Synthesis and Analysis of Pressure Vessel For Deep Sea Experimental Investigation: A Review

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Abstract **This paper surveys research of various analysts on the failures and improvement of Deep sea pressure vessels. The examination incorporates different purposes behind vessel failure as Due to improper support excess deformation occur, stress concentration at junctions, end meshing ,strengthening etc The review paper indicates developing interest for enhancement. The inspiration for this investigates is to advance the pressure vessel by finding out the materials, that which will help to bear the surrounding effects and its shape structure. Studies carried out for deep sea pressure vessel configuration, according to the norms set by ASME in pressure vessel code. It is investigator's choice to choose suitable explanatory information for assurance of thickness of the bearable walls of vessel. In this paper some of current and past research carried on the pressure vessel analysis and synthesis.**

Keywords —Deep Sea Pressure Vessel, Deformation, Material Reinforcement, External Pressure, Stress Concentration etc.

I. INTRODUCTION

Experimental vessels are broadly utilized where it is required to hold the liquids at high temperature just as high pressure. They are significantly utilized in handling plants, atomic power plants, and oil refining businesses, synthetic industry. But during the study of this review paper can be understood to understand how can use Pressure Vessel for Deep Sea exploration or Deep Sea Experiments. There numerous mishaps caused due to the pressure vessel failures which resulted human death and durable impacts on the adjacent condition. Especially the deep sea vessel needs to configuration by thinking about higher safety factor. The structure must be completed according to the ASME principles and guideline. There are numerous spots in vessel where stress might be concentrated or the vessel may burst or deform in such a place that end supports, hole of rivets, welding ends, high stress zone. Henceforth it is required to give more consideration towards this point. Numerous papers are examined for the exploration to do. [1]

II. LITERATURE REVIEW

1. Author Name/ year V. Singh et al.

Journal Name - AIP Conf. Proc., 2013

Title - Prospects of Dark Matter Direct Search under Deep Sea Water in India

Objective - To study the experimental performance of dark matter search

Methodology - Experimental Approach

Finding - In this article, authors talk about the benefits and loss of utilization of remote ocean water in obscurity matter pursuit.

Limitation - This paper gives the information about the experiment setup and its relevant data but does not provide information about the housing of experimental setup.

Gaps Identified - Optimum design of vessel or housing for deep sea experiment can be find out by means of mathematical or analytical approach. [2]

2. Author Name/ year - Yusuke Yano et al.

Journal Name - IEEE, ISSN: 1554-1559, 9-12 Nov. 2004

Title - Study on spherical pressure vessel of ceramics for deep-sea buoyancy module applications.

Objective - To set up the strategy of creating the ceramic pressure vessels for remote ocean operations.

Methodology - Exploratory Research

Finding - Engineering ceramics has been one of the applicant materials for remote ocean pressure vessels as a result of its high compressive strength. The estimated results demonstrated that the irregularities of sphere pressure vessel were fundamentally improved compared with the sample of approximately 20 years back.

Limitation - For buoyancy module it was studied only the spherical pressure vessel for application of deep sea.

Gaps Identified – It only used single layer but it's not mentioned multilayer vessel of ceramic in this paper. [3]

3. Author Name/ year - Weicheng Cui (2013)

Journal Name - Marine Technology Society Journal 47(3):37-54

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Title - Development of the Jiaolong Deep Manned Submersible

Objective -To present the development procedure from an authentic perspective, including the realization of parts, design, assembly, ocean trials and open water tank tests of the Jiaolong deep manned submersible. .

Methodology - Field Experiment

Finding – The prerequisites of remote ocean investigation for China Ocean Mineral Resources R&D Association (COMRA), a deep manned submersible was currently advancement in China from 2002 to 2012 and was named Jiaolong in 2010 and both unmanned and manned deep submergence vehicles are fundamental methods for remote ocean investigation.

Limitation - The technical troubles experienced at each stage, and their answers are complex and time consuming.

