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Modification in Design and Analysis of an Effective Light Weight S- Shape Agitator for Mixing Of Pulp in Pulping Industry

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ABSTRACT— Proposed project is to modify design and FE analysis of S shaped agitator to perform pulp stirrer and feeder operations in pulping equipment. Generally in pulping industry pulp is mostly feed to different processes by screw feeder mechanism, here also screw feeder is already designed and standardized, in that standard screw mechanism upper hollow tank collecting the pulp which is very unmixed and not properly stirred after bleaching and other operation in chemical as well as in mechanical pulping. So, to make this purpose solve practically in existing setup, we need to design an agitator which will help to distribute the pulp in feeder opening of screw conveyor. Now while distribution pulp must be previously stirred for that on the top of agitator assembly stirrer is to be mounted preliminary it can be T shaped vertically mounted as shown. Stirrer will be designed in such a way that it must hold load of coming pulp from the top and must be rotate without any bending deformation occurred in the agitator.

KEYWORDS - *Agitators, ANSYS, CAE, CFD, Weldment etc.*

I. INTRODUCTION

Agitation is the process of inducing motion of material in a specified way. In the chemical and other processing industries, many operations are dependent to a great extent on effective agitation and mixing of fluids. Generally, agitation refers to forcing a fluid by agitator means to flow in a circulatory or other pattern inside a vessel. Agitation is a means mixing of phase can be accomplished and by which mass and heat transfer can be enhanced between phases or with external surfaces. In paper making process different processes are takes place in which bleaching is also one of the important process. In bleaching process heating of raw material with water takes place and here is separations of fibers are takes place. After bleaching process the pulp is goes for agitation process, in agitation process mixing of additives with the pulp are takes place.

So here this project gives brief conceptual idea about installation and working of agitator with its mechanical parameter. Previously this was used in separate vessel which was dismantled condition with the bleaching plants. Also agitator making technology was in casting as the agitator is a single device used here which is in non standardized dimension and shape so there is no scope to make it in casting process that’s why we come to make within weldment.

II. LITERATURE REVIEW

Saeed Asiri (2012) design and implement a new kind of agitators called differential agitator. The Differential Agitator is an electro- mechanic set consists of two shafts. The first shaft is the bearing axis while the second shaft is the axis of the quartet upper bearing impellers group and the triple lower group which are called as agitating group. The differential agitator avoids the vortex forming in the liquid and gives a high homogeneous motion of the liquid due to transferring the vortex from the outer tank to internal container. The optimal shape of the internal container is the full open suction and discharge intakes.

Kazuhiko Nishi et al (2013) Mixing is one of the most fundamental operations in chemical engineering. Stirred tanks are widely used in the manufacture of such materials as chemicals, paints, inks, electronics materials, ceramics, foods, pharmaceuticals and cosmetics. Suitable mixing is indispensable to the purpose achievement of a process. The power consumption and mixing time for marbled, which is a type of large impeller, were investigated. the power consumption, p, and mixing time, θm, were measured under various eccentric conditions. The relation between the power number (np) and Reynolds number (re) and that between the dimensionless mixing time (nθm) and re were investigated. When eccentric mixing is used industrially, we should be concerned about the horizontal load to a agitating shaft. The large oscillating horizontal load causes serious problems, such as the falling off of the impeller or the breakage of the motor, mechanical seal or gearbox. It is, therefore, important to understand the relation between these values and the impeller rotational speed when designing the mixing equipment and determining the operating conditions. They have studied, the torque and horizontal load were measured in eccentric mixing under various eccentric conditions. The averages of both, the torque and the horizontal load, and their standard deviations, corresponding to the amplitude of fluctuation were shown.

III. PROBLEM IDENTIFICATION

Objectives:

To reduce the weight of agitator, perform the design modification and analysis agitator.

And to increase the rate of pulp feeding, reduce the cost of the agitator and increase the production rate with decrease in maintenance cost.

Scope and process layout of new agitator

We have existing design of agitator and its process lay out. The conceptual design of new shaped agitator is as follows. It is having stirrer on the top of agitator and stirrer having S shape so in both side cavity is created in blade.

Design and optimization of S shaped Agitator for stirrer mechanism in Screw feeder assembly.

