Review Paper on Design and Analysis of Pressure Vessel with Expansion Joint

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Abstract- *An expansion joint and movement joint is an assembly designed to safely absorb the heat induced during expansion and contraction of construction materials to be absorb vibration, to hold parts together and allow movement due to ground settlement. Thus its main function is to reduce deformation stresses which produce by pressure vessel. Expansion joints are create the important component for distribution of thermal stresses in a pressure vessel. In addition to being flexible because of the joint has to be also structurally safe. Expansion joints must accommodate cyclic and long-term structure movements in such a way as to be minimize the imposition of secondary stresses in the structure. This can be achieved through material changes and design changes .Use of Finite Element Analysis (FEA) and conduct a series of trial runs and try to identify the design for the expansion joint also determining the critical area where maximum stress is developed and perform fatigue analysis on the final design. Finally the validation is done by Displacement sensor and ultra-sonic testing machine.*

Keywords- expansion joint, vibration, pressure vessel, Finite Element Analysis, Mechanical properties thermal stresses.

I. INTRODUCTION

Bellows have a function to be absorb regular and irregular expansion and con-traction in piping system. Most of the industrial piping system often the suffer of maximum deformation, displacement, heat expansion, vibration, and other causes are responsible for the failure ..A expansion joint is a flexible connector fabricated of natural or synthetic Elastoplasts fabrics . where necessary the metallic reinforcements. They provide stress relief in piping systems caused by thermal and mechanical stress In different piping system it is used as elements that is aerospace, micro microelectronic and different industrial system following special structures are require for high strength as well as good flexibility. It can be used for overcome problems of noise. Rubber as a material of construction in the expansion joint has superior noise and vibration removing qualities over all other types of material. The standard expansion joint is of the spool-type with a single arch and flagged ends. The movement capability of the expansion joint is dependent upon the arch. .If maximum expansion or contraction are required than can be absorbed by a multi pal arch, then a multiple arch joint can be used with up to four arches. Elastoplasts expansion joints are suitable for both pressure and vacuum systems. a multiple arched constructions are not suitable for vacuum applications systems unless specifically designed are required for vacuum application.

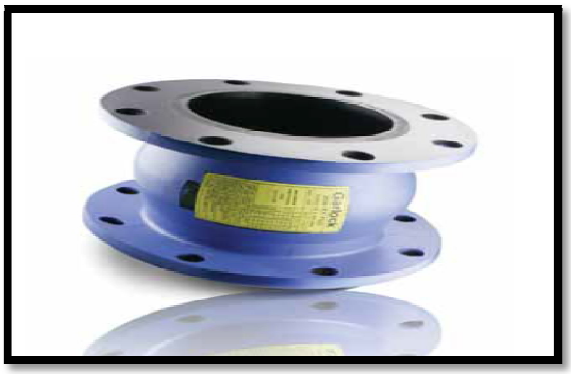

Fig: 1 Expansion Joint

1.1) Types of pipe movement:-

a. Axial compression:-

Longitudinal movement shorten face to face dimension along axis of expansion joint or flexible coupling. Pipe flanges remain perpendicular to axis.

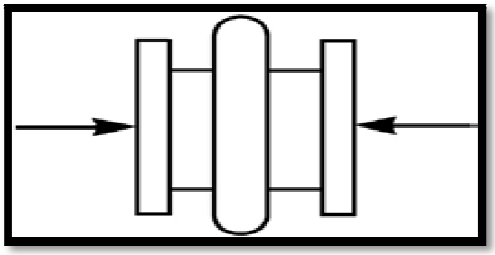

Fig. 1.2 Compression

b. Axial elongation:-

Longitudinal movement lengthen face to face dimension along axis of expansion joint or flexible coupling. Pipe flanges remain perpendicular to axis.

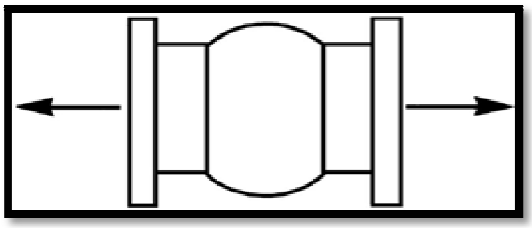

Fig. 1.3 Elongation

c. Torsional movement:-

Rotation of one flange with stationary counter part. Simultaneous rotation of both flanges in opposing motion.

