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Agitator and Wiper Design Modification for Milk Khoa Machine

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Abstract: Mixing is a very important unit operation in any dairy and food process industry. For instance, all operations involving blending homogenization, emulsion preparation, extraction, dissolution, crystallization, liquid phase reactions, etc., need mixing in one form or the other. This project is about a dynamic mixer of a food processing industry particularly about Milk khoa making process. To attain uniform mixing with the optimal product preparation time for the desired quality and to remove the drudgery of human folk this newly developed automated agitator is suggested. The existing agitator is not suitable to for a comfortable working condition to the workforce thus creating problems in the output of the different parameters of the organization efficiency like quality, quantity, delivery schedule and work force satisfaction. This project suggests a new design for the agitators. By careful study of three different models in all aspects one will be taken for the final fabrication. To finalize the best design, simulation will be used to conduct required experiment. Required inputs has been taken from different literature surveys and the discussion with the experts who are on the field and real time study has been conducted to get the exact requirement of the customer.

Keywords— Agitator, Impeller, Mixing, Materials, Magnetic Motor

I. Introduction

Mixing is a very important unit operation in any dairy and food process industry. For instance, all operations involving blending homogenization, emulsion preparation, extraction, dissolution, crystallization, liquid phase reactions, etc., need mixing in one form or the other. Broadly speaking two type of commercial mixing devices are available, namely, i) Static, ii) Dynamic. Static mixtures are becoming popular among processes, and hence among plant engineers, for they are very simple to install, and need minimum maintenance. The static mixture devices are also used as a chemical reactor to carry out reaction between two fluids. The static mixture is now available for conducting highly exothermic reaction involving gas-liquid operations. The dynamic mixture consists of the basic equipments, which may be a tank, a reaction vessel or crystallizer having an agitation (mixer) system. Selection of an agitator system will depend on the nature of the liquid, the detailed design of a dynamic mixer (agitator) system, operation conditions and the intensity of circulation and shear. The process of inducing motion of materials in a specific way depends on effective agitation and mixing fluid to a great extent.

Generally, agitation refers to force a fluid by agitating and to flow in a circulatory motion. Agitator has various purposes such as suspending solid particles, blending miscible liquids, dispersing a gas through a liquid in the form of small bubbles, and promoting heat transfer between the liquid and coil or jacket. There are some factor affecting the efficiency of agitating, some are related to the liquid characteristics such as viscosity and density. And some are related to geometry such as the container diameter (D), impeller length (Y), rotating speed (N), and height of impeller from bottom of the container (H), other characteristics of mixing include the liquid the necessity of performing the process to make the liquid experience all kind of movement inside container. There is no universal system till now that is valid for all liquids and all tanks except. In our project we are using milk as a raw material which is having a property becoming pasty when we apply uniform heat and agitation/mixing. For this requirement we used to design a proper agitation in this project.

A. Problem definition

Most of the operations for making khoa are done manually like stirring, tilting, etc. The entire process time is about 45 minutes and the heat coming out from the system is greater than 45ºc in a moisture condition of RH

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98%. When the existing agitator is not suitable and does not provide a comfortable working condition to the workforce thus creating problems in the output of the different parameters of the organization efficiency like quality, quantity, delivery schedule and work force satisfaction.

B. Agitator

Agitators are devices that are used to stir or mix fluids, especially liquids, which is one of the basic mechanical process engineering operations. Essentially, agitators are used for the homogenization of liquids or liquid-solid mixtures by generating horizontal and vertical flows. These flows are generated by rotating agitator blades. [1], [3]

B. Types of Agitator

Mechanical agitators can be divided into seven basic groups, namely

1. Paddles 2.Turbines, 3. Propellers, 4. Helical screws, 5. Cones, 6. Radial flow propellers and 7. High speed disc. Mixing by agitator take place due to momentum transfer. High velocity streams, produced by the impeller, entrain the slower mixing or stagnant liquid areas from all parts of the vessel and a uniform mixing occurs. As viscosity increase, frictional drag forces retard the high velocity stream and confine them to immediate vicinity of the impeller. Thus stagnant areas develop and uniform mixing is not achieved.[1]

Agitators having a small blade area which rotate at high speed, for instance, propellers, flat or curved blade turbine are used to mix liquids having low viscosities.[1]

C. Need of Automation/ Semi Automation

Now a day's most of the manufacturers are making khoa by manual and semi-automatic methods. The product manufactured by the above said methods are not sufficient to cope up with the supply and to meet out the demand. Increasing the temperature when the milk boils to the maximum temperature 120ºc and then milk particle will stick on inside the pan surface. Agitator is act as an important role for mixing of the milk properly until the boiling stage 120ºc and then the agitator used to remove the milk particle from the pan. If automatic methods are introduced, the demand will be adjusted and fulfilled.[1]-[12]

D. Objective

1. To find a better stirring method.
2. To increase the productivity of the khoa making machine.
3. To remove the drudgery from the working condition.

