Design and Failure Analysis of Crushing Cage for (PULP) Continuous Loading

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Abstract **—** This assignment gives failure resolving solution in the heavy machinery part that is crushing cage used in vertical hard crusher. Presented and existing cage is found failed in the running conditions when crushing medium changed from 2400 kg/m3 density and lower that this density medium is working fine. Crushing is to be made for multiple density medium that should with stand up to 3200kg/m3 density material.

Project work gives new structural weldment crushing cage with effective gyratory crushing with same existing drive and sub assemblies. Ansys results will give proper analysis results with boundary conditions examined and calculated .technology being used for making crusher is weldment with raw material standard structural rod with welding joints preparations. Finally validation will be done with considering crushing medium pulp compacted cubes of size 150 x150 x150mm in wet state. To provide optimized design and analytical validation to make feasible in high density medium crushing in cage crusher mounted vertically. Performance improvement will be with Design changes for higher density material Increasing Size of vessel.

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I. HARD CRUSHER PROFILE:

Crusher is extensive squashing hardware, utilizing the gyratory sports as a part of packaging cone pit of pulverizing cone to create expulsion, breaking and twisting part to materials for smashing dry mash of different hardness and densities. Hard Crusher Structure: this crusher is made out of transmission, motor base, unpredictable bushing, squashing cone, focus outline body, shafts, unique element part, oil barrel, pulley, apparatuses and dry oil, slender oil grease framework segments and so on..Crusher Working Principle: In gyratory crusher, the highest point of the axle with pulverizing confine cone is bolstered in the bushings at bar focal, the base is put in the capricious gap of shaft sleeves. At the point when Gyratory crusher works, electromotor through even pivot and a couple of angle apparatus drives unconventional bushing revolution, when unpredictable bushing turns, pulverizing cone does unusual and gyratory movement around the machine centerline, makes the devastating cone surface close to the devastating divider surface now and again and abandon it once in a while, along these lines make the metal in squashing cavity always getting expulsion and twisting and being broken, the broken materials is released by weight from pounding depression base.

PROBLEM IDENTIFICATION AND NEED :

Time or Frequency of Failure

After Every 30 mins cycle twisting began and twisted structure watched

All out Working Capacity

Volume of 2000 liter vessel limit with crusher confine RPM ~600 process duration 25-30 mins

Because of Failure of Crusher aggregate Production Loss

Creation separation until new pen fitting, confine get futile after disappointment

II. LITERATURE REVIEW

1. Disappointment because of Inadequate Lubrication in moving segment.
2. Vertical crusher - XSM Vertical Shaft Impact Crusher is a sand making machine, otherwise called sand creator, is primarily made out of upper spread, chamber, impeller, rotor and so forth. Xuanshi VSIX vertical shaft sway crusher is recently planned on the premise of cutting edge sand making innovation of Germany and America. Contrasted and VSI sand making machine, it has higher diminishment proportion, enhanced limit and lower force utilization
3. A review of stone crushers in created nationsGeneral - The pulverized stone industry in created nation like USA is the biggest non-fuel, non-metallic mineral industry as for both aggregate volume and estimation of generation with around 901 million tons creation esteemed at more than 2 billion US $ in year 1975. The business is geologically very scattered with all states. The stone generation by individual states is corresponding to populace and mechanical action. There are more than 5400 crushers in the USA situated in urban, rural and country regions. Arrangements are either stationary or compact sort in the limit range differing from 100 tons to a few thousand tons for every hr. The different rock sort handled are lime stone, stone, trap rock and sandstone. Critical items incorporate development related material, for example, indicated and unspecified development totals and street stone, solid total, bituminous total and so on. According *to USEPA information, the pounded stone industry was positioned third most astounding among the countries 56 no. of biggest particulate source transmitting class commercial enterprises in the year 1975.*

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III. DESIGN AND DEVELOPMENT

- Input
- RPM =600
- Total volume of vessel is 2000 litre
- Medium of crushing material = MDF cubes.
- Density of mdf cube is 2800 kg/mm3
- Crushing materials and its size.
- crushing of compacted pulp cubes of size 120 x120x60 mm
- Crushing material is wooden pulp compacted blocks made from wooden pulp ,
- Imported from Europe , after crushing and fibre separation it will be send for treatment of bleaching
- In india we don't have enough wooden pulp supply , to make availability for paper making we order it from European pulp makers , they send us this in weighing quantity not in volume so for more weight in less volume they treat this hot wet pulp in compaction to form compressed cubes .