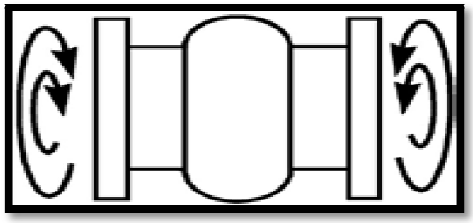

Fig. 1.4 Torsional

d. Angular movement:-

Deflection or rotation of one or both flanges and forms angle with axis of expansion joint or flexible coupling.

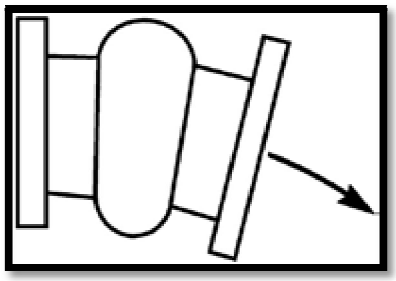

Fig. 1.5 Angular

e. Lateral movement:-

Offset movement of one or both pipe flanges and both flanges remain parallel to each other while forming angle to axis of joint.

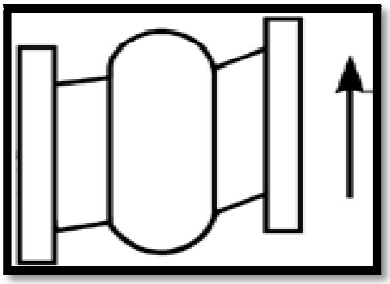

Fig. 1.6 Lateral

f. Vibration:-

Oscillating movement around the axis of expansion joint and flexible coupling, Pipe flanges remain parallel with each other, Mechanical vibration in steel piping system reduced with installation of expansion joints**.**

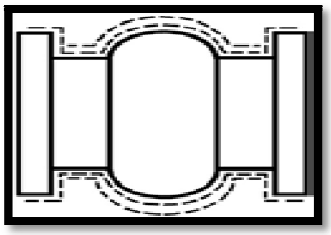

Fig.1.7 Vibration

II. LITERATURE REVIEW

2.1) SudeeZirmire et.al.[1]Presented in "Analysis and Weight Optimization of Butane Separator Using Finite Element Analysis", that the analysis of current separator design using FEA. Also understand the complex interaction of low temperature and pressure. Establish safety norms for the vessel, and determine critical areas for inspection. and the optimum design is found which means the value of stress is lower than permissible stress. Methyl ethyl ketene (MEK) is a solvent that used in paint coatings and used widely in the auto industry. Butane traditionally was a waste product used in crude oil supply.The butane vessel separated by expansion joint and supported with saddle support . All the cases exhibits stress generated is less than allowable or design stress. After carrying out structural analysis that is proved that the given model is safe from strength and rigidity point of view. MEK is obtained from Butane.

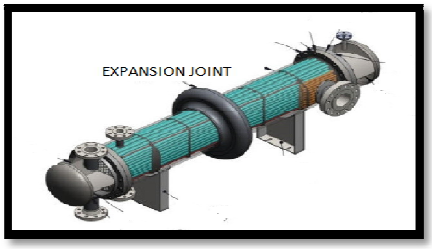

Fig. 1.1 Pressure vessel with expansion joint

2.2) G.Wang and K.F. Zhanget.al. Presented on Super plastic forming of bellows expansion joints made of titanium alloys . that is used to complex SPF method for applying gas pressure and comprehensive axial load are developed . It is used to manufacture "U" type bellows expansion joints which made by titanium alloys. and Welded pipes bent by hot bending with a set of specific dies . A multi-layer die structure is adopted to determine the final shape of convolutions. The

forming load route is divided into three steps to obtain optimum thickness distribution. This technology can also be used to fabricate stainless steel bellows expansion joints. because of their large deformation resistance, severe spring back, low plasticity and form-ability at room temperature. A bellows expansion joint of titanium alloys has excellent corrosion-resistant performance and can be used to match a press vessel of titanium alloys and replace that of stainless steel and anti corrosion alloy. A bellows expansion joint of titanium alloys has excellent corrosion-resistant performance and can be used to match a pressure vessel of titanium alloys and replace that of stainless steel and anti corrosion alloy. The SPF technology of fabricating bellows expansion joint was first develop by the author G. Wang.

