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Introduction about Design and Stress Aanalysis of Tail Cone Rotary Agitator in Horizontal Feeder

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Abstract- The proposed work is to be carried out for validation and anti deflection solution in design for cone hub agitation system in feeding process of pulp. This agitation process is different from conventional processes other processes carried out in vertical position it's a horizontal heavy work application is to be carried out for making pulp feeding and screening horizontally as to avoid inlet feeding from height. To give shape for this application end fitting tail cone agitator is designed to fulfil the application. In results will shows all the designed parameters are capable to withstand with boundary conditions provided. Boundry conditions to be evaluate for pulp capacity and vessel volume also rotary parameters involved. Pulp is the medium where this system will work ,pulp is simple wooded bleached coming from bleaching preheater in hot condition and to be feed to screw conveying system all these machineries are part of paper and pulping industry. Gusseting rings to be used for perfect stability and optimised cover sheet thickness. To minimise the weight of whole cone structure. So weldment big structure to be formed which will be cage formed inside the cone.Results will show the comparison in multiple designed tail cone agitator with its validation in stress analysis and deflection analysis also it proves the stability with modal analysis.

Index Terms-Tail cone Sructure**,**Axel Hub Design,Agitator.

1. INTRODUCTION

Tail cone structure idea taken from aircraft building process if the same structure is used here to make mixing and stirring process in horizontal vessel , this tail cone is to be used as hub to hold blades outside .Agitator blades are to be fixed on this cone with dedicated fixtures provided with bolting or other feasible option.

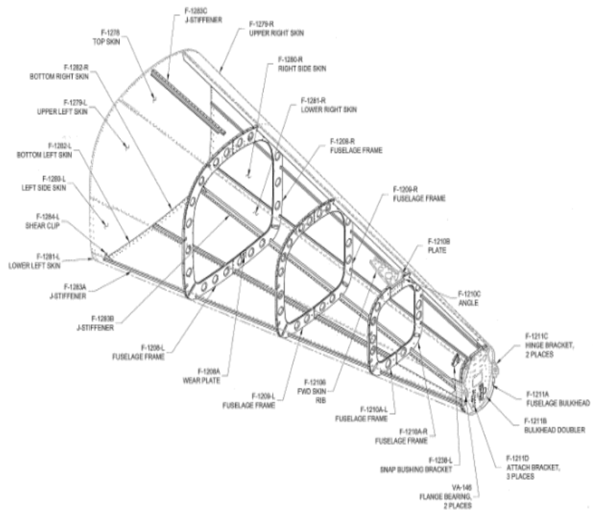

Fig1.1: General tail cone structure used in air craft design

In required application big tower around 10 meter high supplies pulp with bleaching processed this material need to be washed by dewatering process by big twin roll press before passing to dewatering twin roll press pulp must be mixed with some chemicals involves to make fibre soft and healthy ,it can be say the process to be designed here is to mixing and screening of material from flow condition .

2. PRODUCT WOKING STRUCTURAL SKETCH

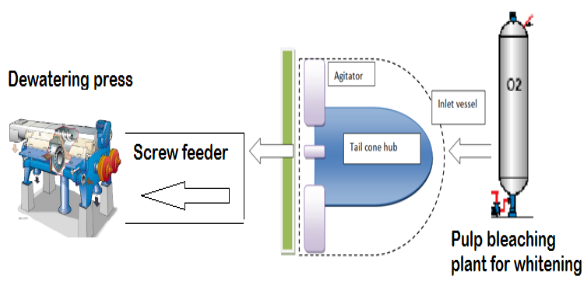

Fig.2.1: Tail cone agitator hub assembly

Tail cone agitator hub assembly showing that our design is works in between pulp bleaching and Dewatering press.

3. WORKING

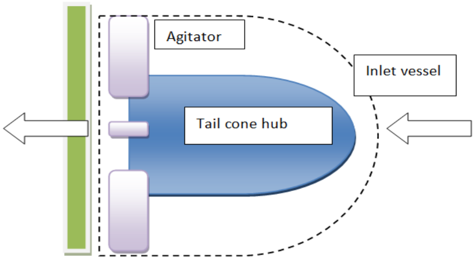

Fig.3.1: Tail cone rotor assembly in application

Agitation: It refers to the induced motion of a “homogenous” material in a specified way.
“Agitation is the process of keeping a mixture that has been mixed state required for end product”
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.