The gray part gives scope of our project and this all assembly diagram gives process layout of our project

We have to design such an agitator which can be feed more pulp to screw convener

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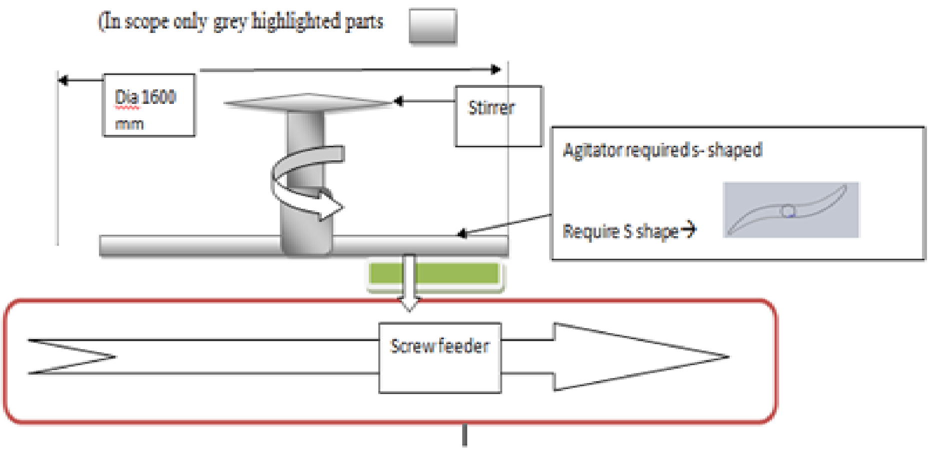

Fig.1 Process layout of new agitator

Problems Identified:

The problem found that, The existing agitator have low feeding rate Feeding from horizontal inlet changed to top feeder axial from height. Weight of existing mechanism is very high The Maintenance cost of existing agitator is so high. Production delay due to maintenance in existing system Improper mixing of pulp additives Pulp cannot reach to each corner of vessel to feed towards screw feeder assembly.

Grade	Elastic Modulus	Elongation %	Shear Modulus
AISI 316	197 Gpa	70%	86 Gpa

IV. RESEARCH METHODOLOGY

The S shape agitator is modified design of old flat agitator. It is made up from the weldment method. This agitator consists of three parts that is stirrer, central hub and blade. This agitator gives more efficiency. The mixing vessel contain agitator, opening for screw feeder conveyor, motor, motor shaft. The motor is located at the bottom of vessel and agitator rotate in mixing vessel. All the agitation group have to locate at the bottom of bleaching plant, pulp is come from this is now direct comes in agitation group and mixed the additives in pulp.

Material Selection:

Material for bolt – A4 80 derives from "A" meaning the material is a cold worked austenitic stainless, divided into 5 grades (1-5, hence the "4") The "80" denotes the minimum tensile strength to be met by the material (actually the bolt, screw or nut after manufacture).

A4-80 is an austenitic, acid proof stainless grade (usually 316 material)It is corrosive resistance steel grade. It is acid proof material. It is having good weld ability and formability. This all properties are well suited for our working conditions also it can sustain load applied by pulp on it[21].

Material for hub and agitator arm:

AISI (AMERICAN IRON & STEEL INSTITUTE) 316 is the standard molybdenum-bearing grade. It is having excellent weld ability and Formability The molybdenum gives better overall corrosion resistant properties for chloride environment. It is having resistance to pitting It is having corrosion resistance property It is having good oxidation resistance properties This all properties are well suited for our working conditions also it can sustain load applied by pulp on it.

Agitator shape selection:

Depends on the viscosity of the liquid

As the viscosity if consider the system require more surface to pass the pulp forward hence 60 mm width plate is welded to collect and spread towards the screw feeder. Also S shaped gives more collective and hollow portion to collect pulp also mixing the material with circular hollow section is better than flat portion. In our design shape of agitator more stability and more area to collect also very less chances to get failed ,as there are no more bolting and casting joints involved only proper weldment are considered into the current new design which gives more flexibility to repair if any wear tear occurs in future.

CAE Tool:

ANSYS, Inc. is an engineering simulation software (computer-aided engineering, or CAE) developer headquartered south of Pittsburgh in the Southpointe business park in Cecil Township, Pennsylvania, United States. One of its most significant products is Ansys CFD, a proprietary computational fluid dynamics (CFD) program.

