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# Survey on Pitched Blade Impellers for Industrial Mixture

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## ABSTRACT

**In any mixing industry, impellers play an important role for mixing or homogenizing the liquids. This work is aimed at achieving the axial motion created by the pitched blade impeller without compromising the process requirement and ensuring proper blending the fluids. In this work, a pitched blade impellers are designed to ensure proper mixing for all low viscosity fluids. To facilitate proper blend of liquids, the pitched blade impellers is designed on a station with certain degrees of freedom like longitudinal/axial motion of mixer for loading and unloading, facility to adjust the impeller location from the bottom, etc. In this dissertation, different components required for the impeller for mixing such as shaft, motor mount and frame were modeled using CAD software (Solid works). Stress analysis of the components was carried out using FEA software package (Solid works Simulation).**

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## I. INTRODUCTION

The pitched blade impellers must be designed for mechanical and process operation. Although impeller design begins with a focus on process requirements, the mechanical design is essential for successful operation. The process conditions, design and calculation such as impeller operation near a liquid surface, can impose severe mechanical loads. When the mechanical assembly not design proper then proposed model fails for getting the accurate result, such as the natural frequency of a shaft, appropriate mechanical design must be determined by the equipment designer. The knowledge of the mechanical requirements for design impeller will help to the guide engineer toward a design that industrial mixture will meet both process and mechanical criteria. Once the process, design and criteria will meet proper then proposed mechanical assembly will get accurate result.

## II. LITERATURE SURVEY

[1] Potential of an asymmetrical agitation in industrial mixing by Kazuhiko Nishi, Naoki Enya Kazuhiko Nishi, Naoki Enya studied the performance of an eccentrically located MAXBLEND impeller was investigating, based on the power consumption. Further, the torque and horizontal load on the agitating shaft in an eccentric mixer with a MAXBLEND impeller were measured in turbulent state. In comparison with the laminar flow the Np of the eccentric mixing and concentric mixing in small. However in the turbulent region (Re > 2000), the Np of the eccentric mixing is larger than concentric mixing without baffles. It was confirmed that the large amount of energy can be supplied to the mixing liquid in eccentric mixing. Eccentric mixing under suitable conditions controlled the flow pattern in the vessel in good mixing than concentric mixer. Since these impellers have a high mixing performance over a wide range of viscosities, they are used in mixing, dispersion, reaction and polymerization processes. Their use in the food and pharmaceutical industries is being considered. For agitation in the turbulent region, these large impellers are usually used with baffles to promote mixing. However, baffles often cause problems for washing and sterilization. Furthermore, in the laminar region, baffles are not effective for mixing, and in fact, they often obstruct mixing. Power consumption of the impeller was measured with a torque meter (Satake Chemical Equipment Mfg Ltd.; ST-3000). This equipment can measure the torque on the agitating shaft in the mixing liquid without mechanical friction by correcting, using the torque value previously measured in air. Mixing time was measured by a decolorization method using iodine and sodium thiosulfate. The mixing liquid in the vessel was colored by adding 0.010 L of the 0.5 mol/L iodine solution ($8.0 \times 10^{-4}$ mol/L), and mixing with a sufficiently large impeller rotational speed. The 0.012 L of 1.0 mol/L sodium thiosulfate solution (1.2 chemical equivalent to iodine) was injected, and decolorization

 

started. In eccentric mixing, the sodium thiosulfate solution was injected at a point midway between the shaft and the vessel wall, on the side opposite to the eccentric direction.

[2] Design analysis and scale up of mixing processes by H.S Pordal and C.J Matice H.S. Pordal and C. J. Matice studied on multi-tiered approach for the design analysis and scale up of mixing processes. The primary function of a mixing vessel is to provide adequate stirring and mixing of the fluid. The mixing characteristics influence the product quality and efficiency of the process to a great degree. Stirred vessels come in various shapes and sizes. The main vessel is cylindrical in shape and the vessel bottom is very often contoured. Baffles are included in the vessel to break the vortex and prevent solid body rotation of the fluid. Draft tubes are included to direct suction and discharge streams. Diptubes are employed to inject fluids at specific locations. An important component of a stirred tank is the impeller. The rotating impeller imparts motion and shear to the fluid thus inducing mixing. The type of impeller employed depends on the nature of the task. Very often the same stirred vessel is required to perform various duties. It is important to ensure efficient and optimum operation of the stirred vessel for a given duty. There is also need to create process conditions that are optimum at the lab-scale, pilot-scale and production-scale so that productivity is maximized. Tier-one methods are based on general guide-lines and dimensional analysis for mixing equipment.

