DESIGN AND FABRICATION OF BICYCLE OPERATED MILKING MACHINE

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Abstract

Modern milking machines extract milk from the dairy cow by applying a vacuum to the teat creating a pressure difference that results in milk flowing from the teat. Vacuum is applied by placing the teat into a cup in which the interior of the cup is subjected to a vacuum. The vacuum must be periodically reduced or removed to provide the teat with a rest period. The rest period is required because the vacuum causes the fluids (blood and other fluids) to accumulate in the teat causing congestion. Modern conventional milking machines attempt to provide this rest period by periodically applying a higher pressure (atmospheric) to the exterior of the cup causing the cup to collapse toward the teat. The typical conventional milking machine will thereby reduce the vacuum level on the teat. The periodic liner action created by the pulsing of higher pressure on the exterior of the liner is provided by a pulsates.

Key Words: *milking, dairy, pressure, vacuum, pedal, teat, pressure difference.*

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1. INTRODUCTION

Milking is most critical work in dairy farming. When done manually, milking a cow, which yields 15 Litre milk is very tiresome. People who milk 2 or more cows in a day may suffer stiff shoulder and weakness. Milking machines make milking easier. There are different models and various makes of milking machines available in the market. Some milking machines can support 10 to 15 milking clusters simultaneously. Small formers having less than 6 cows cannot afford to buy and use these machines. So we are developing a simple, easy-to-use, low-cost, manually-operated machine for milking dairy cows. The machine consists of a powering unit and teat cluster assembly. A bicycle arrangement enables the user to sit on it and start pedalling. The vacuum generated by pedalling draws milk from the teat and massages the teat by squeezing the rubber liner.

1.1 Components of milking machine

The basic components of milking machines as given below, it include Milk collection in a bucket placed next to the cow; Pipeline systems in which cows are milked in a cowshed and the milk flows to a central collection tank; Parlour systems in which all the equipment is centralized and cows come to the parlour for milking. Despite the great diversity of milking installations, milking machines work on the same basic principle: milk is collected from the cow by vacuum (suction).

1. Piston and cylinder
2. Teat cup
3. Bearing
4. Shaft
5. Bearing
6. Cattle
7. vacuum gauge
8. Pulley
9. Non-return valve

1.2 Proposed solution

Safe milking of cow/buffaloes is a requirement across rural India. In rural India availability of skilled labor for milking is also a problem now days. Adding to this is the fact that milking by hand is not considered healthy or hygienic anymore. Power operated milking machines are available in the market which are very expensive, suitable and affordable only for large cattle farms. Finding skilled labor for milking a small herd of cows is a problem often faced by a small-time farmer. Adding to this is the fact that milking by hand is not considered healthy or hygienic anymore. But milking using a machine is a luxury which only a large farm or dairy house can boast of, calling for a huge investment in power supply and machinery. All of these we are thinking very hard about developing an alternate means of mechanized milking which would be affordable to all farmers.

2. WORKING

The principle of cycle operated machine milking is to extract milk from the cow by vacuum. The machines are designed to apply a constant vacuum to the end of the teat to suck the milk out and convey it to a suitable container, and to give a periodic squeeze applied externally to the whole of the teat to maintain blood circulation. When operator start cycling the manual force is get applied on the pedal so that the driving sprocket is start rotating. This power is transmitted to the driven sprocket by means of chain drive system. The shaft is connected to the driven sprocket starts rotating; the disc also rotates which is attached at the end of shaft. This rotary motion of disc is converted into reciprocating motion of the vacuum pump through linkages.
This reciprocating motion of vacuum pumps sucks the air present in the storage tank and release into the atmosphere and creates vacuum in the storage tank. Generally the vacuum pressure of 400 mmHg is required and when it obtained the teat cup and cluster assembly is attached to the cow teat. After proper attach of assembly open the cock and due to the negative pressure difference in cows udder and storage tank the milk is extracted and store into storage tank.