Fig.3.2 Agitation process

Mixing: It is the random distribution, into and through one another, of two or more initially separate phases
“Mixing refers to actual stirring of diff liquid or material to blend together into end product or mixture

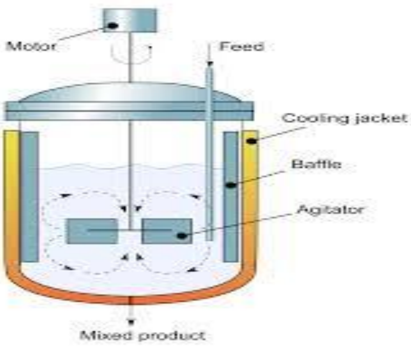

Fig. 3.3 Mixing process

4. Literature review

4.1. *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. 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 agitating group is located inside a cylindrical container equipped especially to contain square directors for the liquid entrance and square directors called fixing group for the liquid exit. The fixing group is installed containing the agitating group inside any tank whether from upper or lower position. The agitating process occurs through the agitating group bearing causing a lower pressure over the upper group leading to withdrawing the liquid from the square directors of the liquid entering and consequently the liquid moves to the denser place under the quartet upper group. Then, the liquid moves to the so high pressure area under the agitating group causing the liquid to exit from the square directors in the bottom of the container. For improving efficiency, parametric study and shape optimization has been carried out. A numerical analysis, manufacturing and laboratory experiments were conducted to design and implement the differential agitator. Knowing the material prosperities and the loading conditions, the FEM using ANSYS11 was used to get the optimum design of the geometrical parameters of the differential agitator elements while the experimental test was performed to validate the advantages of the differential agitators to give a high agitation performance of lime in the water as an example. In addition, the experimental work has been done to express the internal container shape in the agitation efficiency. The study ended up with conclusions to maximize agitator performance and optimize the geometrical parameters to be used for manufacturing the differential agitator.

1.Axial Impellers 2. Centrifugal Impellers 3. Multi Stage Impellers 4. Inclined Impellers 5. Helical/Screw Impellers

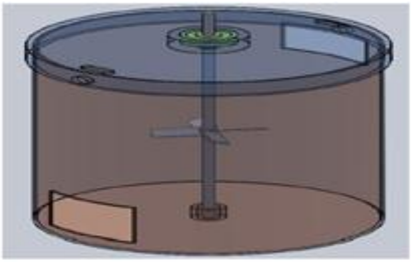

Fig 4.1.1: Normal Agitator

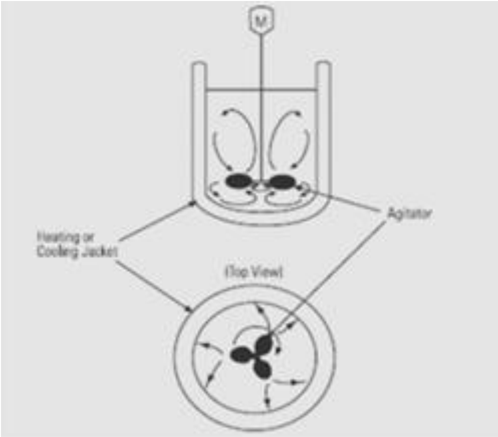

Fig.4.1.2:Agitators Cycle Motion

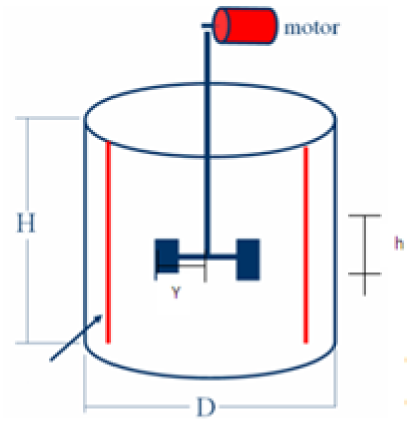

Fig.4.1.3:An example of Classical Agitator

4.2 *11251Side entry agitator test stand*

A side entry agitator test stand is being developed at RIT in conjunction with Lightnin Mixers, SPX Corporation. The test stand requires the ability to measure torque, RPM, axial force, translational force, as well as perform angular movements and vertical translational motion. The system is needed to fill a void in the industry, and will be constructed of steel, utilizing bolted and welded connections. The sensing will be done via load cells, a variable frequency drive, and a LabView interface with the appropriate data acquisition devices. Data will be output in a text file for easy integration with Microsoft Excel and/or matlab

