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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.

Keywords: Milking, Dairy, Pressure, Vacuum, Pedal, Teat, Pressure DIFFERENCE

I. INTRODUCTION

For milking a cow the required vacuum pressure is approximately -41Kpa. This pressure can be achieved with the help of piston cylinder arrangement. The vacuum is generated inside the kettle by the suction of air with the help of piston moving inside the cylinder actuated with the help of single slider crank chain mechanism. Now a day's increasing busy schedules of human due to lose the maintainability. So we develop a manual Milking machine is driven by Manpower, through a linkage. This machine is useful for human exercise. In this project we use crank chain mechanism which are operated by bicycle through a operating pedal. In market hand operated, battery operated and automatic operated milking machines are available but cost are more, so we want to use manual operated milking machine for vacuum creation.

The manual 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 liner in which the interior of the liner 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 The main benefit of this system is cost effective over the other available systems with considerable reliability.

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.

II. METHODS AND MATERIAL

General layout of milking machine

Figure 1. Bicycle Milking machine

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. Milking Cluster
2. Teat cup
3. Bearing
4. Shaft
5. Bearing
6. Cattle
7. vacuum gauge
8. Pulley

Vacuum Pump

The source of vacuum in a milking machine is a vacuum pump. Its function is to create a partial vacuum in the system by removing air from a confined space (the lines, teat cup liner, and reserve tank).

Figure 2. Vacuum pump

These pumps are normally of the sliding vane type and are driven by electric motor. They require little maintenance and periodic checking of drive belt tension along with topping- up of the oil reservoir is usually sufficient. The pump should have sufficient capacity to be able to maintain a vacuum of 15 inches of mercury through out the milking period. This level of vacuum should be sustained even if a unit is kicked off by a cow or as unit are fitted or removed from the animal. It is generally recommended that the pump be of sufficient size to displace at least 25% more air than is required to operate the milking units and to lift and transport the milk to the cooling and storage area if a pipeline system is used. This additional displacement allows for efficiency as the pump wears with age. Excess capacity is controlled by vacuum regulator.

Teat Cup and Cluster Assembly

Consists of four teat cup assemblies each having a rubber liner and connected to vacuum by rubber tubes and claw. The air admission hole to stabilise the vacuum must be kept clear. The cluster which attaches to the cow, consists of four teat cup assemblies a claw, a long milk tube. Teat cup shells are normally made of stainless steel, Plastics or a combination of plastics and metal are also used. The liner is a flexible rubber sleeve having a mouthpiece, and when assembled in the shell under tension, forms an annular space between the liner and shell. The teat cup assemblies are connected by short to stabilise the vacuum in the teat cups during milking, the claw has a small air admission hole, about 0.8 mm in diameter, which admits approximately 7–8 litres of air/min into the bowl of the claw. This air helps to carry the milk away, preventing flooding and violent vacuum fluctuations. The claw is made of plastics, and usually weighs about 0.25 kg and the total all up weight of a milking cluster is about 0.5 kg. The weight of a milking cluster is important and the correct weight relates to the design of liners. Too little weight gives incomplete milking because of high levels of stripping, too much weight will result in milking units falling off during milking. The bore of the rubber short milk tubes should not be less than 8 mm and the short pulse tubes not less than 5 mm, and the long milk tube should not be less than 12.5 mm. The effective claw bowl volume should not be less than 80 ml.

Figure 3. Teat cup and cluster Assembly

Table 1. Selection of appropriate variant for efficient and gentle milking.

Variants	Selection decisions
Size of teat cup liners	Dia. 19mm, 23mm, 25mm and 27mm
Vacuum level	Ranges from 40-50 kPa
Type and length of stimulation phase	Conventional or European. Time in minutes
Weight of milking cluster	Ranges from 1.5-3.5kg
Milk capacity of claw piece	200 cm3 or 300 cm3
Way to attach milking unit	From the side of animal or from the hind legs
Milking with one or two milking cluster per bucket	Requirement of dairy farmer and capacity of machine

Vacuum gauge

Air Hoses

Milking Claw

Milking Bucket

Figure 4. Different parts of mobile bucket milking machine

The following methodology was adopted:

