Review Paper on Design Aspects of Stirrer Shaft Butter Extraction Machine

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Abstract— Traditional Butter Extraction Machine is developed & fully mechanized in automated form using electromechanical application in previous study. In present scenario many different kinds of butter extraction machine working on different principles and mechanisms. When shaft is rotated in clockwise and anticlockwise direction & vice versa, stirrer shaft is continuously rotated without lagging. One end of stirrer shaft is fixed and other end is freely rotating (over hanging) during butter extraction, due to centrifugal force jerk acted on shaft. During extraction process, stirrer shaft moves away from the center of axis of rotation. Study on design of shaft for continuous clockwise and anticlockwise rotation, in highly efficient machine for stress calculation & fatigue failure is to be carried out using ANSYS & analytical methods. The study implies on parameters like diameter, material, length & speed of motor for butter extraction machine. Analysis of stirrer shaft & stresses occur during twisting moment can be carried out to be optimized. Aim & Objective of study is to re-design and fatigue failure analysis of the stirrer shaft. Length & critical speed can also be studied for further analysis as future scope of study.

Key words: Stirrer Shaft, Diameter, Material, Length, Speed, Butter Extraction Bearing, Coupling, Rpm, Stresses, Fatigue Failure, Analytical Calculations, FEA Analysis

I. INTRODUCTION

Conventional butter extraction machine is a fully mechanized and automated form using electromechanical application in previous study. In present scenario many different kinds of butter extraction machine working on different principles and mechanism.

Butter is extracted by churning the curd with the help of Stirrer which to be rotated clockwise and anticlockwise direction & reverses continuously during the process. The speed of stirrer ranges from 75 to 100 rpm. There is no time lag in changing the direction with rotation which imposed jerks on shaft.

In this project we have shown timeline of butter extraction machine. This machine will satisfy the need of small and medium size industrial because of its price functionality and design. when shaft is rotated clockwise and anticlockwise direction continuously reverses direction, the stresses coming over the shaft length whose one end is fixed and other is freely rotating (over hanging). Centrifugal force tries to move free end of the shaft away from the axis of rotation. Invention of Butter though not only exactly known but in India it is predicted to be in existence since the era of Hindu God Lord Shree Krishna till date. There are various methods of butter extraction also come up during the course of time but then still the clockwise an anticlockwise way of extraction. The method is still existing having own significant as regard the quality and chemical structure or chemistry of butter is concern the output highest quality.

The exiting Butter exaction machine is working since eight months, when the shaft is rotated clockwise and anticlockwise direction continuously reverses the direction stresses coming over the stirrer shaft. So need to design Optimization of stirrer shaft of Butter Exaction Machine using material and design the shaft according to specification. The main objective of the analysis is to investigate the stresses & deflections of shaft subjected to torsion. The life of stirrer shaft & fatigue failure can be observed as well as comparing the results with analytical calculations can be verified with accuracy of the results.

II. REVIEW OF LITERATURE

A. Shaft Design

A Shaft is the component of mechanical device that transmits rotational motion and power. Because of simultaneous occurrence of torsional shear and normal stresses due to bending the stress analysis of a shaft virtually always involves the use of a combined stress approach. The recommended approach for the shaft design and analysis is the distortion energy theory of failure .Vertical shear stresses and direct normal stresses due to axial loads may also occur.

B. CREO Professional – For 3D Component Design

For analysis of stirrer shaft, it is necessary to model it first. So, modeling of the corresponding shaft is done using Creo Professionalas a 3D modeling software Creo Professionalis a family or suite of design software supporting product design for discrete manufacturers and is developed by PTC. The suite consists of apps, each delivering a distinct set of capabilities for a user role within product development. Creo runs on Microsoft Windows and provides apps for 2D design, 3D CAD parametric feature solid modeling, 3D direct modeling, Finite Element Analysis and simulation, schematic design, technical illustrations, and viewing and visualization. The Creo suite of apps replace and supersede PTC's products formerly known as CREO Professional, Co Create, and Product View. PTC Creo Parametric helps you quickly deliver the highest quality, most accurate digital models. With its seamless Web connectivity, it provides product teams with access to the resources, information and capabilities they need – from conceptual design and analysis to tooling development and machining. In addition, high-fidelity digital models have full associatively, so that product changes made anywhere can update deliverables everywhere. That's what it takes to achieve the digital product confidence needed before investing significant capital in sourcing, manufacturing capacity and volume production.

C. Finite Element Analysis (FEA)

The finite element method (FEM), sometimes referred to as finite element analysis (FEA), is a computational technique used to obtain approximate solutions of boundary value problems in engineering. Simply stated, a boundary value problem is a mathematical problem in which one or more dependent variables must satisfy a differential equation everywhere within a known domain of independent variables and satisfy specific conditions on the boundary of the domain. Boundary value problems are also sometimes called field problems. The field is the domain of interest and most often represents a physical structure. The field variables are the dependent variables of interest governed by the differential equation. The boundary conditions are the specified values of the field variables (or related variables such as derivatives) on the boundaries of the field. Depending on the type of physical problem being analyzed, the field variables may include physical displacement, temperature, heat flux, and fluid velocity to name only a few.