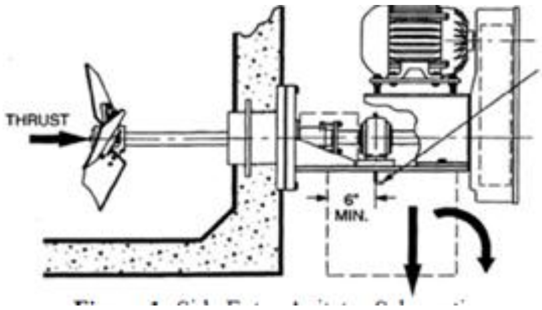

Fig.4.2.1:Side Entry Agitator Schematic

CALCULATION OF SYSTEM FORCES SPX has provided the team with two specific mixing impellers (model: A100 & A312)ranging in diameter from six to ten inches. It was suggested to utilize 4HP of a 5HP rated AC motor. The additional 20% can accommodate for power and torque loss between the shaft, coupling, and motor workings. Given the following formula, shaft speed, torque, thrust, and fluid force maxima were determined. SPX specified a maximum shaft speed of 1200RPM, which led to back calculating the maximum values taking the upper and lower bounds of shaft speed into consideration. A maximum torque of 23.6 ft-lbs, maximum thrust of 108.9 lbs, and maximum fluid force of 51.5 lbs, were calculated. These parameters were all calculated using "worst case" methodology for each term. The formulas employed are summarized below: (1) 5 3 14 *** *10 *54.6D N SG Np SHP FLUID □ □

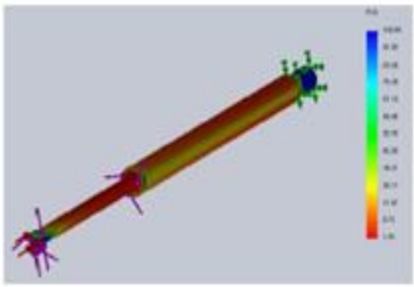

Fig.4.2.2:Solid Works Simulation Express

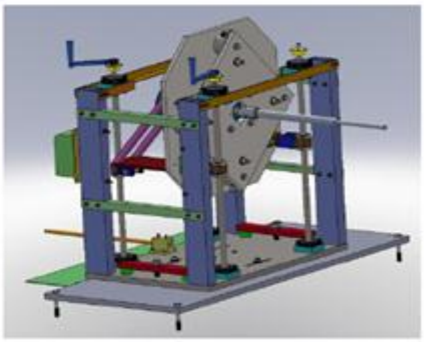

Fig.4.2.3:Structure Assembly

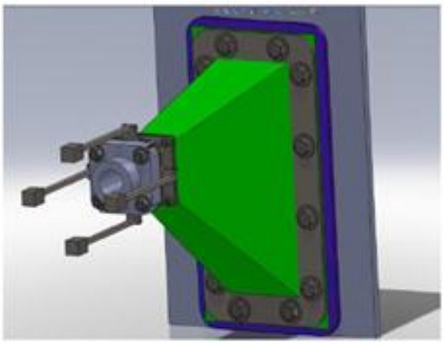

Fig.4.2.4:Seal Subassembly

4.3 ***Agitator and wiper design modification for milk khoa machine***

B. Kumar suggests a new design of agitator and wiper modification for milk machine. He studied that the mixing is a very important unit operation in any dairy processing food process industry. For instance, all operations involving blending homogenetic, 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 product making process. To attain uniform agitation 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 comfortable working loads thus creating problems in the output of the different parameters of the organization efficiency like quality, quantity, delivery schedule and work force capacity. 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 .

4.4 ***The flow pattern in an industrial paper pulp chest with a side entering impeller***

Daennis Beatty studied the side entry agitator test stand. A side entry agitator test stand is being developed at RIT in conjunction with Lightnin Mixers, SPX Corporation. The test stand requires the ability to measure torque, RPM, axial force, translational force, as well as perform angular movements and vertical translational motion. The system is needed to fill a void in the industry, and will be constructed of steel, utilizing bolted and welded connections. The sensing will be done via load cells, a variable frequency drive, and a Lab View interface with the appropriate data acquisition devices. Data will be output in a text file for easy integration with Microsoft Excel and/or Matlab .