E. Organization of The Report

This report contains five chapters. The first chapter gives the introduction of agitator; it's important and need for agitator. The second chapter presents an over view of the literature reviewed, pertaining to this project. The details of milk khoa manufacturing process are given in the third chapter. The methodology and components used to fabricate the agitator device presented is in the fourth chapter. The task completed and work plan is explained in the fifth chapter.

II. REVIEW OF LITERATURES

Saeed Asiri, et al., "Design and Implementation of Differential Agitators to Maximize Agitating Performance". This research is to design and implement a new kind of agitators called differential agitator. parametric study and shape optimization has been carried out. a numerical analysis, knowing the material prosperities and the loading conditions, the fem using ANSYS was used to get the optimum design of the geometrical parameters of the differential agitator elements while the experimental test was performed to validate.[2].

Steven Wang et ,el al,. "Energy efficient solids suspension in an agitated vessel–water slurry". Power consumption required to suspend water–solid slurries in a mechanically agitated tank has been studied over a wide range of design and solids conditions with the goal to improve the agitation energy efficiency.[3].

Tomas Jirout,, et al "Impeller Design for Mixing of Suspension". This paper deals with effect of impeller type on off-bottom particle suspension. On the basis of numerous suspension measurements correlations are proposed for calculation just suspended impeller speed for eleven impeller types and geometries in the wide range of concentrations and particle diameters.[4].

Domanskii,.et al.,"Large size Agitator with Precession Impeller for ore Slurries—Study, Design, Tests" An one-dimensional mathematical model addressing the field of tangential velocities, agitation power and other hydrodynamic features necessary for designing large-size unbaffled agitators with a precession impeller is proposed in this study. The adequacy of the model is confirmed by tests. [5].

S. Masiuk et al,."Comparison density of maximal energy for mixing process using the same agitator in rotational and reciprocating movements", The aim of this paper is to present experimental investigations of the influence of the

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new construction of agitator with the inclined blades on the maximal power consumption and mixing time. The comparison of two kinds movement (rotational or reciprocating) of the same agitator is based on the so-called density of maximal mixing energy. This energy is defined as the product of the power input to the mixed liquids and mixing time. The power consumption is calculated from the easured force acting on a dynamometric ring. A thermal-response technique is used for mixingtime measurements. [6].

Niedzielska et al., "Heat Transfer and Power Consumption for Ribbon Impellers". Experimental investigations and model calculations of power consumption and heat transfer coefficients from a vessel wall to mixed liquid for ribbon impellers operating in a laminar regime are discussed in the paper. On the basis of the obtained results, the heat transfer efficiency of particular impellers was calculated and geometrical dimensions of the most efficient ribbon impeller were determined. [7].

S. Masiuk et al,."Mixing Energy Measurements in Liquid Vessel With Pendulum Agitators". The aim of this paper is to present investigations of the influence of geometry of the pendulum agitators with clapping blades and of the physical parameters of mixed fluid on the homogenization time, the power consumption and the energy of mixing. Measurements were carried out using a vertical cylindrical vessel having a diameter of 0.5 m filled with 0.5 m height of liquid. An agitator was inserted centrally into the mixer and mounted on a rod jointed with a mechanism transforming the rotational movement into the forward–backward movement in the horizontal direction. The mixing power of an agitator was calculated from measured deforming force acting on a dynamometric ring. The homogenization time was determined. [8].

F. C. Laurent et al .,"Performance of single and six-bladed powder mixers" the material was stirred essentially as a solid body by the six-bladed agitator. Velocity 7elds and axial dispersion coe4cients scaled with rotor speed but trans axial e>ects were more complex. The pulsing regime induced by the single-bladed agitator enhanced radial displacement whereas the continuous stirring of the bed by the six-blades showed an increase of the mean velocity of the particles and of the rate of axial dispersion. The next steps are to extend the range of designs evaluated and to understand the in3uence of vessel size. [9].

J. Aubin,.et al., Blending of Newtonian and Shear-thinning Fluids in a Tank Stirred with a Helical Screw Agitator" Newtonian and non-Newtonian laminar fluid flow has been simulated using Computational Fluid Dynamics for a cylindrical vessel stirred by a helical screw agitator. Simulations have been performed for vessel geometry with and without a draft tube. Simulated patterns in the vessel have been examined and compared with the experimental work of previous authors. The power number and the circulation number have been evaluated, and interpreted in a similar manner to other works. [10].

