Methodology for Design and Fabrication of Planetary Mixer for Preparing Cake Cream - a Review

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Abstract— This paper presents the methodology for design and fabrication of Planetary Mixer for Preparing Cake Cream with the related search. The study specifies factors influencing the cake cream making process and recommends a number of design options for planetary mixer. These are based on a systematic study of the cake cream making process and testing of a prototype model of planetary mixer. For which we consider literatures reviews & some of them are explained.

Key words: Cake Batter, Planetary Mixer, Rheology, Shear Rate, Visco-Elasticity, Gear, Heat Treatment, Sun Gear, Ring Gear

I. Introduction

The planetary mixer is used for making bakery product like cake cream. In this machine planetary gear system is used. It is operated on epicyclical gear train. The gear train rotates clockwise direction simultaneously rotate the tool in anticlockwise direction and mix the all raw content of cake cream in proper way to obtain good qualities of cake cream for preparing different size and shape of cake as per customer requirement.

Industrial Mixers and Blenders are used to mix or blend a wide range of materials used in different industries including the food, chemical, pharmaceutical, plastic and mineral industries. They are mainly used to mix different materials using different types of blades to make a good quality homogeneous mixture. Included are dry blending devices, paste mixing designs for high viscosity products and high shear models for emulsification, particle size reduction and homogenization. Industrial mixers range from laboratory to production line scale, including Ribbon Blender, V Blender, Cone Screw Blender, Screw blender, Double Cone Blender, Double Planetary High Viscosity Mixer, Counter-rotating, Double & Triple Shaft, Vacuum Mixer, Planetary Disperser, High Shear Rotor Stator and Dispersion Mixers, Paddle, Jet Mixer, Mobile Mixers and Drum Blenders. Mixing fulfils many objectives beyond simple combination of raw ingredients. These include preparing fine emulsions, reducing particle size, carrying out chemical reactions, manipulating theology, dissolving components, facilitating heat transfer, etc. So even within a single pharmaceutical product line, it is not common to employ a number of different style mixers to process raw ingredients, handle intermediates and prepare the finished product.

A. *Concept:*

1) *Planetary Gear:*

A planetary gear system will not assemble unless the number of teeth for each gear is selected properly. Once the design requirements are specified, the remaining parameters must be calculated to create a working configuration. Let's say the desired gear ratio is 5:1. This means the sun gear must make 5 revolutions for each revolution of the output carrier (Note: this assumes that the sun gear is the input, the planet gears drive the output carrier, and the ring gear is stationary. Other configurations are possible depending on the application). One more design requirement must be specified to do the remaining calculations. Let's say the sun gear must have 24 teeth. The other parameters can be found using the following equations:

- R: Gear ratio, to 1
- Nr: Number of teeth on the ring gear
- Ns: Number of teeth on the sun gear

Plugging in the known values, we get

Solving for Nr, we find that the required number of teeth on the ring gear is 96. We can now begin to solve for the number of teeth on the planet gear:

Np: Number of teeth on the planet gear(s)

Plugging in the known values, we get Solving for Np, we find that the required number of teeth on the planet gear is 36. This is independent of how many planet gears are used. Note that the pitch of the gears is not specified. These equations hold true regardless of the pitch, but a pitch will ultimately need to be selected when designing a planetary gear system. Either the pitch itself will be a design requirement, or size limitations will be a factor, and the pitch can be selected accordingly.

The following table gives an example of the gears used in a particular planetary system, with all specifications included: Sun Gear Planet Gear Ring Gear

- Quantity 1 3 1
- Module 1 1 1
- Number of Teeth 24 36 96
- Pressure Angle 20° 20° 20

B. *Planetary Gear Design:*

A planetary gear system, also referred to as epicyclic gearing, consists of three elements – a sun gear, one or more planet gears, and a ring gear. The sun gear is located at the center, and transmits torque to the planet gears that orbit around it. Both are located inside the ring gear. The tooth formation of the sun and planet gears is external, while the ring gear is internal. Planetary gear systems can vary greatly in size and configuration to produce a broad range of speed ratios and meet various design requirements. They are used in many different applications such as clocks, lunar calendars, car mirrors, toys, gear head motors and turbine engines.