Gaps Identified - It is not mentioned in this paper that which design of submersible is far better for deep exploration. [4]

4. Author Name/ year - Jun Chen et al. (2013)

Journal Name - IEEE Xplore, ISSN**:** 0197-7385, 23-27 Sept. 2013

Title - Design and Experiments of a Deep-sea Hydraulic Manipulator System

Objective - In 7000 meters depth, the 7-function master-slave hydraulic manipulator design and control can be utilized.

Methodology – Model Design and Control Testing

Finding – Design of Remote ocean master-slave hydraulic manipulator is among most generally devices prepared on remotely-operated vehicles or human occupied vehicles.

Limitation – It only describe about design and control of 7-function master-slave hydraulic manipulator design.

Gaps Identified – From this paper we can creates an analogy between hydraulic manipulator design and vessel , it is not clearly mentioned material of motion element in deep ocean and how ROVs and HOVs affects by manipulator design criteria. [5]

5. Author Name/ year - Nenad Zrni u et al. (2004)

Journal Name - IEEE Xplore, ISSN**:** 0197-7385, 23-27 Sept.

Title - Development of design of ship-to-shore container: 1959-2004

Objective - The examination of historical advancement and best in class in present day container empowers us to examine future trends in mechanical and basic structure design.

Methodology - Descriptive Study

Finding –Advancement of the container industry, the cutting edge in present day modern container, and core finding specific consideration on mechanical structure of trolleys and technical assessment of the current structures and design. .

Limitation – It only describe about length of time consideration design

Gaps Identified – For a considerable other configuration parameter - mechanical, civil, automation, and electrical can be incorporated to deliver conservative structure that meet operational requests and that can be effectively created and raised. [6]

6. Author Name/ year - Donald Mackenzie et al. (2008)

Journal Name - Elsevier Thin-Walled Structures 46 (2008) 963–974

Title - Design by analysis of ductile failure and buckling in torispherical pressure vessel heads

Objective - Analysis of thin shell torispherical pressure vessel heads are known to be a complex elastic– plastic deforming and buckling conduct under static pressure.

Methodology - Analytical Approach

Finding – In this paper, plastic crumple or gross plastic deformation loads are assessed for two sample torispherical heads by 2D and 3D FEA dependent on an elastic-perfectly plastic material model. Little and substantial deformation impacts are considered in the 2D analysis.

Limitation – The plastic load is controlled by applying only the ASME twice elastic slope criterion of plastic collapse.

Gaps Identified – The impact of geometry and load perturbation are not considered in 3D investigation. [7]

7. Author Name/ year - Patel Nikunj S1 et al. (2013)

Journal Name - (IJSR), ISSN: 2319-7064, Volume 2 Issue 4, April 2013

Title - Design and Analytical Calculation of Reactor Pressure Vessel

Objective - To check the structure of existing reactor pressure vessel which is fabricated by "NEW BLUEMOON ENGINEERS" furthermore, make new plan of some real parts of reactor pressure vessel and utilizing advanced CAE tool, experimental and analytical base model comparison of design and thermal examination of reactor pressure vessel.

Methodology - Analytical Approach

Finding – The design pressure and thickness of the new structure reactor pressure vessel is increase compare with existing reactor pressure vessel however decreases the longitudinal and circumferential stresses is decline in new design reactor pressure vessel.

Limitation – It gives a portion of the critical data, information and analytical computation of reactor pressure vessels.

Gaps Identified – It not gives a proper computation and comparison of existing and new plan reactor pressure vessels to engage the essential things to complete work. [8]

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8. Author Name/ year - Vishal V. Saidpatil et al. (2014)

Journal Name - IJEERT, Volume 2, Issue 3, June 2014, PP 1-8 ISSN 2349-4409 (Online)

Title - Design & Weight Optimization of Pressure Vessel Due to Thickness Using Finite Element Analysis

Objective - Examination of definite structure of pressure vessel utilized in evaporator for ideal thickness, temperature appropriation and dynamic conduct utilizing finite element analysis software.

