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Development of New Compact Design to Rinse the Milk Jar – An Innovative Practical Machine Mechanism for Commercial Utility

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Abstract

Rinsing milk jar is a not common problem, but it is generally known that milk jar getting scaled due to improper rinsing action. In traditional way, this has usually been done by pouring water into it and washing is done by hand only .In short it leads to unhygienic cleaning. Sometimes due to contamination present in one jar whole stored milk get wasted. Another serious disadvantage is formation of scale. Scale is formed inside the jar which doesn't removed by regular or traditional washing. This residue is of more or least continuous film and presence of milk spot left on jar as result of continuous storage of milk in short words due to dissolved solids, fats present in milk. This operation produced a great deal of formation of scale that is rather objectionable both from the standpoint of health and cleanliness and also more water gets used for rinsing purpose that is consumption of water in proportion with quality of cleaning is not suitable. Therefore, it is necessary to have the provision for automatic cleaning which removes retained scale in inner side of jar. This type of cleaning removes each either possibility of health related problem caused due to scale residue. For this reason, the design is based on simple centrifugal action, which includes scrubber pads initially attached together makes mechanism compact. In this paper, concept puts forward a kind of mechanism that can removes scale residue and perfectly clean the jar as compared to the traditional method. In design methodology, the mechanism provides method of rinsing machine to rinse the milk jar at room temperature that is desired in

commercial which is simple, easily practiced, highly effective in void the formation of milk spots upon rinsed and dry milk jar, and it doesn't require elaborate and expensive apparatus or skilled operator. It's connotation of 'compact' includes the attached scrubber pads to shaft which get spreads through angle of 90^{o} and becomes parallel to jar.

Keywords: Scale residue, rinsing action, jar, rotary type mechanism, scrubber pads, design analysis, force analysis etc.

1. Introduction

Essential proteins and vitamins require for normal growth and for sustaining in any type of environment for human body is provided by milk. In India after white revolution takes place, the concept originated by Dr. Verghese Kurien takes place there are so many milk firms working on co-operative basis or commercial basis grows rapidly. Aim of this revolution is simple, to provide essential vitamins and proteins to each individual through milk. So the collection and distribution of milk serves importance. The importance is given for storage and identification of content of milk, which is must in proper way but cleaning of milk jars by which milk is collected from different farmers from different places to one place that is milk diary is neglected era. In developing country like India washing of milk jar is done by pouring water into it, shaking jar by hand, removes water from it and jar get dried by placing it in inverted position. Though this method seems simple it gets various drawbacks. Sometimes due to contamination present in one jar whole stored milk get wasted. Another serious disadvantage is formation of scale around the inner surface of jar and in the bottom of jar. Scale is formed inside the jar which doesn't removed by regular or traditional washing. This residue is of more or least continuous film and presence of milk spot left on jar as result of continuous storage of milk in short words due to dissolved solids, fats present in milk. More water gets used for rinsing purpose that is consumption of water in proportion with quality of cleaning is not suitable. Therefore to overcome disadvantages of conventional rinsing, concept of machine mechanism was thought, of which would be very simple for working purpose or gives output instantly on time scale. The machine mechanism perfectly cleans the milk jars from top to bottom in short duration of time over conventional one. According to patent filed in U.S at March 8, 1966 attempts were made to establish such machine mechanism, but that is for washing the dishes and utensils used in hotels only and have some disadvantages. Now, this developed machine mechanism provides method of rinsing machine to rinse the milk jar at room temperature that is desired in commercial which is simple, easily practiced , highly effective in void the formation of milk spots upon rinsed and dry milk jar, doesn't require elaborate and expensive apparatus or skilled operator. It's connotation of 'compact' includes the attached scrubber pads to shaft which get spreads through angle of 90^{o} and becomes parallel to jar. In this paper, the design is based on simple centrifugal action, which includes scrubber pads initially attached together makes mechanism compact and the supporting design components are spring

which moves the scrubber pad up and down and central spindle shaft and machine structure. The scrubber pad is most important part of design which bears centrifugal force and based on that force analysis of scrubber pad is carried out to see the force distribution.

