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Performance Improvement of Milking Machine

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ABSTRACT

Dairy production is a long term production of milk, which is processed either on the farm or at a dairy plant. For producing dairy products from milk; dairy machineries are required for milking, storing, transporting, processing, pasteurizing, in which milking plays vital role. It is first step to move milk from animal udder to storage tank. In current scenario most of the farmer prefer milking machine compare to hand milking. It avoids labour availability; reduce drudgery and is faster in milking. But now a day manufacturing industry faces the problem in milking machine such as choking of pulsator, decreasing vacuum flow of pump, which may affect performance of milking machine on site. So our work is focused on design implementation and testing of milking machine component for performance improvement with help of testing and data analysis. By imposing new design we can reduce cost, weight and size of machine and with help of long term testing of components major problems such as pulsation failure or choking of pulsator on site can be eliminated.

KEYWORDS: Milking Machine, Pulsator, Vacuum Pump, Design and Performance

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INTRODUCTION

In today's highly competitive market, industries should view customer satisfaction. One of the most important is the quality of service and quality of product.

In the field of dairy machinery production, we know that dairy is a class of agriculture for long-term production of milk, which is processed (either on the farm or at a dairy plant, either of which may be called a dairy) for eventual sale of a dairy product.For producing a dairy product from milk; huge amount of milk is required there for some of industries developeddairy machines for easy to work with long term milk storage, huge amount of milk transported and fast milking.[1]

Most commonly used dairy machines for milk are:

1. Milking Machine
2. Bulk Milk Cooler (BMC)
3. Silo

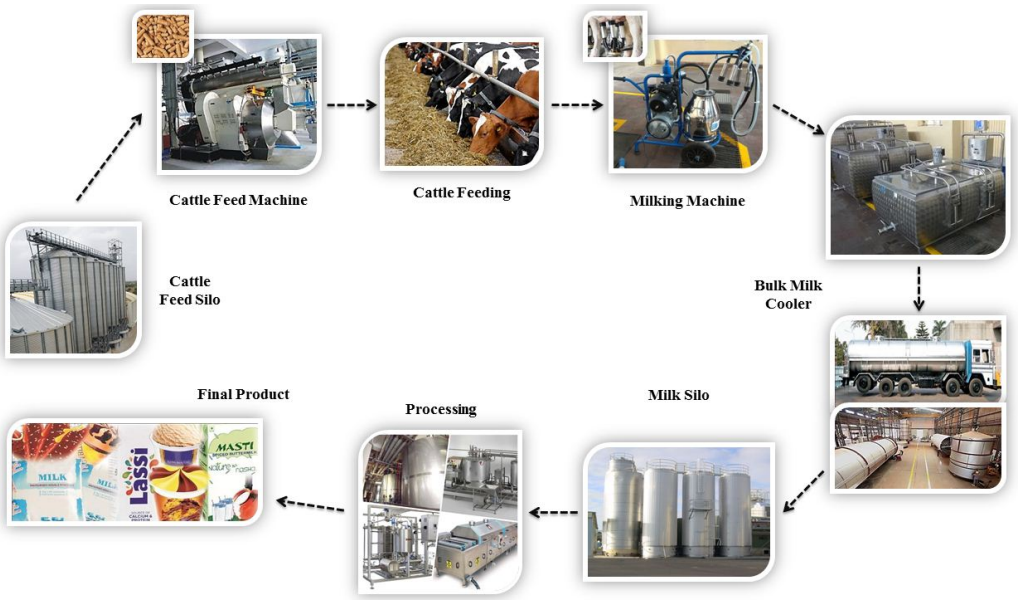


Figure1. Integrated Approach to Dairy

These all machines are partnering the whole supply chain integrated approach to dairying from the cow to the consumer as shown in figure 1.

A milking machine is a device composed of several parts that when properly assembled and supplied with a source of energy will remove milk from an animal's udder and transport milk to a storage vessel (BMC).