Methodology - Software based analysis

Finding – Pressure vessel weight optimization because of thickness utilizing by FEA in accordance with ASME boiler and pressure vessel regulations comparison and diminishes in weight of pressure vessel.

Limitation – FEA is successful and has effectively satisfied the objective of financial aspects

Gaps Identified – It directly approaches towards ASME codes without considering the variable working condition of vessel. [9]

9. Author Name/ year - Daniel Vasilikis et al. (2011)

Journal Name - JPVT 2011, ASME FEBRUARY 2011, Vol. 133 / 011205-1

Title - Buckling Design of Confined Steel Cylinders under External Pressure

Objective - The buckling of cylinder bound within a deformable elastic medium by using finite element simulation tool.

Methodology - Analytical Method

Finding –To demonstrate a critical dependency of an ultimate pressure on the estimation of initial defects initial gap type flows and initial out-of-roundness for locking in both the flexible and the inelastic regime.

Limitation – Consideration of design guidelines using a two-dimensional model with nonlinear finite elements, investigate the structural response for both geometric and material nonlinearities.

Gaps Identified – Show Relevancy of design guidelines using only a two-dimensional model with nonlinear finite elements. [10]

10. Author Name/ year - You-Hong Liua et al. (2004)

Journal Name - IJPVP 81 Elsevier (2004) 619–624

Title - Limit pressure and design criterion of cylindrical pressure vessels with nozzles

Objective - To elaborates the importance of limit pressures and corresponding membrane stresses.

Methodology - Geometrical Analysis

Finding – The local stress criterion for reinforcement design of opening in a cylindrical pressure vessel subjected to internal pressure can be accepted generally except for a few cases of large thickness ratio.

Limitation – Limit pressure and maximum local membrane stress concentration factor (SCF) are assessed for two orthogonally intersecting thin-walled cylindrical shells subjected to internal pressure.

Gaps Identified – Show Relevancy of design only on local membrane but vessel design consists notches, hole for cable that means many sense of SCF concern is needed. [11]

11. Author Name/ year - R.C. Carbonari et al. (2011)

Journal Name - Elsevier, IJPVP 88 (2011) 198-212

Title - Design of pressure vessels using shape optimization: An integrated approach

Objective – In coupling cylindrical shaped region, the thickness variety from nozzle to dished end it decreases the optimality of the final outcome which may be affected by the limit conditions.

Methodology - Analytical Method

Finding – For vessels beginning of shapes close to a semi-sphere and mechanical loading only, one notification that the most extreme head stresses are smaller than the cylindrical stresses and the optimization investigation of pressure vessels is led thinking about a model of the whole pressure vessel.

Limitation –Only representative samples are analyzed and solution acquired for the whole vessel considering temperature and pressure loading.

Gaps Identified – It is essential that diverse shapes from the typical ones are obtained for the real impact of shape in the conduct of pressure vessels. [12]

12. Author Name/ year - Kiran D. Parmar et al. (2012)

Journal Name -IJAERS, Volume I, Issue III, April-June, 2012/184-187

Title - Thermal analysis for skirt dished end joint of pressure vessel using finite element analysis approach

Objective – Finding out the 'most extreme' parameters which gives extreme strength for skirt to dished end joint and the optimum parameters can minimize the stresses in pressure vessel joint.

Methodology - Analytical Method

Finding –After exploring distinctive strategies author ought to be concluded that skirt to dished end joint is a piece of pressure vessel in which most extreme failure is created After optimization diminish the stresses of this joint because of change the weld size of skirt to dished end joint and furthermore increment the life of pressure vessel.

Limitation – Only three instances of cracks is consider of skirt dished end joint are: splitting of inside, cracking because of absence of penetration and substance chemical problem.