[3] Mixer Mechanical Design- Fluid Forces by Ronald J. Weetman's and Bernd Giga's Ronald J. Weetman's and Bernd Gigas's paper outlines the fluid forces that are imposed on impellers by the fluid continuum in the mixing vessel. The analysis shows that the forces are the result of asymmetries acting dynamically and transmitted from impeller blades to the mixer shaft and gear reducer. Several experimental techniques coupled with the role of computational fluid dynamics in mixer process and mechanical design is shown. When the mixer applications are varied. With these various processes occurring, the fluid motion in the tank is unsteady. This means that the loads on the individual impeller blades as well as the shaft, reducer, motors are dynamic. Normal current fluctuations at the motor is ± 5 to ± 15 percent from the mean. Typical load fluctuation on the shaft is about twice this and impeller blade load fluctuation if four times what occurs at the motor. Hence, The job of the designer is to be aware of the impact of mixing process conditions on these highly oscillating loads and their impacts on mixer components. Even with seemingly calm motion, there are severely fluctuating loads on the blades. Depending upon the magnitude and dynamics of the resultant bending loads on the mixer system, care is needed in the design of the individual mixer components. In addition to designing for the loads in the shaft, these loads are transmitted through the gearbox, mounting structure, and finally the tank. Power transmitted by the prime mover through the reducer and shaft which can be through the reducer and shaft is given as. Computational Fluid dynamic has been a great aid in understanding and showing details of mixing environments.

[4] Mechanical Design of Mixing Equipment by David Dickey in Handbook Of Industrial Mixing – Science & Practice Because of the diversity of fluid mixing applications and variety of vessels, many different styles of mixers are used in industrial applications. Mixer sizes include small fractionalhorsepower portable mixers to huge 1000 hp plus mixers. Although normally viewed as a single piece of equipment, like a pump, the typical mixer is composed of several individual components, such as a motor, gear reducer, seal, shaft, impellers, and tank, which is often designed and purchased separately. Although highly customized for many applications, most mixers are a combination of standard components, sometimes with modifications, and often with unique characteristics, such as shaft length. Generalizations, especially for mixers, can misrepresent individual situations, but some features are common to the largest number of mixers built worldwide. The most common motive force for a mixer is an electric motor, so a knowledge of standard motor characteristics is useful. Most mixers operate at or below typical motor speeds, so some type of speed reduction is common. Speed reduction can be accomplished with several different types of gears, usually in enclosed housings, or with belts and sheaves. Besides speed reduction, antifriction bearings are found in all types of rotating equipment. Some type of seal around the rotating shaft is required for closed-tank operation and the type depends on degree of seal required, operating pressure, and operating temperature. The shaft for a mixer, especially a large one, involves significant mechanical design, partly because of the myriad of shaft lengths, impeller sizes, and operating speeds, and partly because both strength and rigidity are necessary for a successful design. The combination of custom process and mechanical design necessary for mixers is unique for chemical process equipment.

[5] Design and fabrication of bi directional mixer In this paper published in IJAREST in March 2017, the authors have designed and fabricated a bi-directional mixer for mixing powders, chemicals & semisolid works. A chemical mixer is being designed which consist of a container impeller blades, electrical motor, pair of pulleys, pedestal bearings and drive shafts. We are using the container made up of PVC; it is placed at about 6inches from ground, so that it is easy to pour the material for the workers preparing the chemical solution. The motor is placed vertically in order to mount the pulley and belt assembly on the motor shaft. This machine is designed to mix the cleaning solution used for cleaning the floors. In electrically powered system an electrical motor is used to run the motor shaft. As the motor shaft rotates, the pulley mounted on motor shaft also rotates. The power transmission will be takes place from motor to impeller shaft. As the impeller shaft rotates the impeller blades also rotate along the direction. And hence the mixing of chemical ingredients is obtained. The speed of the electrical motor is controlled using speed regulator. Design process involved selection of motor for the process design. Selected motor has following specifications: Single Phase AC motor of 50 watt power running at 60 rpm. The torque delivered by motor is calculated to be 7.96 N-m. Further, rope drive was designed and the dimensions were calculated which was followed by bearing selection. The gearbox was designed to deliver the required speed reduction at required torque. Thus bi-directional motor was designed and fabricated.