This machine is used to milk cows and buffaloes. This milking machine is manually operated low cost device that can help farmers to milk the animal hygienically, reduce drudgery and eliminate the problem of labor availability. Bucket milking machines are easy to operate, provide efficient and

consistent milking, faster and batter in milking than hand milking. Mainly two types of milking machines are available viz. fix type and trolley type.[2]

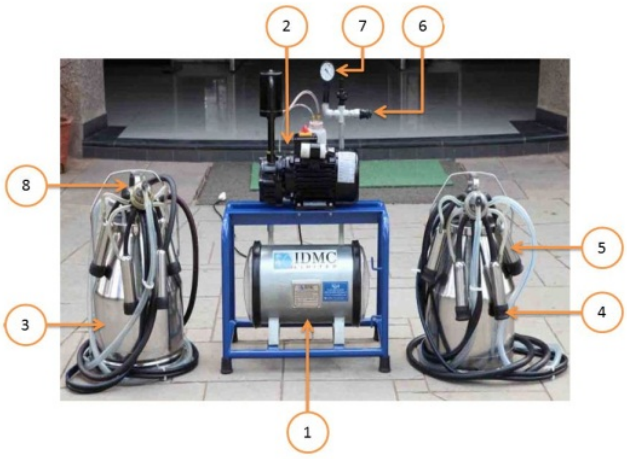


Figure2. Fix Type Milking Machine

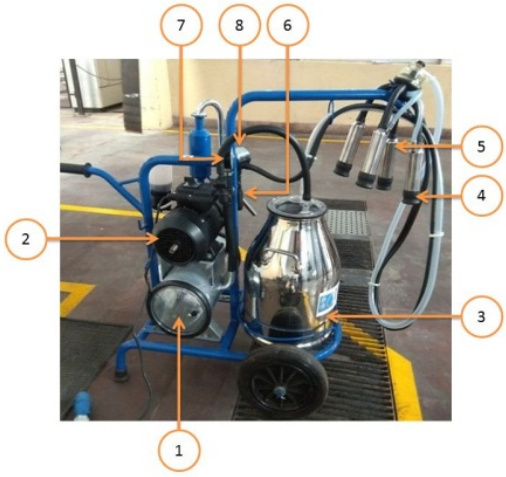


Figure3. Trolley Type Milking Machine

The working principles of these both types of machines are same. It opens the streak canal through the use of a partial vacuum, allowing the milk to flow out of the teat cistern through a line to a receiving container. It massages the teat which prevents congestion of blood and lymph in the teat.[3]

In fixed type milking machine, cattle is taken to the machine for remove milk when in trolley type milking machine cattle is fixed and machine is taken for milking from cow barn. The milking capacities of this both types of machines are same, in addition single bucket and double bucket machine is used for more cattle milking.[4, 5]the main components of the milking machines as shown in figure 2&3 are:

1) Vacuum Tank
2) Vacuum Pump
3) Milk Bucket
4) Liners
5) Teat Cup Shell
6) Regulator
7) Gauge
8) Pulsator

The main system of milking machine can be divided into three categories:

1) Vacuum System
2) Milking Unit or Cluster
3) Pulsator

In the vacuum system, a vacuum is generated by mono block pump and stored into vacuum chamber. The system consists of vacuum pump, vacuum tank, silencer, gauge, regulator, oil lubricator, stopper valve and frame. Almost all the operations connected with the milking process are carried out using vacuum as a source of energy.This system creates the vacuum pressure and removes the air from whole system.[6]

In the milking unit, milk is stored into bucket from cluster which is connected to animal udder. The milking unit consists of milk tube, pulse tube, claw, liners, teat cup and bucket. Each unit style is designed to maintain optimal flow rates, stable vacuum levels, ergonomic handling, and proper unit alignment to the udder.