Gaps Identified – FEM analysis focus towards Splitting of inside only. [13]

13. Author Name/ year - M.H. Toorani (2003)

Journal Name - Elsevier IJNLM 38 (2003) 1315 – 1335

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Title - Dynamics of the geometrically non-linear analysis of anisotropic laminated cylindrical shells

Objective - The displacement function are acquired by the correct solution of the equilibrium conditions of a cylindrical shell dependent on shearable shell theory rather than the normally utilized and progressively arbitrary interpolating polynomials.

Methodology – Mathematical Model

Finding –Geometrical non-linear effects on the vibration conduct of laminated shells could be exhibited at the point when the coupling between different modes is considered by considering the non-linear stiffness matrices. The non-linear strain terms arising from results of in-plane strain might be critical important in buckling problems.

Limitation – For laminated shells, direct stiffness matrices are inferred by correct systematic integration.

Gaps Identified – Direct stiffness matrices form has been made with only mass as a parameter. [14]

14. Author Name/ year - A.E. Burov et al. (2017)

Journal Name - AIP Conference Proceedings 1915, 040006 (2017)

Title - Strength and Reliability Analysis of Metal-Composite Overwrapped Pressure Vessel

Objective - Consolidate impermeability and high pressure effectiveness with upgraded load and steadiness. To meet these necessities, theoretical and experimental studies on the mechanics of disfigurement, failure of MCOPV are required.

Methodology - FEM based Empirical Method

Finding – Investigation on quality strength, lifetime and reliability of MCOPV is displayed. On full scale samples, justified the high performance by comparing the calculation result with experimental data of MCOPV.

Limitation –The investigation performed utilizing the created models and experimental results.

Gaps Identified – This paper does not show the performance of criteria of dependability for MCOPV. [15]

15. Author Name/ year - V.N. skopinsky et al (2006)

Journal Name - IJAME, 2006, vol.11, No.4, pp.965-979

Title - Modeling and stress analysis of nozzle connections in ellipsoidal heads of pressure vessels under external loading

Objective - The effects of geometric parameters on the maximum effective stresses in the ellipsoid-cylinder intersections under loading is performed and studies results of the analysis and parametric study of the nozzle connections are presented.

Methodology - FEM based study

Finding –The numerical results show that it is necessary to pay more attention to the effective stresses in the shells in external loading cases. Although the stresses due to the external loadings are secondary stresses with respect to primary stresses from the internal pressure, these stresses should be taken into consideration in a complete stress analysis for nozzle connections of a pressure vessel.

Limitation – Structural modeling and stress analysis of nozzle connections in ellipsoidal heads subjected to external loadings.

Gaps Identified – This paper shows analysis of only static behavior of external loading. [16]

16. Author Name/ year - Kumar. N P G et al. (2015)

Journal Name - (IJERT) ISSN: 2278-0181, Vol. 4 Issue 07, July-2015

Title - Design Development Analysis on Pressure Vessel under Different End Conditions using Ansys.

Objective – To designing pressure vessel, 3D modeling of pressure vessel and stress evaluation by means of finite element method under similar and dissimilar conditions of pressure vessel.

Methodology - Modeling and Analysis

Finding – Flat head type of pressure vessel shows the maximum hoop stress is 5406.52 MPa & longitudinal stress is 4787.88 MPa. Trivial head type of pressure vessel shows the hoop stress is 183.738 MPa & the longitudinal stress is 135.993 MPa. The maximum stresses in a trivial head pressure vessel will be less than four times than the flat head pressure vessel & it is preferable.

Limitation – Separate evaluation of stress under similar and dissimilar condition by means of FEM

Gaps Identified – Consideration of FOS should be two or three times for dissimilar condition of pressure vessel and do not combined situation. [17]

17. Author Name/ year - Shafique M.A. Khan (2010)

Journal Name - Elsevier IJPVP, 87 (2010) 239-244

Title - Stress distributions in a horizontal pressure vessel and the saddle supports

Objective -Common fraction of pressure vessel is modeled and ratio of the distance of support from the end of the vessel to the length of the vessel in the pressure vessel and the saddle structure are investigated.