4.5 ***Design of multiple impeller stirred tanks for the mixing of highly viscous fluids using CFD***

Joelle Aubin design of multiple impellers stirred tanks for the mixing of highly viscous fluids using CFD. He has investigated the effect of multiple internal impeller variants on hydrodynamics and mixing performance in a stirred vessel has been investigated using computational fluid dynamics. Connection between impeller stages and compartment has been assessed using Lagrangian particle tracking. The results show that by a rotating Intermit impeller by 45° respect to its be sided thing, instead of a 90° rotation as recommended by producers, enables a larger range of operating conditions, and lower Reynolds number flows, to be handled. Furthermore by slightly decreasing the distance between the lower two impellers, fluid exchange between the impellers is ensured down to Re = 27 .

4.6 ***Mixer mechanical design- fluid forces***

Ronald J. Weetman describe mixer mechanical design for fluid forces. He represents the mechanical design of mixer with the emphasis on the fluid forces that are opposed on the impellers by the fluid continuum in the mixing vessel. The analysis shows that the forces are a result of transient fluid flow a symmetries acting on the mixing impeller. These loads are dynamic and are transmitted from impeller blades to the mixer shaft and gear reducer. A general result for the form of the fluid force equation can be developed. The importance of the mechanical interaction of the mixing process with the mixing vessel and impeller is stressed .

4.7 ***Design and implementation of differential agitators to maximize agitating performance***

Saeed Asiri 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 agitating group is located inside a cylindrical container equipped especially to contain square directors for the liquid entrance and square directors called fixing group for the liquid exit. The fixing group is installed containing the agitating group inside any tank whether from upper or lower position. The agitating process occurs through the agitating group bearing causing a lower pressure over the upper group leading to withdrawing the liquid from the square directors of the liquid entering and consequently the liquid moves to the denser place under the quartet upper group. Then, the liquid moves to the so high pressure area under the agitating group causing the liquid to exit from the square directors in the bottom of the container. For improving efficiency, parametric study and shape optimization has been carried out. A numerical analysis, manufacturing and laboratory experiments were conducted to design and implement the differential agitator. Knowing the material prosperities and the loading conditions, the FEM using ANSYS11 was used to get the optimum design of the geometrical parameters of the differential agitator elements while the experimental test was performed to validate the advantages of the differential agitators to give a high agitation performance of lime in the water as an example. In addition, the experimental work has been done to express the internal container shape in the agitation efficiency. The study ended up with conclusions to maximize agitator performance and optimize the geometrical parameters to be used for manufacturing the differential agitator.

1. Axial Impellers
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5. Helical/Screw Impellers .

4..8 *Impeller design for mixing of suspensions*

Tomas Jirout "Impeller design for mixing of suspensions." has investigated 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. The suspension efficiency of tested impellers was compared by means of the power consumption required for off-bottom suspension of solid particles.

4.9 *The flow pattern in an industrial paper pulp chest with a side entering impeller*

Julian B. Fasano analyze the fluid flow in stirred chests. However, most work concentrated on the computation of flow patterns in lab-scale tanks equipped with top entering impellers. Industrial problems are usually much harder to tackle. Complicating factors are the use of fluids with complex non-Newtonian behavior, the use of side entering agitators instead of top entering agitators and the fact that the agitator may be operated in the transitional regime. A difficult mixing problem is found in the paper industries. The paper pulp, which is a suspension of thin, flexible fibers, exhibits a very complex rheology. As a result of this rheology multiple flow regimes are found in paper pulp storage tanks. Part of the chest will be laminar; some parts of the chest are turbulent .

a) Agitation and Mixing of Fluids

- Purpose of agitation: intensification of transport processes in agitated batch (heat and mass transfer)
- Preparation of materials of required properties (suspension, emulsion)

These are some examples of industrial applications

- Blending of two miscible liquids as ethyl alcohol and water.
- Dissolving solids in liquids, such as salt in water
- Dispersing a gas in a liquid as fine bubbles, such as oxygen from Air in a suspension of microorganisms for fermentation or for the activated sludge process in waste treatment liquid-liquid dispersion, such as dispersion of pigment in solvents
- Suspending of fine solid particles in a liquid, as in catalytic
- Hydrogenation of a liquid agitation of the fluid to increase heat transfer between the fluid and a coil or jacket in the vessel wall.

b) Method of Mixing Fluids

- Mechanical mixing (rotating, vibrating)
- Hydraulic mixing
- Pneumatic mixing
- Pipeline mixing (turbulent flow, static mixer)

