
- Cutting mechanism & piston movements are work on only single motor, hence power consumption is low.
- It is cheaper than its conventional machines with results and performance better.
- It doesn't occupy productive space, thus enabling proper utilization of work area.
- It is easily affordable for local fish farmer.

Limitations

1. We need to adjust the stroke length for different size of pallet.

2. Feeding of the material is manually.

3. Output capacity of our machine is low.

Applications

The applications of fish food pallet machines are numerous. Apart from fulfilling the primary functions for which it has been conceptualized it renders useful cervices also.

- It is economical for those fish farmers whose production is only in fishing sections.
- It is useful for small scale industry

Result

Given input (kg)	Received output (kg)	Time (min)
1.00	0.70	40

Hence, per month production can be calculated by

Production = (output for 1 kg no of working hours) × 30 days

= (0.7 × 6) × 30

= 126 kg/ month

If we take cost of production per 1 kg to be Rs.100 then,

Income = Rs.12600/ month

7. CONCLUSIONS

Feeding of material is manual and rest working of machine is automatic. It converts 70% of given dough input into a required fish pellet. Compared to the conventional machine the overall design is compact and occupies a smaller floor area. Looking at the income per month the cost of pellet machine is recovered within the two months of production.

From above information we can conclude that our machine is simple in construction than conventional machines, also our machine is simple in handling.

8. FUTURE SCOPE

The limitation of our pellet machine is the feed which is given to it. It is manual there by increasing the time of production. In future if the feed given to it is automatic then time for the production will be considerably reduced. Also if the screens of variable size are made automatically adjustable then it will contribute much to the production.

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