 

[6] Comparisional Study of Pitched Blade Impeller and Rushton Turbine in Stirred Tank for Optimum Fluid Mixing by S. Saravanakumar, P. Sakthivel, S. Shiva Swabnil and S. Rajesh This study was done by S. Saravanakumar, P. Sakthivel, S. Shiva Swabnil and S. Rajesh. This work compares the importance of impeller and tank geometry for two widely used impellers. For the Rushton turbine, power consumption is dominated by form drag, so details of the blade geometry and flow separation have a significant impact (30%) on the power number. For the PBT, form drag is not as important, but the flow at the impeller interacts strongly with the proximity of the tank walls, so changes in the position of the impeller in the tank can have a significant impact on the power number (15%) due to changes in the flow patterns. For both impellers, the importance of geometry decreases as the Reynolds number drops into the transitional regime and viscous forces come into play.

[7] Study and Design of Impellers for Multiphase Reactors D. Devkumar's D. Devkumar's research paper gives a lot information about Designing and Calculations. Mixing in tanks is an important area when one considers the number of processes, which are accomplished in tanks. Essentially, any physical or transport process can occur during mixing in tanks. Qualitative and quantitative observations, experimental data, and flow regime identifications are needed and should be emphasized in any experimental pilot studies in mixing. In fact, the geometry is so important that the processes can be considered geometry specific. Solid suspension is very much dependent upon the shape of the tank bottom; liquid-liquid dispersion depend upon the geometry of the impeller; blending, upon the relative size of the tank to the impeller; and power draw, upon the impeller geometry. Mixing efficiency in a stirred tank is affected by various numbers of parameters such as baffles, impeller speed, impeller type, clearance, tank geometry, solubility of substance, eccentricity of the impeller. Flow patterns can be changed according to the type of impellers, and fall into three categories: axial, radial and tangential. Mixing at high solid concentration is a classical operation in process engineering.

## III. PROBLEM STATEMENT

To design a pitched blade impellers for mixing a range of low viscosity fluids with viscosity range up to 3cP and density ranging from 1000 to 1100 kg/m3. The station is designed for a maximum tank capacity of 200 liters. Existing mixture blade is not proper to designed and mix material and not getting proper accuracy. However, it can accommodate different tank capacities with limited variations in the volume of fluid for homogenize the fluid. To facilitate portability, the impellers should be designed to ensure axial motion of the fluid.

## IV. METHODOLOGY

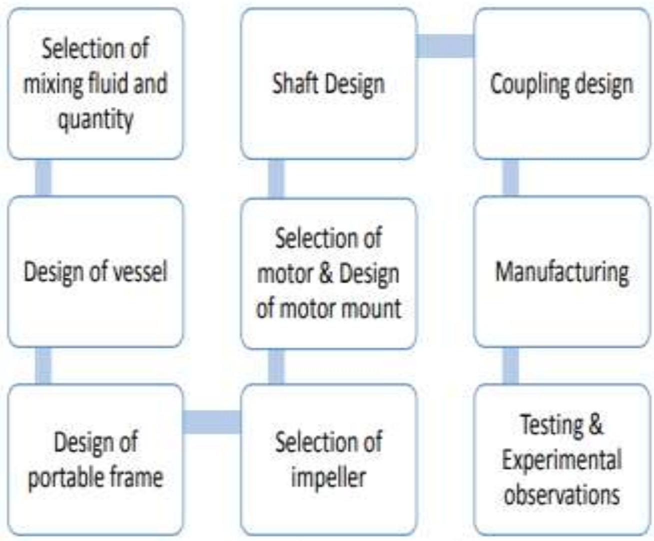


Fig 1. Detail approach

## V. CONCLUSION

The conclusion of the project was to design and develop an pitched blade impeller for a range fluid viscosity (1-3cp). In this project, studied the different configuration, pitched blade impellers and mixture layouts and have come to select the best possible outcome based on safety, availability and feasibility of manufacturing.
All components of mixture design in the set up was designed and analyzed using computerized software packages such as Solidworks Simulations and ANSYS Workbench for safety requirements.

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