2. Survey Report

2.1 Survey Taken for the Concept Developed and Suggested Medical Report

A survey was conducted at various small scales, native purpose milk collecting centers situated near post Manchar. Dist. Pune, Maharashtra. Also the survey is taken at Gowardhan milk factory, Manchar, Dist: Pune (M.S.). This report is based on the questionnaire and its findings come out.

Some of the responsible position holding member of milk diary firm of the above-mentioned milk plant was surveyed and their opinion on the whole is summarized as below:

- Storage of milk in jar per day Twice
- Total duration of storageapprox... 4 hrs
- Waiting time for washing10min. – 1hr. (time changes according to diary firm)
- Use of cleaning methodconventional
- In case of scale formation either use of soda water or replacing the milk jar.
- Scale formed to new jar within days.

A survey was made in the various dairy firms, and the opinion of the various members from farmer to engineer was taken about cleaning of the jar in above manner, Most of the members in the favour of the machine mechanism, which can precisely clean the milk jar.

3. Concept Methodology

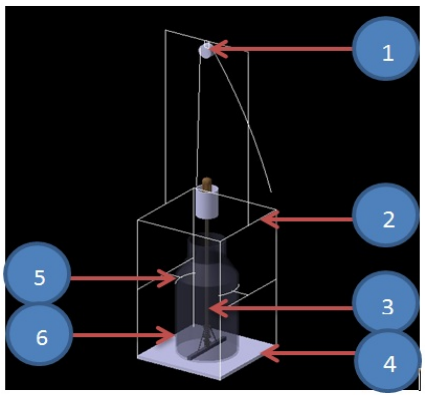
The traditional way for the washing of milk jar is done by pouring water into it, shaking jar by hand, removes water from it and jar get dried by placing it in inverted position. Though this method seems simple it gets various drawbacks. Sometimes due to contamination present in one jar whole stored milk get wasted. Also the scale is formed inside the jar which doesn't removed by regular or traditional washing. This residue is of more or least continuous film and presence of milk spot left on jar as result of continuous storage of milk in short words due to dissolved solids, fats present in milk. More water gets used for rinsing purpose that is consumption of water in proportion with quality of cleaning is not suitable. This is the conventional way of rinsing. Now to overcome above problems of conventional rinsing and increase the productivity, the design concept of machine mechanism is thought of which would be very simple for working purpose or gives output instantly on time scale. The machine mechanism suggested that will be perfectly clean the milk jar from top to bottom surface in short duration of time over conventional method.

4. Rinsing Machine Mechanism

4.1 Construction and Working Principle of Rinsing Machine Mechanism

The basic principle of rinsing machine mechanism is based on principle of the centrifugal force. The vertical spindle shaft carries scrubber pad at the one end other end the single phase motor 0.5 HP, 3000RPM. When the motor starts, the vertical spindle starts to rotate and exert the centrifugal force which tends to rotate and open the scrubber pads. As the scrubber pads moving in outward direction it compresses the helical spring in downward direction via connecting link. The helical compression spring exerts radial inward force. As the motor speed decreases and hence the centrifugal force , the inward spring force increases. The different stages of operations to clean the jar from top to bottom in short duration are

1. Scrubbing- Single phase Motor is operated by 3 speed regulator switch, therefore, In low speed (1st speed), the scrubber cleans the hard scaling inside the can or jar.
2. Cleaning- In second speed, it removes scales and starts cleaning the surfaces by increased speed.
3. Finished Cleaning- In third and final step of cleaning in which the scales inside the can is totally removed and inner surface of can or jar gets finished like mirror.