- A herd of 12 buffaloes will be machine milked for full lactation period;
- Suitable sizes of teat cup liners will be determined among the available liners of 19, 23, 25 and 27 mm in diameters;
- Suitable weight of the milking cluster will be determined among the available clusters of 1.8, 2.1 and 2.6kg;
- Milking will be performed two times in a day (Morning and Evening) with even milking gap. The instantaneous increase in milk weight will be measured with time;
- Milking with one and or two clusters per bucket will be performed. Milking will be made on different vacuum levels. The most appropriate vacuum level will be determined;
- Any changes occurring in the teats after milking will be examined; and
- Alternate washing of the machine will be performed with an alcalic rinsing agent in the morning and an acidic rinsing agent in the evening.

III. 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.

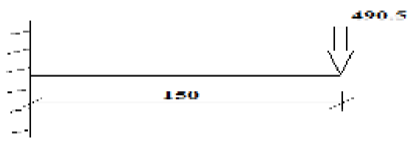
Fig 2: Working of Milking machine

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.

IV. CALCULATION

Design of lever

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*103 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

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

I= (7*283)/12 = $\frac{28}{2}$

=12805.33 mm4 =14 mm

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

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

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

=80.44 N/mm2

Design check for safe

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

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

=150 N/mm2 $\frac{300}{2}$

As obtained value is less than design value i.e. 80.44 N/mm2<150 N/mm2

Hence, design of lever arm is safe.

V. RESULTS AND DISCUSSION

The milk buffaloes of this study in the beginning of the experiment were much nervous and shy due to unfamiliar milker and noise of the machine pump. However, the animals used to machine milking after 4-5 milking. The response of buffaloes to machine milking with different variables is summarized as under:

A. Size of teat cups liners for water buffaloes

The best suited size of teat cup liner for the milked animals was 25mm in diameter among the liners used (19mm, 23mm, 25mm and 27mm). All test buffaloes with long and short teats could be milked extremely well using this liner. The 25mm dia. liner was used throughout the experiment period.

B. Vacuum level

Different vacuum levels were set for single and double clusters using vacuum control valve. The pulsation ratio and pulsation rate of the pneumatic pulsator was 60:40% and 60 per minute, respectively. The vacuum level 46-48kPa and 44-46kPa gave maximum milk yield (0.807 and 1.086 liters per minute) for single and double clusters, respectively (Table-2).

C. Type and length of stimulation phase

The milk let down was achieved by stimulating teats for two minutes and stripping the first jets into the buffalo's mouth.

D. Weight of milking cluster

The weight of the milking cluster has decisive influence on the milking results. Three different clusters weighing 1.8, 2.1 and 2.6kg were used. The 1.8kg cluster was having light teat cup shell and plastic claw piece. The disadvantage of this cluster was that the liners climbed up the teat contraction, resulting in long milking time and low milk output. The 2.1kg cluster was having light teat cup shells and stainless steel claw piece. This cluster proved to be superior for the smooth and sponge like teats. The 2.6kg cluster had normal teat cup shell and stainless steel claw piece. The problem faced was its adhesion and stretching.

E. Milk capacity of claw piece

The claw piece having volume of 300 cm3 gave the best results.

F. Way to attach milking unit

All the animals were milked from the side of the animals.

G. Milking with one or two milking cluster per bucket
This depends on the requirements of dairy farmer and the capacity of machine. During this experiment the animals were milked using single and double clusters.

Table 1. Selection of appropriate vacuum level using single and double cluster milking.

Nature of milking	**Vacuum level (Pressure)** (kPa)	**Average milk yield per minute** (Liters/minute)
Single cluster	42-44	0.71 1
	43-45	0.78 6
	44-46	0.79 2
	46-48	0.80 7
	47-49	0.72 4
Double cluster	41-43	
	41-43	0.72 6
	42-44	0.92 7
	43-45	0.96 4
	44-46	1.08 6
	45-47	0.98 1

VI. CONCLUSION

The equipment is useful for removal of milk by utilizing less energy gives better performance. After making this innovative system, we conclude that this system totally operated on man power. Therefore no requirement of energy means type of system is useful for save natural energy source. System gives better performance considering manual milking machine.

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