D. Overview of fatigue

The majority of component designs involve parts subjected to fluctuating or cyclic loads. Such loading induces fluctuating or cyclic stresses that often result in failure by fatigue. About 95% of all structural failures occur through a fatigue mechanism. The damage done during the fatigue process is cumulative and generally unrecoverable, due to the following:

It is nearly impossible to detect any progressive changes in material behavior during the fatigue process, so failures

Often occur without warning. Periods of rest, with the fatigue stress removed, do not lead to any measurable healing or recovery. Fatigue, or metal fatigue, is the failure of a component as a result of cyclic stress. The failure occurs in three phases: crack initiation, crack propagation, and catastrophic overload failure. The duration of each of these three phases depends on many factors including fundamental raw material characteristics, magnitude and orientation of applied stresses, processing history, etc. Fatigue failures often result from applied stress levels significantly below those necessary to cause static failure.

V. S. Khangar1, Dr. S. B. Jaju2" A Review Of Various Methodologies Used For Shaft Failure Analysis" This paper studied on comparison of the different methodology used, their application & limitation of bridle roll shaft used in continuous steel industry to prevent repetitive failure. Bridle roll failure leads to heavy loss approximately Rs 80000 per hour due to line stoppage & repairing cost associate with the breakdown. Roll shaft failure can be prevented primarily by introduction of better material design optimization & by using correct manufacturing processes. To fluctuating loads of combined bending and torsion with various degrees of stress concentration. For such shafts the problem is fundamentally fatigue loading. Failures of such components and structures have engaged scientists and engineers extensively in an attempt Failure occurs at neck of drive end shaft. Failure occurs at every six to seven months of operation. This leads to heavy loss therefore find their main causes and thereby offer methods to prevent such failures.

According to results Bridles roll shaft design by considering maximum bending & torsion theory for variable loading .and Avoiding stress raiser by major step down, machining marks & by providing proper fillet, good surface finish.

1) Sandeep Gujaran and Shivaji Gholap, "Fatigue Analysis of Drive Shaft"

This paper studied to investigate the stresses & deflections of drive shaft subjected to combine bending & torsion. It carries a load of two vacuum rollers weighing around 1471N and rotates at 1000 rpm, hence there is a scope of analyzing this part to predict its fatigue life and damage. Therefore checking for fatigue life as well as comparing the results with analytical calculations to verify accuracy of the results. Drive shaft is a critical component used in paper converting machines. Deflection is a function of the geometry everywhere, whereas the stress at a section of interest is a function of local geometry. Most shafts are subjected to fluctuating loads of combined bending and torsion with various degrees of concentration. For such shafts the problem is fundamentally fatigue loading. Failures of such components and Structures have engaged scientists and engineers extensively in an attempt to find their main causes and thereby offer methods to prevent such failures.

2) Sumit P.Raut, Laukik P.Raut "A Review of Various Techniques Used For Shaft Failure Analysis"

This paper studied the various methodologies used for the shaft failure analysis and to choose best methodology suitable for the failure analysis of shaft used in gear box which is mounted on the overhead crane to prevent repetitive failure. Shaft failure leads to heavy loss due to stoppage and repairing cost associate with the breakdown. Most shafts are subjected to fluctuating loads of combined bending and torsion with various degrees of stress concentration. For such shafts the problem is fundamentally fatigue loading. Failures of such components and structures have engaged scientists and engineers extensively in an attempt to find their main causes and thereby offer methods to prevent such failures. The various methodologies used for the shaft failure analysis and to choose best methodology suitable for the failure analysis. In this paper the various failure of shaft is discussed, modeling of shaft with the existing dimension analysis, Finding out the various load and stresses on the shaft. Special care is to be taken for stress relieving in welding repairing works. So in order to overcome this problem.

3) YézoumaCoulibaly, StéphaneOuédraogo and Nathalie Niculescu "experimental study of shea butter extraction efficiency using a centrifugal process."

Experiments were carried out in the laboratory with a small focused on shea butter extraction with a centrifuge machine. That the current machine would not be as profitable as expected. That had been designed was then tested using the same variables as parameters for butter extraction efficiency at various sites. Extraction efficiency was found to be barely higher than 30% on average. The reasons for partial or total failure are numerous. They range from the laboriousness of the work, low extraction efficiency and maintenance difficulties, to the degree of investment required and the limited profitability of projects involving them. The levels of extraction efficiency obtained were similar to those obtained by traditional methods, thus leading to the conclusion, it was found to be of interest by its users with regard to the consistency of the efficiency values obtained, less laborious work, and the time saved on the activity. Improvements and the construction of the second prototype are already under way. The processing capacity is to be increased from 10 to 20 kg of paste, high butter extraction efficiency. All the solutions put forward, such as heating the paste, or diluting it and churning it prior to centrifugation led to the same levels of efficiency.

4) TomášJirout, FrantišekRieger "Impeller Design for Mixing of Suspensions"

This paper studied the effect of impeller type on off-bottom particle suspension. On the basis of numerous suspension measurements there were proposed correlations for calculation just-suspended impeller speed of eleven impeller types and geometries in the wide range of concentrations and particle diameters. From their conclusions it follows, that it is generally understood that axial-flow pattern impellers are the most suitable agitators in such cases. This article extends impeller-designing recommendations for particle suspension with many axial-flow impellers types in wide range of concentrations and particle diameters. It is to help designers to choose between alternative impellers and to calculate the critical (just-suspended) impeller speed and power consumption necessary for off-bottom suspension of solid particles.

III. Conclusion

In order to eliminate the problem of Stirrer Shaft of Traditional Butter Extraction Machine due to the stresses developed during its operation, the Stirrer Shaft had been analyzed considering different parameters like Diameter, materials and tool life of stirrer shaft it is found that there is scope for optimization & analysis of stirrer shaft using FEA.

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