Figure4. Pulsator

Pulsator is heart of milking machine as shown in figure 4. It works on the vacuum pressure receive from the pump and this pulsator action generally takes place around 60±5 times per minute. The pulsator alternately admits air and vacuum into the pulsation chamber formed between the rubber liner and the shell. This causes the liner to open and close during milking.Twotypes of pulsation system are commonly used for milking machine viz. simultaneous and alternate pulsation system.[7] the design and working of pulsator is very critical.[8]

The objective of this study was to investigate the working of milking machine and to eliminate existing problems. Also design modification of milking machine can reduced the cost. In addition, the result of testing and data analysis of vacuum pump and pulsator can also improve the performance of milking machine.

INVESTIGATION OF MILKING MACHINE

Company is a leading manufacturer and supplier of a complete range of equipment for the dairy industry. The major problems faced by company are decreased vacuum flow rate, pulsator failure and defective raw material of pulsator.[9, 10]

The present work is aiming at continuous production of milking machine and improving its performance for easy to use. The continuous production shall be done in light of regularly access material and by imposing design and testing can improve its function.

Investigation of milking machine leads to following three issues:

1) Design modification and its validation
2) Testing of vacuum pump

3) Choking of pulsator

Our existing design of milking machine frame is used to fit the vacuum pump and vacuum tank. Design modification of milking machine can be done by eliminating the existing vacuum tank by utilizing volume of hollow frame. Resultant proposed design can reduce weight, cost, and space.

Pulsator is heart of milking machine and works on vacuum system. There are twenty one very small parts inside the pulsator. Performance of pulsator depends on various assemblies of pulsator parts into pulsator hub. But on site many pulsator fails to perform. The reasons behind the failing of pulsator are lots of burr into hole of air circulation, casting impact, environmental dust and improper assemblies of parts.[11]

DESIGN MODIFICATION OF MILKING MACHINE FRAME

To eliminate the vacuum tank our new design of frame is proposed as shown in figure 5. In which only vacuum pump is fitted on the frame. The volume of existing vacuum tank (6505.45cm^3) is equivalent to newly design hollow frame. Here, ASTM A312 standardize material was used.

The dimension of pipe is outer diameter 42.16 mm and thickness is SCH 40 (3.56 mm) and the dimension of rectangular hollow pipe is 50 mm ×100 mm.

For experimental work, A312 pipe was used which is common stainless steel for industries and the material grade is TP304. The weight of the new developed frame with mounted pump is 42.04 kg, which is lighter than existing frame with mounted pump i.e. 60.05 kg.

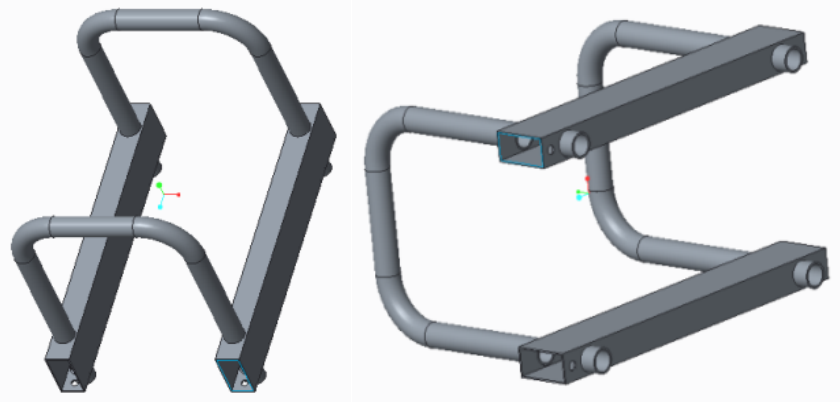


Figure5. Design of Milking Machine Frame

TESTING OF VACUUM PUMP

The setup of vacuum pump testing is shown in figure 6. Here, vacuum pump is continuously tested for eight hours. Its performance parameters viz; vacuum pump voltage, ampere, vacuum flow rate, temperature and tolerance were analyzed. As per capacity of vacuum pump, standardize acceptance and rejection criteria were made for vacuum pump. The vacuum pump flow rate is kept over 185 LPM.[12]