III.MANUFACTURING PROCESS OF MILK KHOA

A. Existing Process and Basic Design

The manufacturing of milk khoa is by using the saucer type of pan by using the steam for heat generation. Increasing the temperature when the milk boils to the maximum temperature 120ºc and milk particle will stick on inside the pan surface. Agitator is act as an important role for mixing of the milk properly until the boiling stage at120ºc and the agitator used to remove the milk particle from the pan.

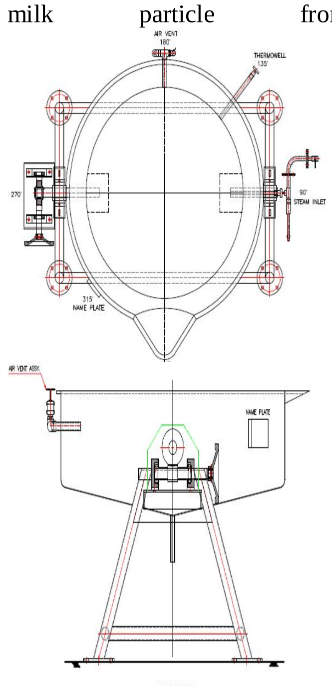

Fig.1 Khoa pan

B. Component

- Khoa Vessel is Jacketed,
- Insulated S.S. Jar fitted with Pressure gauge,
- Trap Valve,

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- Safety Valve, other structure in S.S Pipes. All hose pipes in S.S.

IV. METHODOLOGY

1) Material selection

Stainless steels are widely used in food and beverage manufacturing and processing industries for manufacture, bulk storage and transportation, preparation and presentation applications. Depending on the grade of stainless steel selected, they are suitable for most classes of food and beverage products.
'Stainless' is a term coined early in the development of these steels for cutlery applications. It was adopted as a generic name for these steels and now covers a wide range of steel types and grades for corrosion or oxidation resistant applications. The main requirement for stainless steels is that they should be corrosion resistant for a specified application or environment. The selection of a particular "type" and "grade" of stainless steel must initially meet the corrosion resistance requirements. Additional mechanical or physical properties may also need to be considered to achieve the overall service performance requirement (304types) ASME (2007), Boiler and pressure vessel code, ASTM [1]-[11]-[12]

TABLE 1

STAINLESS STEEL BAR MATERIAL 304

S. No	Properties	Specification	Units
1	Min /Tensile Strength	515	Mpa
2	Yield strength	205	Mpa
3	Max allowable stress	130	Mpa
4	Modules of elastics	193	Gpa
5	Max temp limit	399	°C

TABLE 2
STAINLESS STEEL PLATE MATERIAL 304

S. No	Properties	Specification	Units
1	Min /Tensile Strength	515	Mpa
2	Yield strength	205	Mpa
3	Max allowable stress	130	Mpa
4	Modules of elastics	193	Gpa
5	Max temp limit	816	°c

TABLE 3

PEEK SHEET MATERIAL

S. No	Properties	Specification	Units
1	Min /Tensile Strength	14500	Psi
2	Working Temp	250	°C

2) Data Collection

Frequent visits has been made to the khoa making industry situated in Chennai (a private firm) which is a major player in this field. A study has been conducted about the existing system of making milk khoa product in the following aspects to understand the domain.

i. Process Nature
ii. Product Nature
iii. Equipment
iv. Structure of the equipment
v. Working method
vi. Interaction with works/ Technicians

The basic raw material used have is milk, is a general commodity in the world. Mixing is the basic process of making khoa from the raw material milk.
The milk required for making 8kg of milk – khoa is 40 liters. Milk is poured in the vessel (S.S) and it is kept in the process temperature of (100°c - 120°c) by streaming process. The stirring and wiping is done manually by minimum of two workers for about 40 to 45 munities. After getting the required semi solid state khoa the export decide to take the khoa from the vessel. After that the cleaning will be performed. So per day this organization produces 64 kg khoa in 8hrs/shift.

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Fig.4 (a) An image of khoa making process.

During the process we absorbed that the manual work involved is very high and it does not provide comfortable working condition to the work force when temperature/humidity reaches 40°c/98%R.H.while discussion with higher level people in the organization we come to know that there are lot potential for the product, mean time the manual work method consumes most of the production time in nature. So this point has been taken as a major input from the stake holders of the organization. [1]- [12]

a) Identification of New Design Method

A new method incorporating mechanized agitation along with stirring is the need of the hour. By the input gathered from the organization people, we found that making automation will be very useful to the problem of this process hence we have proposed a paddle type agitator with automatic devices. Because the blades of these agitators are normally extend close to the tank wall. They are simply pushers and cause the mass to rotate in a laminar swirling motion with practically no radial flow along the paddle blades or any axial flow. The main advantage in this type is the cleaning and the crystallization nature. Thus we have calculate to suggest a "Automated Paddle type Agitator" to replace the manual agitator which in existing in the system. [8]