ANSYS workbench platform:

The ANSYS Workbench platform is the framework unifying our industry-leading suite of advanced engineering simulation technology. An innovative project schematic makes it possible to build even complex metaphysics analyses with drag-and-drop simplicity. With bidirectional parametric CAD connectivity, powerful highly automated meshing, an automated project-level update mechanism, pervasive parameter management and integrated optimization tools, the ANSYS Workbench platform delivers unprecedented productivity, enabling process capture and Simulation-Driven Product Development.

ANSYS Meshing:

Mesh generation is one of the most critical aspects of engineering simulation. Too many cells may result in long solver runs, and too few may lead to inaccurate results. ANSYS Meshing technology provides a means to balance these requirements and obtain the right mesh for each simulation in the most automated way possible. ANSYS Meshing technology has been built on the strengths of stand-alone, class-leading meshing tools. The strongest aspects of these

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separate tools have been brought together in a single environment to produce some of the most powerful meshing available. Highly automated meshing environment makes it simple to generate the following mesh types:

Tetrahedral, Hexahedral, Hexahedral Core, body fitted Cartesian, prismatic inflation layer. Cut cell Cartesian, tetrahedral inflation layer. Consistent user controls make switching methods very straight forward and multiple methods can be used within the same model. Mesh connectivity is maintained automatically. Different physics requires different meshing approaches. Fluid dynamics simulations require very high-quality meshes in both element shape and smoothness of sizes changes. Structural mechanics simulations need to use the mesh efficiently as run times can be impaired with high element counts. ANSYS Meshing has a physics preference setting ensuring the right mesh for each simulation.

Numerical analysis of existing flat agitator

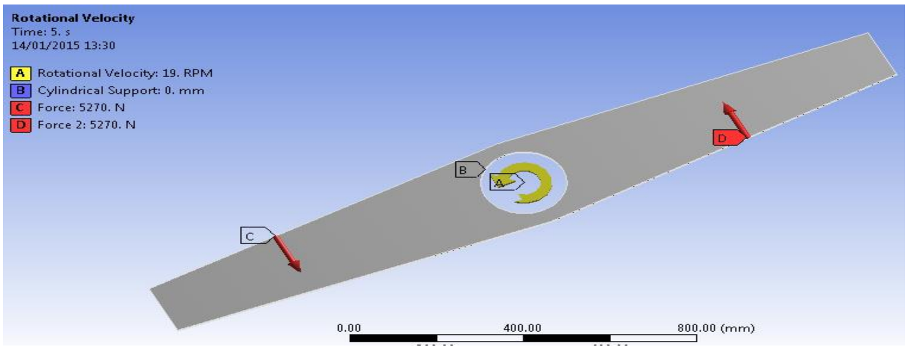

Fig.2 Boundary conditions on flat agitator

Boundary conditions:

This gives boundary conditions on flat agitator which gives different required results. In this force applied in both side but in opposite direction. This agitator given rotational velocity is 19 rpm. Boundary conditions are same environment as that of its working condition. So this gives same result as same as that of working condition. Applied boundary conditions are specified above. After solving this we will get result of stress produced on it, deformation of flat agitator.

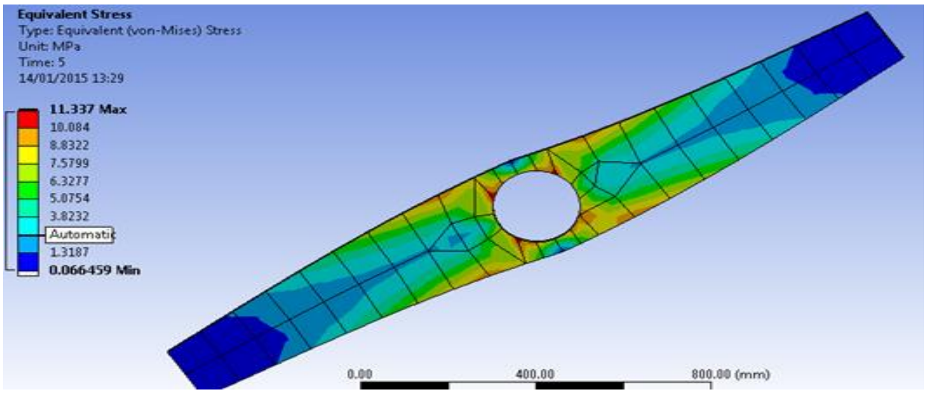

Fig.3 Equivalent stress on flat agitator

This figure shows equivalent stress on flat agitator. After application of boundary conditions we solve this for calculating stress on flat agitator. The Ansys has given results as maximum stress on flat agitator is 11.337 Mpa. This maximum stress is at central part of agitator. The red colour shows maximum stress on agitator. The here stress is very less because the weight and dimensions of flat agitator is so high.