Fig. 1: 3D view of Planetary

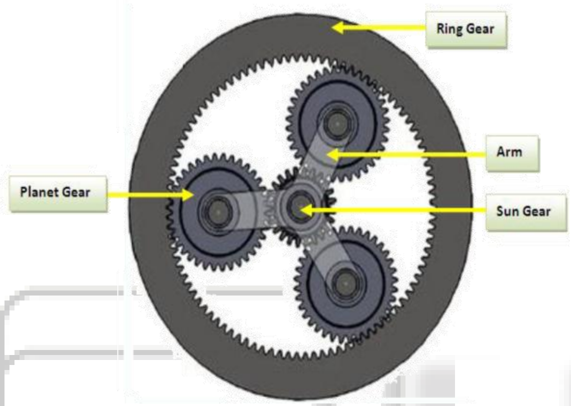

Fig. 2: 2D view of Planetary Gear

II. LITERATURE REVIEW

A. Dr.Schulze T.,Prof.Hartmann C. Prof. Dr. Schlecht B[1]., Calculation of Load Distribution In Planetary Gears For An Effective Gear Design Process:

This paper deals with the design of gears - especially planetary gears - can just be carried out by the consideration of influences of the whole drive train and the analysis of all relevant machine elements. In this case the gear is more than the sum of its machine elements. Relevant interactions need to be considered under real conditions. The standardized calculations are decisive for the safe dimensioning of the machine elements with the consideration of realistic load assumptions. But they need to be completed by extended analysis of load distribution, flank pressure, root stress, transmission error and contact temperature.

B. Kulat P. S., Chadge R.B[2], 3D Motion Mixer For Material:

This paper deals with research concerned it is basically concentrate on "To Design and Fabrication of 3D motion mixer Industrial Mixers and Blenders are used to mix or blend a wide range of materials used in different industries including the food, chemical, pharmaceutical, plastic and mineral industries. They are mainly used to mix different materials using different types of blades to make a good quality homogeneous mixture. Included are dry blending devices, paste mixing designs for high viscosity products and high shear models for emulsification, particle size reduction and homogenization. A mixture can be defined as homogenous if every sample of the mixture has the same composition and properties as any other. The results have been presented through a standard deviation. (Hersey 1982) defined an ordered mixture as having zero standard deviation of the sample concentration at all sample sizes provided that the sample size is greater than the size of a single order unit as opposed to a random mixture where the standard deviation decreases with the increasing of the sample size. The main problem with mixing powders is their determination in the mixture before and after the mixing process (Kaye 1997). The dynamics of mixing has been tested by continuous sampling. Granulometric analysis explains it only partially; the rest of the problem must be characterized by statistics. The important thing is to get reproducibility, which has been achieved, considering low values of standard deviation obtained in all samples (from 0. 05 to 0. 1). Kenics type of a static mixing device has been investigated, which has been proven as the best type of a powdered material (Regner *et al* 2006). Static mixers can replace standard device types and they can contribute to the mixtures quality in processes such as backfilling material during packaging. Many producers mix several batches before they start the packaging of the material. During storage of different batches, the powders have a tendency to segregate. A static mixer added to storage devices outlet would lead to the final products quality.

C. Chesterton A. ed.al [3], Impact of Flour Heat Treatment on Cake Batters:

This paper deals with issue of commercial manufacture of high ratio cakes employs flours which have been subjected to heat treatment in order to improve their baking performance. Since the cake microstructure is directly dependent on the batter from which it is baked, the impact of heat treatment on batter rheology was investigated. Rheological testing (steady and oscillatory shear) was performed on batters made from heat-treated and untreated flours: (*i*) before, (*ii*) after the aeration stage, and (*iii*) after the final addition of fat. The maximum shear rates experienced during preparation were estimated for two commercial planetary mixers, a Kenwood KM250 and a Hobart N50-110, as 20-100 s-1 and 100-500 s-1, respectively. Rheological testing was complicated above 20 s-1 by normal force effects arising from the elasticity of entrained bubbles. Visco-elastic investigations showed that *G*">*G*' in most cases. Frequency dependency data for the aerated emulsions at different temperatures (80, 90 and 100 ºC) were fitted to the weak gel model for foods. The *AF* values increased with temperature, indicating an increase in the strength of interactions in the gel. *AF* values at 90 and 100 °C for aerated emulsions made with heat-treated flour and mixed for 6 and 10 min were higher than values obtained for samples made with base flour, indicating a stronger gel network in these materials. The results highlight the visco-elastic behavior of cake batters under mixing conditions, and identify a method for quantifying differences between heat-treated and untreated flours.