B) Alternative New Design

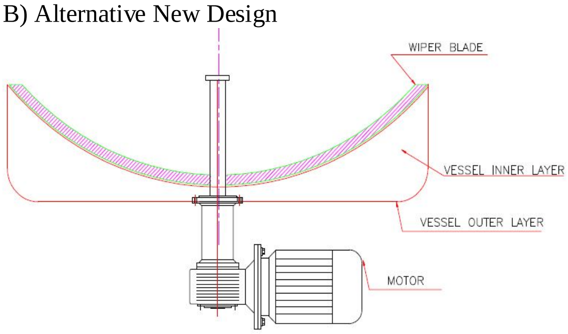

Fig.4 (b) Paddle Agitator Assembly

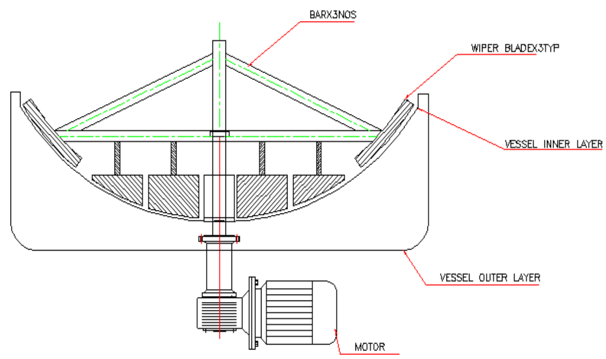

Fig 4 (c) Paddle Agitator Assembly

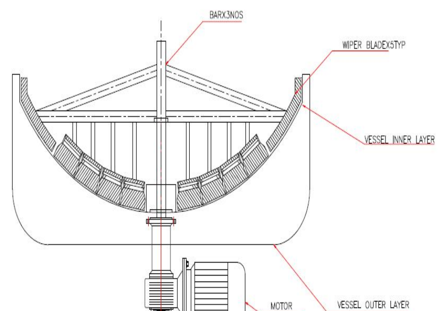

Fig 4 (d) Paddle Agitator Assembly

The main parts of an agitator are the hub and the blades. The hub is attached to the shaft by the use of key bolts. Agitator may either be cast as one piece or in two pieces spilt and bolt at the hub ,cast agitators have two basic advantages, namely, uniformity of materials and hard surface.

TABLE 4

DESIGN COMPARISON

S. No	Component	Design- 1	Design – 2	Design - 3
1	Shaft	1	1	1
2	Motor	1	1	1
3	No of blades	1	6	10
4	Thickness (mm)	6,8	6,8	6,8
5	Vessel	1	1	1

C) Selecting of Suitable Drive System

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From the literature review and the expert opening we have decided to select the magnetic driver system for this design modification of the project.[8]

Vessels other than Bioreactors like media preparation, buffer preparation, etc., which are part of the bioprocess require mixing. Magnetic mixers are used in these types of vessels. The Magnetic Mixers are similar to the Magnetic agitator other than the impellers and normally come without a shaft.

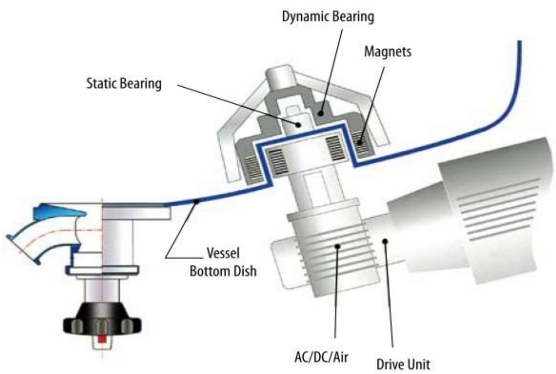

Figure.4.(e) Magnetic Motor

Working Principle

Hygienic-magnetic mixing is mainly designed for the field of pharmaceutical, biological engineering and food industries according to GMP modification. Good performance, reasonable structure, small size, reliable. There are magnets inside, outside magnets, electrical isolation kits and transmission components and other parts. Apply to all stainless steel reactors. Contact materials used in all parts 316L\304 materials, Magnetic Coupling driven by the principle of axial mixing operation work.

Mixing unit is installed on the bottom , which can mix under few matter, with unique mixing oars, and can be suitable to mix various mediums.

Features

- Simple structure
- Mechanical sealing
- East to dismantle
- Easy to clean
- No dead space

Technical Data

- Working temperature: 30-200℃
- Material: SS 304

Advantages

- Absolutely tight system.
- No danger of contamination and leakage.
- Optimal for aseptic production.
- Easy cleaning and sterilization.
- Control of temperature.

V. CONCLUSIONS

To finalize the best design among the available three designs, we have planned to do evaluation of design by ANSYS and we have planned to use PRO-E for modeling, thus the best design will be recommended.

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