1) Pulley with Chain, 2) Machine frame
3) Rinsing Mechanism
4) Height Jack, 5) Can holding Clamp,
6) Can or jar

Fig. 1: Principle of Rinsing Machine Mechanism

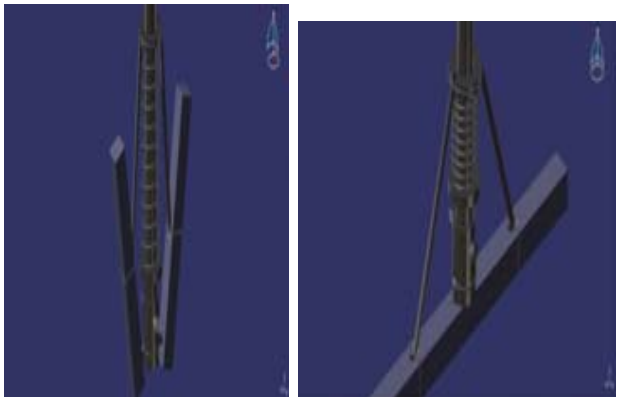


Fig. 2: Closing and Opening of Scrubber pad.

5. Design Methodology

5.1 Selection of motor for the rinsing machine mechanism

The minimum pressure required to clean the can is taken from standard heat exchanger fouling and cleaning protein precipitates, International Conferences 2003.

Minimum pressure required to clean the can p = 30,000 N/m^2, A = Area of scrubber pad = 2*2 = 4 cm^2=4*10^{-4} m^2

Force required for removing the scale residue and clean the can completely f = $30000*4*10^{-4}$ = 12 N

r = Distance of C.G. of scrubber pad from shaft axis = 0.08,T = F*r = 12*0.08

Therefore, T = 0.96 N-m, Power required for 3000 RPM = T*w = (0.96*2*pi*3000)/60

Power = 301 watt = 0.4 HP, Therefore, Minimum requirement of motor → 3000 RPM is 301 watt OR 0.4 HP.

5.2 Spindle Shaft Design

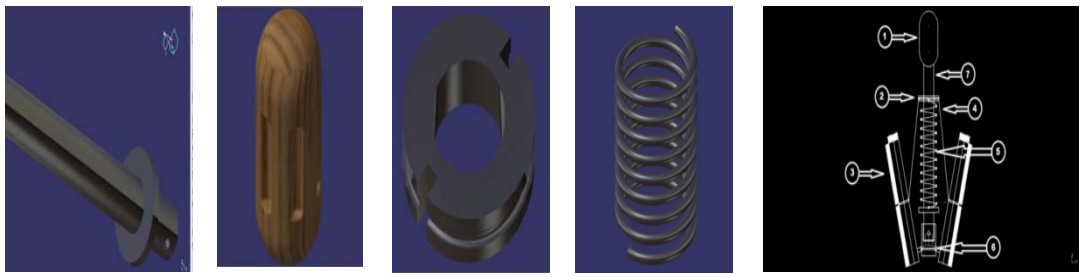
Height of Can = 640mm = 64cm,Therefore, the required length of spindle Shaft (By considering clearances) = 85 cm

The material selected for spindle shaft is stainless steel, D = Diameter of spindle shaft, Now, we have T/J=2*τ/D

J = 2^{nd} Moment Of Inertia (Tau) = Allowable shear stress of S. S. = 80 MPa

Required Torque for removing scale residue and clean the can completely T = 0.96 N-m, J = (pi*D^4)/32, D^3 = (16*T)/(pi*τ),

Therefore, the spindle diameter comes from above is 0.5 cm, Now for safety operation and considering clearances , select the diameter of spindle shaft is 2 cm.