D. Chao Chen [4], the Design of Innovative Epicyclic Mechanical Transmissions: Application To The Drives Of Wheeled Mobile Robots:

This paper deals with issue of Epicyclic mechanisms have found wide applications in industry, especially in automobiles and robotics. Low efficiency due to the high gearing power occurring in an epicyclic train is an important problem. This thesis develops a novel family of epicyclic transmissions, based on cams and rollers. This kind of cam-based mechanical transmissions, Speed-o-Cam (SoC), offers features such as high stiffness, low backlash, and high efficiency. It develops multi-lobbed cam profiles, the sun cam and the ring cam, which comprise an epicyclic cam train (ECT) with the roller follower. New design criteria are established: the generalized transmission index (GTI) and the contact ratio in cam transmissions. The GTI is an index that quantifies the force transmission quality in a mechanism, thereby generalizing the pressure angle, the transmission angle, and the transmission index (TI) proposed by Sutherland and Roth in 1973. The contact ratio is an index of the quantity of overlap occurring between two conjugate cams during transmission. A contact ratio greater than unit y guarantees smooth motion during operation. In order to avoid "po or" transmission, we apply an undercutting technique on the cam profile to achieve a smooth motion. We introduce two new concepts, *viriual power* and *virtual power ratio*, and derive an original algorithm to compute the efficiency in an epicyclic train upon the assumption that power loss is due only to friction upon meshing. The results show that friction has a larger effect on the total efficiency of an epicyclic train than on a simple train. Examples are given to validate this algorithm, by comparison of our results with previous works. The dual-wheel transmission (DWT) , proposed elsewhere using epicyclic gear trains (EGTs), is designed here with epicyclic trains of cams and rollers. We optimize the DWT to achieve a compact design and a high transmission performance. Furthermore, we define the total transmission index (TTI), which allow us to evaluate the final DWT design. Two virtual prototypes of the DWT, the central and the offset versions, are generated: the former is capable of quasi-omnidirectional mobility, the latter of full unidirectional mobility. Finally, we include a general kinematic analysis of wheeled mobile robots (WMRs) with single-wheel drives and apply this method to WMRs with DWT units; then, we obtain symbolic solutions to the direct kinematics (DK) and inverse kinematics (IK) problems, for both central and offset types of units.

E. Dr. Ir. D. Vandepitte, Dr. Ir. P. Sas[5] ,Simulation Of Dynamic Drive Train Loads In A Wind Turbine:

This paper deals with issue of the development of a consistent modelling approach to correctly describe the dynamic behaviour of a complex drive train in a wind turbine, focussing on the gearbox. This research is motivated by the limitations in the traditional design codes for wind turbines, which imply a quasistatic design of all drive train components and yield insufficient insight in load variations and local stress levels. The flexible multibody system (MBS) formulation is chosen as the best alternative for the development of a more detailed drive train model. This study presents a generic methodology based on three MBS modelling approaches. The first approach is limited to the analysis of torsional vibrations only. The second technique offers a more realistic representation of the bearings and the gears in the drive train and its generic implementation can be used for both helical and spur gears in parallel and planetary gear stages. The third method is the extension to a flexible MBS analysis, which yields information about the elastic deformation of the drive train components in addition to their large overall rigid-body motion. The dissertation demonstrates the application of all three simulation methods for the analysis of a single gear stage, of a complete gearbox and finally of a drive train in a wind turbine, including coupling effects with the tower, the rotor and the generator. These analyses cover the low- and mid-frequency range and indicate how possible drive train resonances can be identified in this range. Finally, the simulated results are compared with the results of a unique measurement campaign on a modern multi-MW wind turbine.