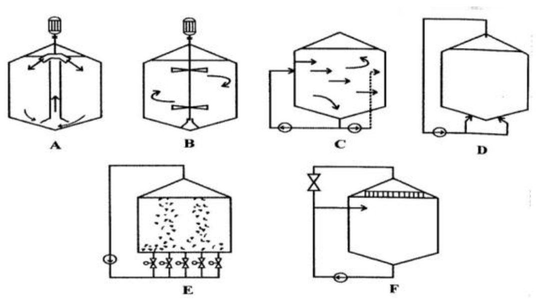


Fig4.9.1 : Various Methods of Mixing

A – Mechanical mixing using turbines
B – Mechanical mixing using blade impellers
C – Hydraulic mixing
D – Pneumatic mixing with stationary inputs
E – Pneumatic mixing with automatic regulation
F – Hydraulic mixing with antifoaming shower

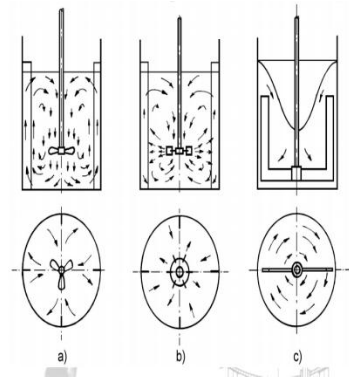


Fig.4.9.2: Flow in Agitated Batch

a – Axial-flow pattern, baffled vessel,
b – Radial-flow pattern, baffled vessel,
c – Tangential-flow pattern, unbaffled vessel

Helical impellers are used primarily in applications involving very viscous materials. This is design layout of Agitators.

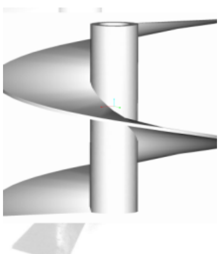


Fig.4.9.3: Close Clearance Agitator

They operate with minimal clearance at the vessel wall and provide axial flow at low speed. Their construction can be single or double outer flight with or without an inner flight. The outer flight provides upward pumping action while the inner flight pumps in the downward direction. (The inner flight does not add to impeller performance in the case of Newtonian fluids.) These impellers, like the Anchor, provide improved heat transfer in a viscous fluid system .

Fig.4.9.4: High Speed Impeller

The Elongated Paddle impeller provides a combination of axial upward and radial fluid flow. It, like the Anchor and Helical Impellers, operates in close proximity to the vessel wall

a) Type of Close Clearance Agitators

No.	Layout of agitator	Name	T/d	Geometrical parameters
1		Anchor (paddle) agitator CVS 69 1014	1,11	$h_r/d=0{,}8$ $h/d=0{,}12$ $H_2/d=0{,}055$
2		Helical-screw agitator with draught tube CVS 69 1028	2	$h_r/d=1{,}5$ $s/d=1$ $D'/d=1{,}1$ $H'/D'=1{,}15$
3		Eccentrically placed helical-screw agitator	2	$h_r/d=1{,}5$ $H_2/d=0{,}25$ $s/d=1$ $c/T=0{,}02$
4		Helical-ribbon agitator CVS 69 1029	1,05	$h_r/d=1$ $s/d=1$ $h/d=0{,}1$
5		Leaf agitator CVS 69 1016	2	$h/d=1$
6		Multi-stage agitator	2	$h/d=0{,}2$ $h_r/d=1{,}65$ $\alpha=45°$ $\beta=45°$ $c/T=0{,}02$ $H_2/d=0{,}175$

Table No.1: Types of Closed Clearance Agitators

b) Type of High Speed Impellers

No.	Layout of impeller	Name	T/d	Geometrical parameters
1		Six-blade turbine with disk (Ruschton turbine) CVS 69 1021	3 ÷ 4	$h/d=0{,}2$ $l/d=0{,}25$ $d_r/d=0{,}75$ 6 blades
2		Six-blade open turbine	3 ÷ 4	$h/d=0{,}2$ 6 blades
3		Pitched six-blade turbine with pitch angle 45 CVS 69 1020	3 ÷ 4	$h/d=0{,}20$ $\alpha=45°$

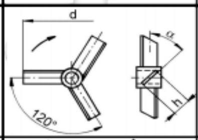
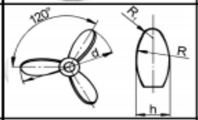
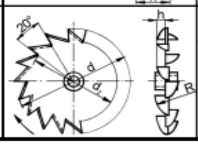
No.	Layout of impeller	Name	T/d	Geometrical parameters
4		Pitched three-blade turbine with pitch angle 45° CVS 69 1025.3	3 ÷ 4	$h/d = 0{,}2$ $\alpha = 45°$
5		Propeller CVS 69 1019	3 ÷ 4	$s/d = 1$ $h/d = 0{,}22$ $R/d = 0{,}4$ $R_1/R = 0{,}16$
6		High shear stress impeller CVS 69 1038.1, .2	2 ÷ 4	1st variant $h/d = 0{,}1$ $d_2/d = 0{,}8$ 2nd variant $h/d = 0{,}075$ $d_2/d = 0{,}85$