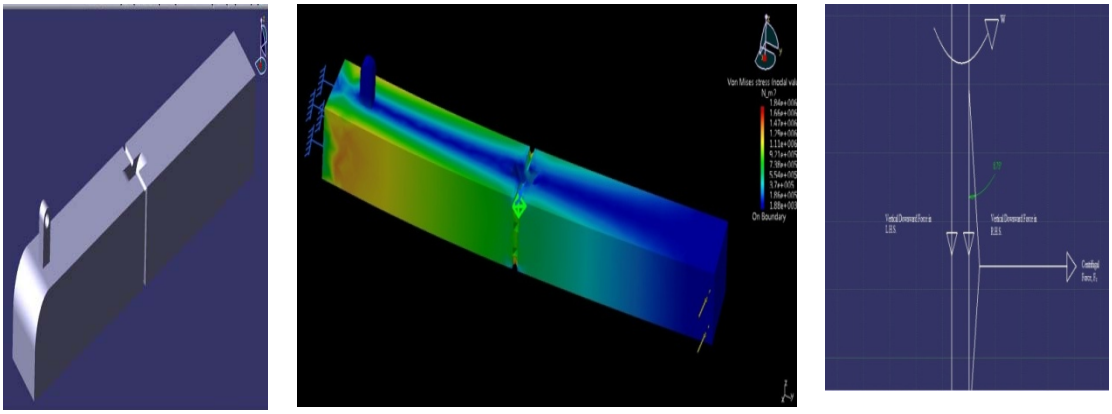


1) Motor, 2) Axial ring, 3) Scrubber pad, 4) Connecting link, 5) Spring, 6) Pivot attachment

Fig. 3: Design components of rinsing machine mechanism.

6. Design Analysis of Rotating Scrubber Pad

As the rinsing machine mechanism is in operation, the scrubber pad rotates at very high speed (around 3000 RPM), it exerts a centrifugal force along the length of scrubber pad and also the maximum tangential velocity acts at the free end of scrubber pad. Therefore, the scrubber pad is subjected to maximum load at the free end and minimum at the centre of the spindle shaft. When this load reaches to critical, the scrubber material starts deforming into plastic range. Therefore the scrubber gets fail under the heavy load. In order to design a rotating scrubber pad for rinsing mechanism and for the selection of its material, the stress analysis of this scrubber pad is more refined and compared with ANSYS. Here, the mentioned analysis is one reference example included for its design.



i) Half length of scrubber pad **ii)** Analysis in ANSYS **iii)** Forces in machine mechanism

Fig. 4: Design analysis of scrubber pad in ANSYS software.

The Material selected and finalized for the scrubber pad – HDPE, total length of scrubber pad is 320mm, therefore for the design analysis, consider half length = 160 mm. it is possible to find the cross section of scrubber pad i.e. breadth and Height

We have, Net force exerted on surface of scrubber pad = $F_N \times \mu$ = mrgω2.....1, But $F_N \times \mu = P \times A \times \mu$ 2

From the equations 1 and 2, we have $P \times A \times \mu = m \times r_g \times \omega^2$,P = 30000 N/$m^2$ ..... (From international conference)

$\mu = 0.25$..... (Metal-Plastic friction), $30000 \times A \times 0.25 = m \times r_g \times \omega^2$

A = 394 $mm^{2,}$ considering square cross section of scrubber, therefore breadth = height

L= 20 mm, b= 20 mm. In this way, we have taken the dimensions of scrubber = 160 ×20 ×20 mm

FOS= Stress of Material/Stress Generated = (1.034*e7)/(1.84*e6) = 5 As FOS>1 , Material is suitable.

7. Conclusion

According to the survey from milk industry and various firms, it was concluded that the most of the workers did not know or were ignorant about the problems caused by improper cleaning of milk jars, which may leads to either wastage of milk or replacement of milk jar. Putting in our entire caliber and sincere efforts to help to milk dairy firm, our design made for milk jar rinsing machine mechanism and this designed device will be of great help for commercial purpose, as it removes the scale formation completely and reduces the various other problems related with it. This machine mechanism automatically cleans the milk jar effectively in short duration of time and reduces the human effort and saves water.

8. Acknowledgements

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