Figure6. Vacuum Pump Testing Setup

Table: 1 Vacuum Pump Test Report

Vacuum Pump Test Report											
Sr. No.	Pump Sr. No.	LPM @ 50 KPA	Max Voltage	Max Ampere	Temperature		Voltage Tolerance			Result	Remark
					Motor	Pump	150 V	200 V	250 V		
1	448918	185	228.7	6.41	81.3	114.7				Ok	
2	362818	165	228.7	5.9	90.3	126	Ok	Ok	Not Ok	Not Ok	Burn
3	386818	198	231.1	6.54	97.7	120.3				Ok	
4	385818	185	228.9	6.67	100.1	130.1				Ok	
5	382818	168	229.4	6.2	94.3	144.6	Ok	Ok	Ok	Not Ok	
6	412818	210	242	7.53	102.3	113.1				Ok	Ok in 2nd Trial
7	2920618	200	241.7	7.58	97.8	108.5	Ok	Ok	Ok	Ok	Ok in 2nd Trial
8	440918	190	227..3	6.14	127.5	128.3				Ok	
9	379819	190	227.8	5.95	129.8	127.6				Ok	
10	338718	203	229.5	6.75	132.6	147.8	Ok	Ok	Ok	Ok	

As shown in table 1, vacuum pump test were satisfied, hence the milking machine pump is completely ready to work on site.

TESTING OF PULSATOR

The setup of pulsator testing is shown in figure 7. Here, pulsator was manually assembled and continuously tested 48 hours for its hygienically performance. Its performance parameters viz; vacuum pressure, pulsation rate, milking phase, massage phase and limp were analyzed.

Considering the condition of the cow in India, standardize acceptance and rejection criteria were made for pulsator. In the range of vacuum pressure 42 to 46 kpa; pulsation rate should be 65 ± 5 cycle per minute, milking phase (A+B) should be 60 to 65%, C should be 5 to 10%, massage phase (D) should be 30 to 35% and limp should not be more than 5% of total pulsator time as shown in table 2.

Figure7. Pulsator Testing Setup

Pulsator test report (table 2) shows that, pulsator number 2 and 4 does not perform satisfactorily & hence rejected. Rest of acceptable pulsator is completely ready to work on site without choking.

Table: 2 Pulsator Test Report

Pulsator Test Report										
Pulsator No.	Total Performance Hour	Vacuum Pressure (Avg.)	Pulsation Rate (CPM) (Avg.)	A + B (Avg.)	B (Avg.)	C (Avg.)	D (Avg.)	Limp	Result	Remark
				Milking Phase		Massage Phase				
1 L	48	44.21	65.94	67.96	60.98	3.04	28.75	7.1	Ok	
1 R		44.21	65.75	60.86	55.01	5.04	33.75			
2 L	28.5	44.15	67.24	55.77	52.61	4.8	39.15	7.15	Not Ok	Leakage of Air
2 R		44.15	67.18	62.92	59.68	2.85	33.99			
3 L	48	44.40	64.17	63.24	58.82	2.85	33.60	1.41	Ok	
3 R		44.40	64.14	61.83	57.43	2.44	35.41			
4 L	43	44.28	66.19	58.2	54.21	2.92	38.50	3.72	Not Ok	Hub Issue
4 R		44.28	66.15	61.92	57.95	3.33	34.58			
5 L	48	44.44	66.67	61.65	56.62	2.77	35.30	1.25	Ok	
5 R		44.44	66.37	60.40	57.24	4.45	34.74			

FINAL TESTING

Modified design of milking machine is shown in figure 8. Subsequently accepted vacuum pump and pulsator was fitted into newly modified frame and final testing of milking machine was carried out. Its performance parameters viz; maximum vacuum, time to reach 50 kPa, and pre-adjustment of pulsation rate were analyzed.[13]

