Donut mixer using bevel gears transmissions with 18 kg/hour in capacity

F Maghfurah and Windarta
Mechanical Engineering Department, Universitas Muhammadiyah Jakarta
windarta@ftumj.ac.id

Abstract. Small scaled donut productions use hand mixer to mix flours, eggs and another dough contents. The usage of this mixer was followed by some obstacles, such as the plastic material astigmatism worm gearbox that resulting the edge of gears has friction loss. Metal material bevel gearbox may overcome the dough stirring problem. This gearbox is able to overcome big load and high spin. As a result, the capacity of stirring container is able to be maximized that increasing working productivity result. There are a few things must be designed in scheming of the design process, such as the scheming of shaft calculation, bearing, bevel gear transmissions and frame. The results show that the production capacity increase 225 % from 7 kg/hour in capacity using hand mixer to 18 kg/hour in capacity.

1. Introduction
In general, small scale industry uses hand mixer device. The device capacity is small and difficult when the mixing of density donut. It is because of the gearbox made of plastic material. The hand mixer will prone damage because of wear out in spur. Furthermore, the usage of hand mixer is less effective for time production efficiency.

The problem could be solved by the usage of metal gearbox for bevel gear type. As a result, the metal gearbox can handle the high burden and high turning, which may increase the result of job productivity. The design of mixer has been proposed by many researchers [1-7]. Ardiansyah et al. [1] state that the same kind of device ever be made in the usage for the dough mixing where kind of density of the dough was the same to the donut resistance. Furthermore, the speed of mixing of dough can be attempted constantly in order that create the qualify product both level of ripeness evenly. As the solution, job principle of the set performance of controlled direction of a full wave which combined with rotary encoder as velocity sensor to produce constant velocity of motor and adaptive torsion.

2. Method
The design concept of the mixer in this research is described in the following procedure:
1) Design the mixer with capacity 7 kg/hour.
2) Calculate the shaft, pin, bearing, bevel gear transmission and frame.
3) Assembling all the components.
4) If the result of the design is 20kg/hour the do the analysis. Otherwise repeat step 2.
3. Result and discussion

The performance design uses bevel gear, by the mover of gear about 10 gear and 16 moved gears. The calculation for finding out the comparison of gear wheel or gear ratio, can be calculated by the equation (1).

\[ i = \frac{z_2}{z_1} = \frac{16}{10} = 1.6 \]  

Surely, the comparison of gear wheel or gear ratio in this device is about 1.6. From the specification of electric motor that be used, the speed of motor is about 1400 rpm. So the speed of output axis from this mixer device (figure 1) is formulated as equation (2).

\[ \frac{n_1}{n_2} = \frac{z_1}{z_2} = n_1 \cdot \frac{z_1}{z_2} = 1400 \cdot \frac{16}{10} = 875 \text{ rpm} \]  

**Figure 1.** Design of mixer device.

Based on calculation the speed of mixer is 875 rpm. This result will be compared to measurement using digital tachometer (figure 2(a) and figure 2(b)). The result can be presented in table 1.

**Figure 2.** The speed of (a) shaft measurement (b) mixer measurement using digital tachometer.


|                         | Motor speed | Output speed |
|-------------------------|-------------|--------------|
| Theory                  | 1400 RPM    | 875 RPM      |
| Measured                | 1454 RPM    | 911 RPM      |
| Error                   | 3.86 %      | 4.21 %       |

It can be observed that the error based on theory and measured the motor speed is 3.86 %. The error for output (mixer) speed is 4.21 %. It is indicating that this result is secure since the error under 10 %.

3.1. Output result of donut cake dough
From the speakers who the writer makes an interview, the usage of hand mixer only can be used small measure device that only have capacity about 2 liters or 1.6 kg. Hand mixing process about 7 minutes, and 5 minutes in entering cake dough composition to the media of mixing. As a result, the output is about 8 kg/hour

   Bevel gear mixer has the capacity of mixing media about 7 kg. From the data testing result, the time for the mixer media and mixing process until evenly be gotten is about 8 minute. The mixer output is then about 26.25 kg/hours or 26 kg/hour. The result of time of mixing between hand mixer and mixer bevel gear device is presented in figure 3 (a) and (b).

![Figure 3](image_url)

**Figure 3.** Hand mixer and mixer bevel gear (a) mixing time (b) output.

Mixing process in mixer bevel gear needed longer time because the bigger capacity compared by hand mixer. However, output result from mixer bevel gear create more output, namely 26 kg/hour.