Fig.After machine crush pulp

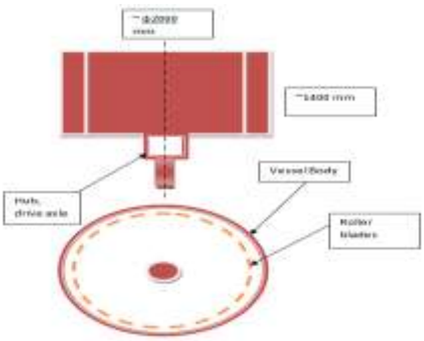


Fig: Conceptual view of crushing cage

- Blade compression roller design -Blade are nothing but the multiple roller installed with hard round surface on cage ring. Those will rotate itself to make compaction crushing of material with vessel inner body Itself rotary roller blade length = 300 -400 mm
- Hard crome roll single unit/
- Crushing medium Stress
- 50-75 Mpa

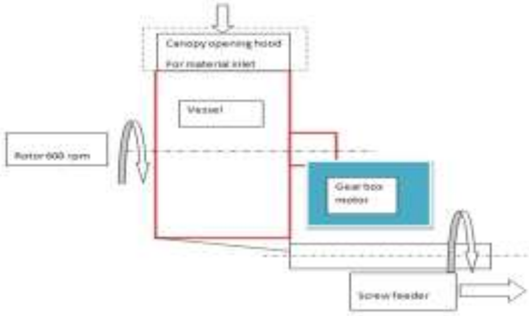


Fig : Process layout of machine

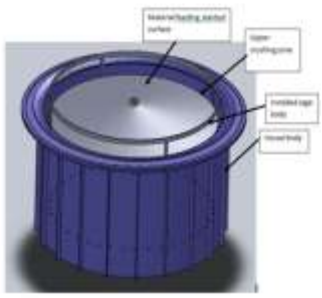


Fig Installation in vessel

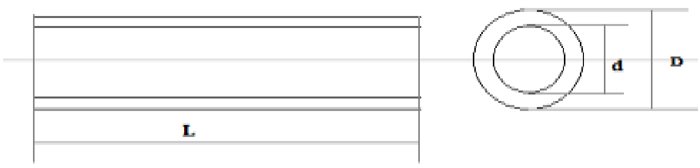
Material selected 316

No limitations on thickness in relation to brittle fracture apply to stainless steel; the limitations for carbon steel are not applicable due to the superior toughness of stainless steel. The austenitic stainless steel grades do not show a ductile-brittle impact strength transition as temperatures are lowered.

1) *Stainless steels can absorb considerable impact without fracturing due to their excellent ductility and their strain-hardening characteristics.*
2) *Volume of total inner tubular vessel=* $\pi r2 h$
3) $r = 800$ *mm*
4) $h = 1000$ *mm*
5) *V= 2000946428.5mm3*
6) *= 2009 litre*
7) *Density of flowing material , d= 2800 kg/m3*
8) *V= m/d,*
9) *M= Vx d = 5635.2 kg*
10) *Coefficient of friction =0. (Neglecting)*
11) *Total load =*
12) *F= 56250 N inside the shell.*

13) *(Reference: A textbook of Machine Design by R. S. Khurmi and J. K. Gupta, S. Chand Publication, (14th edition*

II. DESIGN OF SHAFT



AT THE POINT WHEN THE SHAFT IS SUBJECTED TO BENDING AND TWISTING MOMENT SIMULTANEOUSLY, IT IS DESIGNED ON THE BASIS OF TWO MOMENTS.

BY SOCIETY OF MECHANICAL ENGINEERS (ASME) CODE FOR THE DESIGN OF TRANSMISSION SHAFT THE MAXIMUM PERMISSIBLE BENDING STRESS (Σ) MAY BE TAKEN AS

Σ = 0.6ΣEL OR 0.36ΣUT WHICHEVER IS LESS

SUBSEQUENTLY Σ = 0.6 X 190 = 114 MPA

THEN AGAIN

Σ = 0.36 X 510 = 183.6 MPA WHICHEVER IS SMALL

SUBSEQUENTLY Σ = 114 MPA

WE HAVE FROM FLEXURE FORMULA,

.........(I)