3. DESIGN CALCULATIONS

In our attempt to design a pneumatic train we have adopted a very careful approach. Total design work has been divided into two parts mainly,

1. System Design
2. Mechanical Design

System design mainly concern with the various physical concerns and ergonomics, space requirements, arrangements of various components on the main frame of machine, number of controls, positions of this controls, ease of maintenance, scope of further improvements, height of machine components from the ground etc. In mechanical design, the components are categorized into two parts.

1. Design Parts
2. Parts to be purchased

3.1 Design of chain

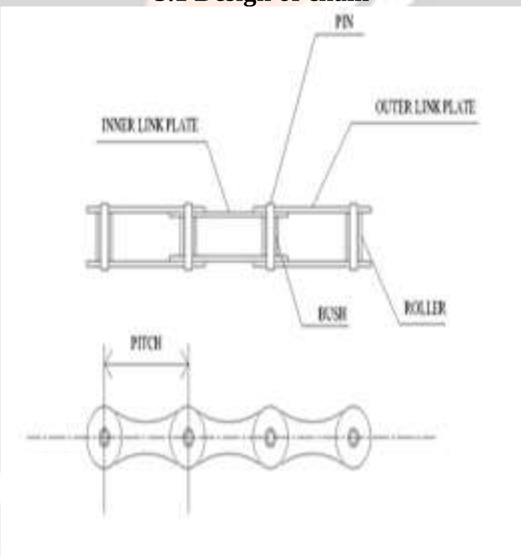


Fig-1: Construction of chain

Table-1: Selection of chain

ISO chain	Pitch P	Roller diameter D1	Width B1	Breaking load for Single stand chain
08 B	12.70	8.51	7.75	18.2

3.2 Design of Bearing

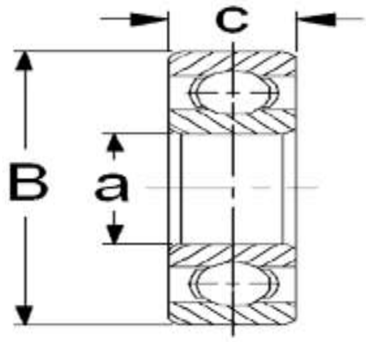


Fig-2: Bearing

Table-2: Selection of bearing

Bearing no	a (mm)	D1 min (mm)	B (mm)	D2 max (mm)	C(mm)
6200	10	14	30	26	9
6201	12	16	32	28	10
6202	15	19	35	31	11

3.3 Design of shaft

As per American Society of Mechanical Engineers(ASME) code.

Material selected for shaft = C40. (PSG Data Book PN. 1.19)

Ultimate Tensile Strength of the Shaft Material (Sut = 580 N/mm^2)

Yield Strength of the Shaft Material (Syt= 380 N/mm^2)

Allowable shear stress for shaft is,

τ = 0.18 Sut = 0.18*580=104.4 N/mm^2

τ= 0.3 Syt = 0.3*380=114 N/mm^2

Select Minimum of two values is,

τ = 104.4 N/mm^2

Torque on shaft= load on gear * (Diameter of gear/2)

Assume load on gear is 50kg.

50kg= 50*9.81N

T = 50*9.81*($\frac{200}{2}$)

T = 49.05 * 10^3 N-mm.

Force Analysis:

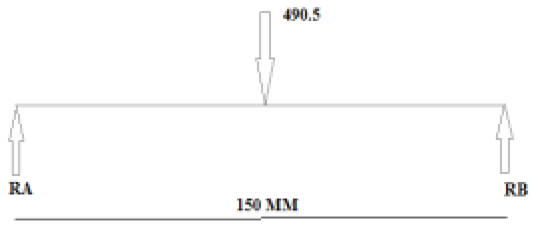


Fig-3 : Force Analyses

Calculate reactions,

$\sum F_y=0;$

$R_A+R_B = F$

$R_A+R_B = 490.5$ (1)

Taking moment about A,

$\sum M_A=0;$

$= (490.5*75)-150R_B$

$150R_B = (490.5*75)$

$R_B = 245.5$ N

Put value of R_B in equation (1),

We get,

$R_A=245.5$ N

$R_A= R_B = 245.5$ N

Bending moment calculation,

$BM_A=BM_B=0;$

$BM_C= 245.5*75=18.393*10^3$ N-mm

Maximum bending moment is $M_C= 18.393*10^3$ N-mm.