F. Ming Jin Yang, Xi Wen Li, Tie Lin Shi, Shu Zi Yang [6], Performance Analysis and Parameter Optimization of a Planetary Mixer:

This paper deals with issue of axial symmetry of geometric and kinematical features of the mixing domain of a planetary mixer, definitions of impact factor of crossing, mixing rate and mixing time were put forward for the performance analysis and parameter optimization of the mixer. It was found that the speed ratio of rotation and revolution of the screw blades has strong influence on the mixing process. An optimum revolution speed was obtained on conditions of the speed ratio of rotation and revolution being constant. The fluid mixing system in the mixing tank can be optimized through geometric and kinematical parameters optimization.

G. Ettore Pennestr [7], Dynamic Analysis of Epicyclic Gear Train by Means of Computer Algebra:

The paper illustrates the application of a systematic technique for the deduction of dynamic equations of epicyclic gear trains. The use of the proposed method is particularly amenable in conjuction with procedures for the computerized enumeration of geared kinematic chains. The discussed examples illustrate how the presented approach can be extended for computing the equivalent inertia of an epicyclic gear train or for the stability analysis of 2 d.o.f. gear trains.

H. Ming Jin Yang et al.[8], Modeling and Stability Analysis of the Speed Regulating System of a Planetary Mixer:

This paper deals with issue of Hydraulic drive mixers are widely employed to process the cohesive mixture, especially the dusty and energetic mixture. In this study, the modeling method of the AC frequency control speed regulating system of a planetary mixer was presented. The speed regulating system consists of links of frequency converter (FC), asynchronous motor (AM), and hydraulic circuit(HC). The stability analysis was conducted by applying specification parameters of the FC, AM and HC. Result shows that the speed regulating system is stable by Routh criterion with amplitude margin 21.4db and phase margin 17.9degree.

I. Adam Lundin, Peter Mårdestam[9], Efficiency Analysis of A Planetary Gearbox:

This thesis consists of an efficiency evaluation and creation of a theoretical model for an Atlas Copcos epicyclic gearbox. The thesis starts with a theoretical chapter containing the fundamentals of epicyclic gearing and the build of the specific gearbox investigated. The following chapter contains former testing and theory of power losses in a gearbox. After the theory is explained the next chapter contains testing, compromises and assumptions during testing and also results from the testing. The next chapter explains the Matlab calculation program based on the theory and measurements. Finally the model is validated against reference a reference model and against real gearbox measurements followed by some closing conclusions. The final model calculates the efficiency rather well and has a linear difference. The difference is static since some losses have been left out, it can be fixed with an empirical correction factor which corrects the values and predicts an acceptable efficiency. The correction factor for the surface roughness also decreases the difference.

J. Rishabh Malhotra [10], Differential Evolution Optimization Technique to Design Gear Train System:

This paper deals with issue of determination of volume or center-to-center distance of a gear is an important issue in design of power transmission systems. The aim of this research work was to automate the design of gear drives by minimizing volume and center-to-center distance of gear trains. Differential Evolution Optimization technique was applied to parallel axis gear train problems. Dynamic penalty to the objective function was also introduced for handling the constraints. Differential Evolution Optimization is metaheuristics search algorithm. It optimizes a problem by trying to improve a candidate solution iteratively. For this it takes a given measure of quality i.e. fitness function. DE does not require the problem to be differential as is usually required by classical optimization methods. It can be used on problems that are not even continuous. DE assumes a population of candidate solution and creates a new candidate solution by combining existing ones in accordance to its formula. It then compares the existing solution with the new candidate solution and keeps whichever has the best score. This process is repeated several times until the stopping criterion is met.

III. Research Methodology

Methodology is a systematic theoretical analysis of the body of methods and principles associated with a branch of knowledge typically it encompasses concepts such as paradigm, theoretical model, phases and quantitative and qualitative techniques.

According to related literature review, we will collect required data and will be design and modified planetary mixer. There is speed variation regulator to adjust speed. The approach will be synthesis, design, development & testing of the machine. The various parameters such as design of planetary gear, pulley design will be carried out to make the machine.

IV. Conclusion

The main conclusion will be drawn find out whether it is possible to automate a skilled manual process which would avoid worker fatigue. Also the future scope for developing the generalized mechanism for any profile can be identified.

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