WHERE,

M = BENDING MOMENT

M = WL2/2 = 1.4 X 106 N-MM

I = MOMENT OF INERTIA =

WE HAVE

DO = 80 MM,

L = 1350MM

Y = DO/2 = 40MM

SO WE HAVE,

WHERE,

T = TORQUE ACTING ON THE SHAFT

J = POLAR MOMENT OF INERTIA

T = TORSIONAL SHEAR STRESS

R = DISTANCE FROM NEUTRAL AXIS TO OUTERMOST FIBER

= D0/2.... WHERE D IS DIAMETER OF THE SHAFT

= 40 MM

WE KNOW THAT, FOR SOLID CIRCULAR SHAFT, POLAR MOMENT INERTIA (J) IS GIVEN BY,

J = 1.0 X 106 MM4

PRESENTLY, THE SHEAR STRESS IS

T = 0.3 ΣEL

= 0.3 X 205

= 61.5 MPA

BY PUTTING IN EQUATION (I), WE GET

DI = 74.5 MM

PRESENTLY

BY SOCIETY OF MECHANICAL ENGINEERS (ASME) CODE FOR THE DESIGN OF TRANSMISSION SHAFT THE MAXIMUM PERMISSIBLE SHEAR STRESS (T) MAY BE TAKEN AS 18% OF ULTIMATE TENSILE STRENGTH (ΣUT).

IN OTHER WORDS,

T = 0.18 ΣUT

MOST EXTREME PERMISSIBLE SHEAR STRESS,

T = 0.18 ΣUT

= 0.18 X 520

= 93.6 MPA

FROM TORSIONAL EQUATION WE HAVE,

THUS,

TORQUE ACTING ON SHAFT

T= 1.533 X 106 NMM

TURNING MOMENT,

BY SHEAR STRESS THEORY,

MOST EXTREME SHEAR STRESS

TMAX =

WHERE, TE = √(M2+T2)

TE = 1.713 X 103 N/MM2

THUS MAXIMUM SHEAR STRESS,

TMAX = 68.7 N/M2

BY METHOD, MAXIMUM DEFLECTION

THUS , MAXIMUM DEFLECTION IS

Y = 3.42 X 103

(REFERENCE: A TEXTBOOK OF MACHINE DESIGN BY R. S. KHURMI AND J. K. GUPTA, S. CHAND PUBLICATION, (14TH EDITION))

V. CAE VALIDATION

SHAFT AUXILIARY CONDUCT SEGMENT FITTING

Fig:Meshing MPA

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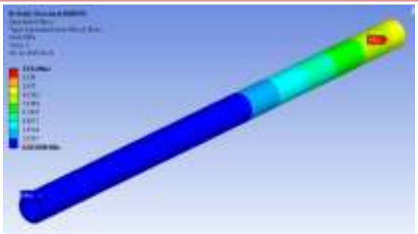
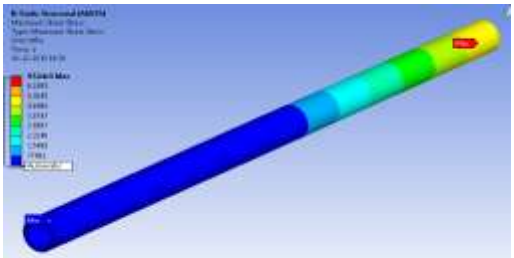
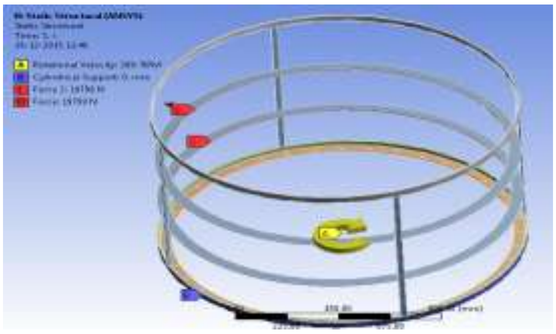


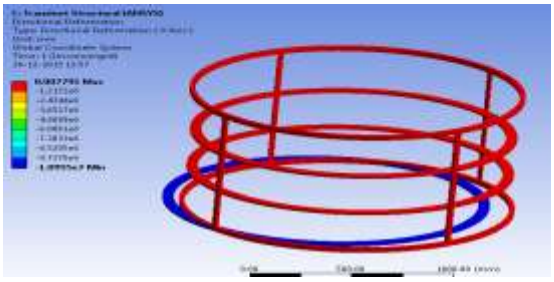
FIG; EQUIVALENT STRESS = 138.2 MPA



FIG;CAGE STRUCTURE :



FIG; BOUNDARY CONDITIONS APPLIED



Fig;Deformation is negligible now ie 0.0077 mm

CONCLUSION

1) Body structure

2) Mechanical parts

Shaft 138 mpa equal sttess where we discovered 93 Mpa hypothetical 103 mpa shear stress

3) Assembly Stresses in body shear 41 mpa, Equivalent van misses .141 mpa Deformation =0 mm

From all the auxiliary results it demonstrates that vertical enclosure sort smashing unit can be introduced in vessel for combining forms in one framework with said limit conditions . Just the condition starting great implied innovation is to be considered while fabricating , every one of the outcomes can change if well-implied joints are not suitable.

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