Calculation of Shaft Diameter:

As per ASME code,

K_b = shock factor = 1.5

K_t= Fatigue factor = 1.0

According to Maximum shear stress theory,

$\tau_{max}= \frac{16}{\pi\, d3}\sqrt{(K_b*M)^2+(K_t*T)^2}$

$104.4 = \frac{16}{\pi\, d3}\sqrt{(1.5*18.393*10^3)^2+(1*49.05*10^3)^2}$

$d^3 = 2745.36$

d = 14.49 mm

= 16mm

Therefore we are selecting the shaft standard diameter of size 16mm

3.3 Design of leaver

Lever is defined as mechanical device in the form of rigid bar pivoted about the fulcrum to multiply or transfer the force.

Material selected for lever is C30 (Cold formed lever)

Sut=550 N/mm^2

Syt=300 N/mm^2

F=force produce by the lever

P=effort required to produce that force

Therefore *l*1 and *l*2 are effort arm and load arm respectively.

Tsaking moment of forces about the fulcrum,

F**l*2=P**l*1

Assume *l*1= *l*2=95 mm

$\therefore \frac{F}{P}=\frac{l1}{l2}$

$\therefore$F=P=490.5 N

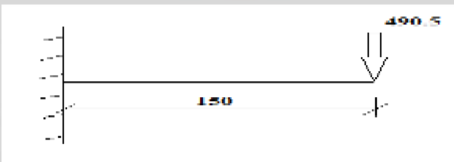
When *l*1<*l*2, mechanical advantage < 1

When *l*1=*l*2, mechanical advantage = 1

When *l*1>*l*2, mechanical advantage >1

3.4 Design of leaver

Force acting on lever is determined; the cross section of lever is subjected to bending moment. The cross section at which the bending moment is maximum can be determined by mending moment diagram. The bending moment is maximum at section XX and it is given by



Mb=P*L

=490.5*150

=73557 N-mm

=73.557*10^3 N-m

The cross section of the lever can be rectangular, for rectangular cross section

I=$\frac{bd^3}{12}$ and y==$\frac{d}{2}$

Where

b = distance parallel to the neutral axis

d = distance perpendicular to the neutral axis.

Assume dimension d is taken as fourth of b d=2b or d=4b (empirical relation)

d=4*7

d=28 mm

$\therefore I=\frac{bd^3}{12}$ and $y=\frac{d}{2}$

$I=(7*28^3)/12$ $=\frac{28}{2}$

$=12805.33\ mm^4$ $=14\ mm$

Using the above proportion, the dimension of the cross section of the lever can be determined by

$\sigma b=\frac{Mb*y}{I}$

$=\frac{73575*14}{12805.33}$

$=80.44\ N/mm^2$

Design check for safe

Assume factor of safety = 2 (PSG Design data book)

$\sigma b=\frac{Syt}{fos}$

$=\frac{300}{2}$

$=150\ N/mm^2$

As obtained value is less than design value

i.e. $80.44\ N/mm^2 < 150\ N/mm^2$

Hence, design of lever arm is safe.

3 CONCLUSION

In this project we have learnt the development of new idea and technique of ejecting the milk from cow effectively and economically which quite difficult and costly task was by using another milking machine.

"This machine enables the milk to be drawn completely, something even the most popular electrical versions in the market cannot do''.While electrical milking machines cost up to Rs.75, 000, including installation, and run up a recurring operational cost on electricity charge, the machine going to develop by the us costs only Rs.12, 680, including the milking can and teat cluster assembly. On mass production, it is expected that the machine can be marketed at a price lower than Rs.10, 000.

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