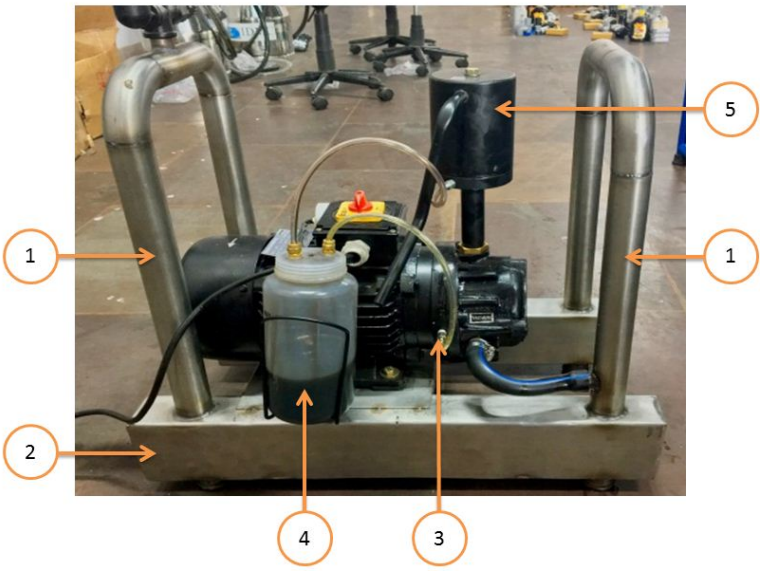


Figure8. Modified Design of Milking Machine

The main components of modified milking machine are:

1) SS304 Pipe
2) SS304 Rectangular Pipe
3) Vacuum Pump
4) Oil Lubricator
5) Vacuum Pump Silencer

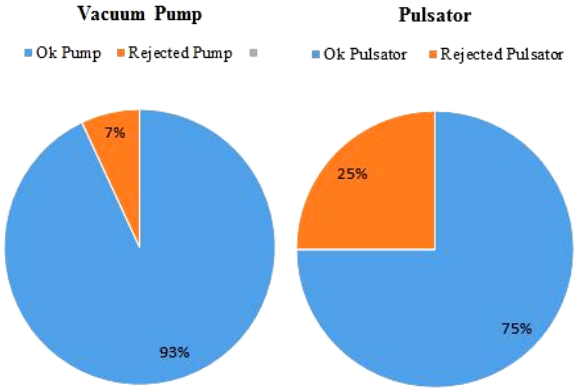
Table: 3 Final Test Report

Final Testing										
M/C Sr. No. 22F0XXXXXXX01						Pump Sr. No. 38XXX8				
Sr. No.	**Pulsator No.**	**Vacuum Pressure**	**CPM**	**A + B**	**B**	**C**	**D**	**Max vacuum should be > 50 kpa @ 80”40 mm dia. vacuum line**	**Time to reach 50 kpa vacuum (second)**	**Remark**
1	J 001	42.3	66.5	64	60.6	2.2	33.8	80	4.76	-
		42.1	66.5	63.7	60.6	2.2	34			
2	J 002	44.7	66.7	62.2	58.8	2.3	35.3	80	4.76	-
		44.5	66.7	64.3	61	2.2	33.3			

Final test report (table 3) shows that new modified milking machine provides excellent performance. Hence the milking machine is completely ready to working on site without complains.

RESULTS AND DISCUSSION

With increase in technology and by optimization of available resources, the testing of milking machine are really useful assets to reduce cost, improve performance, and reduce human error.[14] Graph 1 show the 30 days testing results of vacuum pump and pulsator.



Graph.1: Testing Report of 30 Days

CONCLUSION

Testing of vacuum pump leads to minimum rejection ratio. Also testing of pulsator reduces failing ratio of pulsation. Modified design imposes the ultimate performance compared to existing

one. These testing also able to improve production rate of milking machine by minimizing customer complain.

FUTURE SCOPE

Robotic milking and milking parlor can be developed in future work.[2, 15]

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