Table No.2: Types of High Speed Impellers

5. PROBLEM IDENTIFICATION

To transfer pulp towards dewatering press its essential to make chemical mixing and screening so to make feasible bigger diametric conical feeder needed to pass pulp from small diameter inlet to bigger diametric screw feeder entrance with its stirring and agitation process in vessel. Now a days agitators are used for screening and mixing which is positioned in vertical direction but it causes vortex motion so we need to used baffles to avoid vortex motion, again it causes bubbles which creates cavitation and pressure is formed which minimized the efficiency of agitator. So we are planning to design a tail cone agitatator to overcome this causes by positioning the rotary agitator in horizontal direction.

6. OBJECTIVES

1. Design of cone shaped hub for agitator assembly to make pulp screening.
2. To design fixture arrangement for agitator blade mounting.
3. Optimised design to make compact drive unit and rotary mount.
4. Rotation of cone Supporting components to be considered .
5. Validation by stress behaviour and deflection analysis.
6. Modal analysis to perform and to know behaviour in different frequency conditions.

7. SCOPE OF WORK

1. Cost effective design
2. manufacturability of cone hub as well as agitator.
3. Assembly CAD model.
4. calculations
5. ansys results With approved reports.

8. FORMULATION

1. Concept modelling, (3D model complte assembly)
2. Weldment structure using standard ISO raw material and filler material
3. Multiple options to make optimised selection and best solution
4. J oints/coupling design
5. Dedicated Fixture development for agitator holding and its fittment
6. Ansys results with stress values and affecting component

REFERENCES

[1] " production and mechanical testing of an unmanned helicopter tail cone" by Deniz Kavrar1 http://www.escm.eu.org/eccm15/data/assets/1960.pdf

[2] uav design and manufacture -U067782B - by zhang xuetao National University of Singapore http://dynamicslab.mpe.nus.edu.sg/dynamics/thesis0910/Unmanned%20air%20vehicle%20(UAV)%20airfame%20design%20and%20manufacture.pdf

[3] http://www.buildinganrv.com/tailcone.html

[4] Metso latest pulping equipments product http://dc302.4shared.com/doc/mC_KWSre/preview.html

[5] Design and Analysis of a Composite Tailcone for the XM-1002 Training Round by James M. Sands, James Garner, Peter Dehmer

[6] "Mixer mechanical design- fluid forces" proceeding of the 19th international pump users symposism, by "Ronald j weetam senior research scientist and Bernd Gigas Principal Research Engineer LIGHTNIN Rochester New York"

[7] "Agitation And Mixing" Source: McCabe et al. 2001,by "Abraham Rogelio Martin Garcia"

[8] "The Flow Pattern in an Industrial Paper Pulp Chest with a Side Entering Impeller" Published in "The Online CFM Book" at http://www.bakker.org/cfm.

[9] 1998 André Bakker Updated: February 15, 2000 by "André Bakker and Julian B. Fasano"

[10] "Reactors and Fundamentals of Reactors Design for Chemical Reaction" by "Dr. Sanju Nanda M.Pharm, Ph.D. (IIT Delhi) ,Dept. of Pharmaceutical Sciences ,M.D. University ,Rohtak – 124001, Haryana ,(24-01-2008)" [11] "Fracture and fatigue analysis of an agitator shaft with a circumferential notch" July, 2002 by "Celalettin KARAAĞAÇ"

[12] "Design and development of an economic autonomous Beverage cans crusher" Volume 3, Issue 3, Septmebr - December (2012), pp. 107-122 © IAEME: www.iaeme.com/ijmet.html Journal Impact Factor (2012): 3.8071 (Calculated by GISI). by "A. Elfasakhany1, 2 *, j. Marquez2, e.y. Rezola2, j. Benitez 2"

[13] "Design and Implementation of Differential Agitators to Maximize Agitating Performance" International Journal of Mechanics and Applications 2012, 2(6): 98-112 DOI: 10.5923/j.mechanics.20120206.01 by "Saeed Asiri", King Abdulaziz University, 21589, Jeddah, P. O. Box. 80204, Saudi Arabia