Methodology - FEM based Study

Finding – The slenderness ratio (L/R) of less than 16 is found to generate minimum stresses in the pressure vessel Physical reason for favoring an A/L close to 0.25 may lie in the fact that at this ratio, each saddle is located roughly at the center of the half of the pressure vessel thus supporting the pressure vessel uniformly

Limitation –A pressure vessel is modeled with basic details of saddle supports.

Gaps Identified – Lack of conclusion of Radius of the vessel with the length for optimal values of ratio of distances for minimum stress. [18]

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18. Author Name/ year - Manish M. Utagikar et al. (2013)

Journal Name - (AJER) ISSN: 2320-0847 Vol.-02, Issue-12, pp-343-349

Title - Finite Element Analysis of Elliptical Pressure Vessels

Objective - Determination of stresses in an open ended pressure vessel of elliptical or obround shape with material aluminum alloy. Software "ANSYS" is used for modeling & analysis purpose for finding out the internal pressure.

Methodology - Modeling and Analysis

Finding – In elliptical pressure vessel the hoop stresses, deformation are very much higher as compared to the stresses in circular pressure vessel. The hoop stress is directly proportional to the ratio of major and minor axis as with increase in a/b ratio of elliptical pressure vessel, the hoop stresses also go on increasing.

Limitation – Considering the symmetry about both axes, only quarter model is prepared.

Gaps Identified – This paper only gives the quarter model analysis and this is not enough for complete optimization. [19]

19. Author Name/ year - Bandarupalli Praneeth et al. (2012)

Journal Name - IJETT, ISSN: 2231-5381Volume3, Issue5-2012

Title - Finite Element Analysis of Pressure Vessel and Piping Design

Objective - Parameters of solid pressure vessel, of multilayer pressure vessels over mono block vessels are designed to the respective principles specified in American Society of Mechanical Engineers (A.S.M.E) Sec VIII Division 1. And checked by ANSYS

Methodology - Analytical Model

Finding – Multi layered pressure vessels are superior for high pressures and high temperature operating conditions. And the multi layered pressure vessels have a lot more advantages over the conventional mono block pressure vessels.

Limitation – Check Multi layered pressure vessels for high pressures and high temperature operating conditions over mono block vessels

Gaps Identified – Single parameter consideration always holds lack of conclusions. [20]

20. Author Name/ year - L. Xue et al. (2010)

Journal Name - JPVT ASME JUNE 2010, Vol. 132 / 031203-1

Title - Parametric FEA Study of Burst Pressure of Cylindrical Shell Intersections

Objective - Using nonlinear finite element analysis the fracture location and burst pressure can be determined by the use involving an elastic-plastic large deflection analysis method.

Methodology - Analytical Model

Finding – A nonlinear finite element simulation along with the arc length method can be employed to predict the burst pressure of cylinder-cylinder intersections. The geometric parameters d/D, D/T, and t /T affect the burst pressure of cylindrical shell intersections. The burst pressure increases with t /T and decreases with D/T. The effects of d/D and t /T are less striking when compared with D/T.

Limitation –Parametric study is carried for relationship between various geometric parameters and the burst pressure by correlation equation

Identified – Parametric study done under constraints parameter. [21]

III. CONCLUSION

The review of literatures incorporates investigation of stresses, analysis of thermal and fatigue load conditions, examination of linear and non linear pressure forces. Researchers Significant focus area is on pressure investigation, material investigation and synthesis investigation because all of the reason responsible for failure of vessel. Thus it is discovered that none of the researcher concentrated on the advancement and optimization of vessel for deep sea experimental conditions. It is basic need to investigate the impact of analysis and synthesis area because of which stresses produced in the shell. The location always influences the pressure fixation at the support ends and bore ends side. Location of Support ends and fixation bores help to lesser the stress concentration at specific area. Consequently this loop holes causes to concentrate on the region enhancement or area optimization of synthesis and analysis of vessel structure for under sea water experiments by ends location, desired material and bearable or durable design.

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