The stress on flat agitator is less than yield point of its material and it can sustain load produced by pulp but the weight of this agitator is so high.

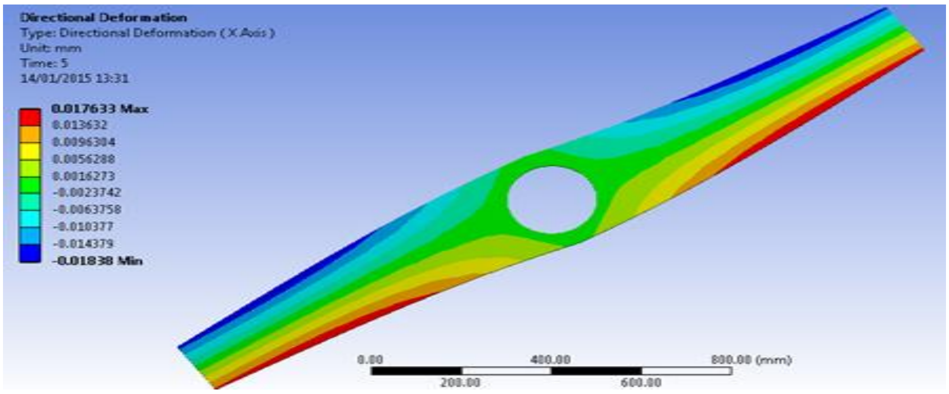

Fig.4 Directional Deformation on of flat agitator

This figure gives the total directional deformation on flat agitator. This gives very less deformation i.e. Maximum 0.0176 mm. The red colour indicates maximum deformation portion. It gives that in flat agitator deformation occurs at maximum portion.

Equivalent elastic strain on S agitator:

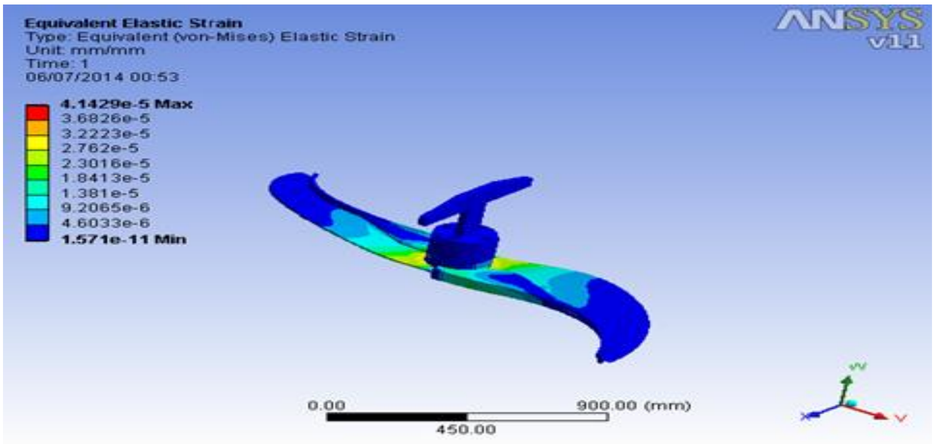

Fig.5 Equivalent elastic strain on S agitator

The above figure shows equivalent elastic strain on S agitator. After completion of meshing, we solve for the different Ansys results. In this Ansys result we got maximum and minimum strain produced on S agitator with given boundary condition. Maximum elastic strain on S agitator is 4.1429 x 10-5 .This shows that strain on S agitator is less and it is negligible. Different color shows the strain at that point or in that portion. Red color shows maximum strain on agitator while blue color shows minimum and safe condition of agitator.