3.2. Break even point
The price of component for 1 mixer vertical device of donut cake dough by gearbox for bevel gear type by capacity about 7 kg will be presented in table 2. In making of 1 mixer bevel gear device, the workshop imposes the project service about IDR 800,000. So that, the price of mixer device that the writer makes in designing for by the expense of IDR 3,800,000 If this mixer device will be sold, according to [2], the price is about 10% + IDR 3,800,000 = IDR 4,180,000.
Table 2. The price of component.

| No | Component name               | Price (IDR) | Quantity | Total (IDR) |
|----|------------------------------|-------------|----------|-------------|
| 1  | Electric motor 0.5 HP        | 700,000     | 1        | 700,000     |
| 2  | Bevel Gear                   | 325,000     | 2        | 650,000     |
| 3  | Pivot ø 20mm                 | 300,000     | 1        | 300,000     |
| 4  | Baring                       | 20,000      | 5        | 100,000     |
| 5  | Iron plate 10 mm             | 550,000     | 1        | 500,000     |
| 6  | Hollow (40 x 40) 1.2 mm      | 300,000     | 1        | 300,000     |
| 7  | Stainless steel container    | 170,000     | 1        | 170,000     |
| 8  | ON-OFF switch                | 50,000      | 1        | 50,000      |
| 9  | Clutch                       | 50,000      | 1        | 50,000      |
| 10 | Stand by light               | 20,000      | 1        | 20,000      |
| 11 | Cable                        | 20,000      | 1        | 20,000      |
| 12 | Bolt                         | 5,000       | 4        | 20,000      |
| 13 | Nut                          | 5,000       | 4        | 20,000      |
| 14 | Spray paint                  | 25,000      | 2        | 50,000      |

Total 3,000,000

If it will be mass production, the use of BEP formula is necessary. There are permanent expense and its variable have been gotten by the leader in workshop which is the place of the making pf such mixer. Thus, by using the calculation of BEP formula, its detail is viewed as in table 3 and table 4.

Table 3. Fixed cost.

| No | Fixed Cost          | Price (IDR) |
|----|---------------------|-------------|
| 1  | Electric            | 800,000     |
| 2  | Rent warehouse      | 1,000,000   |
| 3  | Rent Car/month      | 1,500,000   |
|    | **TOTAL**           | **3,300,000** |

Table 4. Variable cost.

| No | Variable Cost    | Price (IDR) |
|----|------------------|-------------|
| 1  | Salary           | 2,000,000   |
| 2  | Carrying cost    | 100,000     |
|    | **TOTAL**        | **2,100,000** |

The price of mixer that planned to be sold. The calculation of Break Even Point rupiah is done as follows:

\[
\text{BEP in IDR (Rupiah) = } \frac{\text{fixed cost}}{1 - \left( \frac{\text{variable cost}}{\text{selling price}} \right)} = \frac{3,300,000}{1 - \left( \frac{2,100,000}{3,000,000} \right)} = \text{IDR 11,000,000}
\]

BEP Unit. From data of calculation for the value of Break Even Point can be concluded whereas BEP (IDR) will be reached for 4 units production.
4. Evaluation
The design mixer device is vertical for donut cake dough by gearbox bevel gear type for capacity about 7 kg use electricity motor by 0.5 HP by round of motor 1400 rpm. The used gearbox is about 1.6 of mixer bevel gear ratio to reduce the output round to 875 rpm. The mixer uses the media with 7 kg capacity, so that can create output about 26 kg/hour.

The result of output of hand mixer that only 8 kg/hour, so that mixer bevel gear device can increase the result of productivity with more than 18 kg/hour output. In other words, 225% from capacity of hand mixer.

5. Conclusion
The use of hand mixer only can be used in the media that have capacity about 2 litre or 1.6 kg. Process of mixing by hand mixer is about 7 minutes, and 5 minutes in entering the composition of cake dough in the media of mixing. To do so, the result of output in the usage of hand mixer kind is 8 kg/hour. Meanwhile, mixer bevel gear capacity is about 7 kg. By the time about 8 minutes in entering the composition of cake dough in entering the media of mixer and the process of mixing by the time about 8 minutes. The result of output that be gotten by this mixer device is about 26.25 kg/hour or 26 kg/hour.

By the result of capacity from hand mixer that only 8 kg/hour, so mixer bevel gear device can increase the result of productivity by capacity more than 18 kg/hour to increase 225% than the capacity of hand mixer device. The Break Even Point will be reached in 4 units production.

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