Total Deformation on S Agitator:

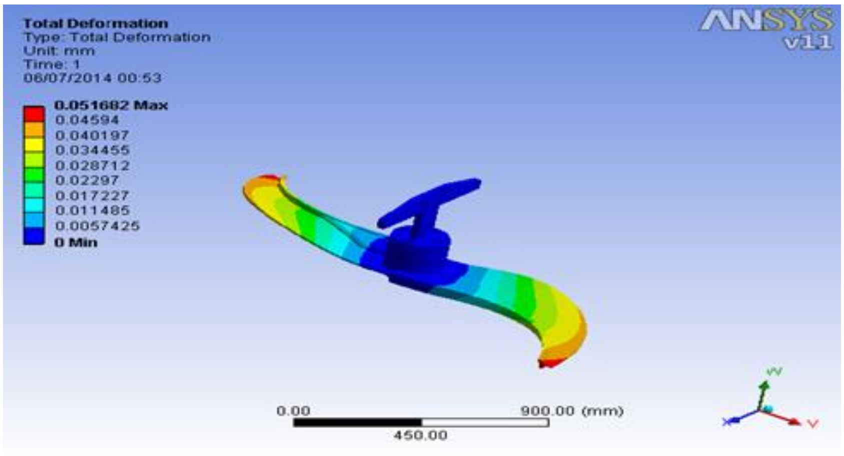

Fig.6 Total Deformation on S Agitator

The above figure shows the total deformation on S agitator. This gives the deformation occurs in S shaped agitator after application Of boundary condition. Total Deformation on S agitator is 0.051682 mm. This agitator deformation is very less and negligible. The red color shows maximum deformation occurs on agitator. This shows that, maximum deformation occurs at the tip of the agitator and less deformation is at the central hub of agitator. As this deformation is very less and negligible so our design is safe. Different color shows the deformation on agitator at that region. Blue color shows the safe condition. This shows we can safely use this agitator.

Equivalent stress on S Shape Agitator:

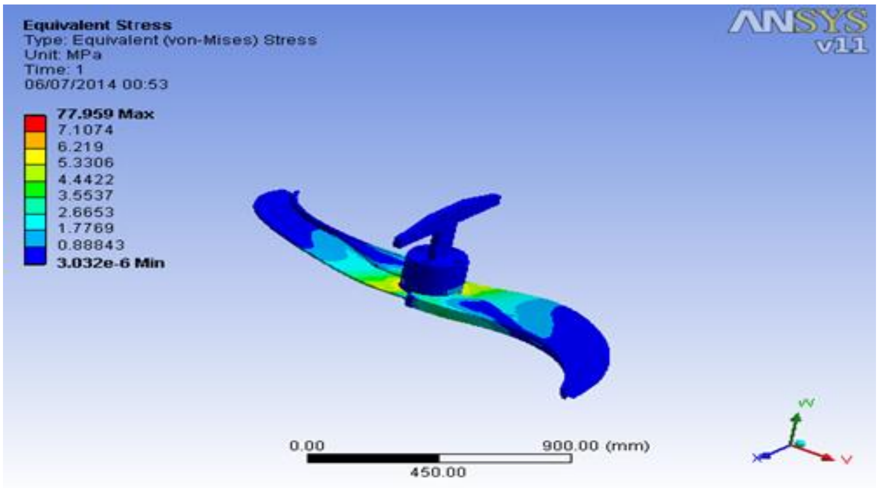

Fig.7 Equivalent stress on S Shape Agitator

The above figure shows the equivalent stress on the S agitator. The figure shows all details about maximum stress produced on agitator. The red colour show maximum produced on new S shaped agitator. Maximum equivalent stress = 77.95 N/mm2Minimum equivalent stress= 3.032 N/mm2 By applying boundary condition on S agitator, we have calculated stress on agitator. Maximum stress is indicated by red in colour. The material used for this agitator is AISI 316 and it is having yield strength 205 Mpa. So it shows that our design is safe and it will not fail in working condition.

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We have validated our stress by numerical analysis and by analytical analysis. So both analyses give nearly equal result.

Sr. No.		
1	Maximum Stress on S agitator	78 Mpa
2	Bending Stress On S Agitator	50Mpa
3	Deflection Stress on S agitator	43.32mm
4	Weight Of S Agitator	205.7 Kg
5	Feed per Revolution Of S agitator	105 lit per revolution

VII. RESULT AND DISCUSSION

We have modified the design of agitator. For safe design of agitator we have calculated different stresses produced on this agitator and some other parameter which are important. The following table will give all values of this stresses

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