2.3) Kaishu Guan et.al. Investigate that failure of a bellow expansion joint of 304 stainless steel has been analyzed. Stress corrosion cracking caused by wet hydrogen sulfide was responsible for the failure. Observation of metal lo graphic sections indicated that the crack is Trans granular with cracking in a direction perpendicular to axial stress. Bellow expansion joints serve as a conduct for chemical pipelines with liquid media containing wet H2S. Both inner and outer surfaces of the failed expansion joint are examined and the main crack is along the circumference on the crest of the expansion joint and several small cracks are observed on inner surface which do not penetrate to outer surface. Dimensional measurements of the cracks are shown. The main crack is longer at inner surface than that at outer surface. The material hardness is increased. Crack initiation and propagation results from SCC induced by wet H2S due to deformation. There is no indication of any localized damage in the form of pits and plastic deformation is observed near the cracks which observed that the failure is brittle fracture in nature. A large amount of marten site is observed in the bellow expansion joint material.

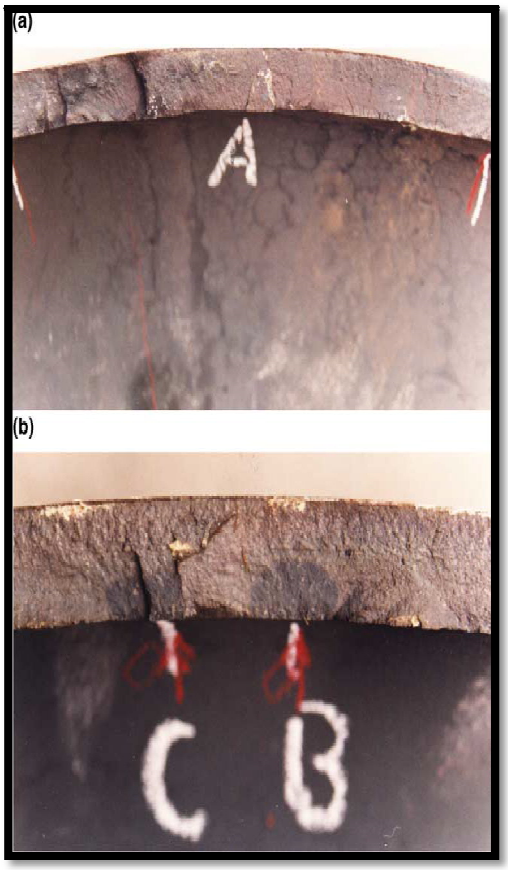

Fig 2.3 Photographic sample of crack in expansion joint

2.4) Hervandil Morosini et.al. presented in A practical procedure to assess critical defects in pressure vessels subjected to fatigue load .some pressure vessel are used in refractory industries for cleaning the hydrogen.to carry the inspection shows that some embedded cracks were found in the entrance nozzle-head weld. by using finite element method a structural stress carried out for finding the stress in crack metals. Even considering the difficulties of dealing with complex variables that arose from fracture mechanics, to applied finite elements method or fatigue method for obtaining stress in crack metals. this study showed that the fitness for service technique can be safely employed in industrial problems. such result shows that if crack obtained in metals than fatigue life reduced two years. By the other hand, this study does not avoid the need for a periodic monitoring, because of actual size of crack found by ultrasonic or magnetic technique.

2.5) Jerzy Okrajni et.al. Presented in Description of the thermo-mechanical fatigue of thick-walled pressure vessels. this paper discus the modeling of stress strain developed in heating or cooling process of power plant. the main purpage of this paper to capacity of power plant equipment carrying the mechanical or thermal load. The heat-transfer coefficients as

time-dependent variables have been introduced. the graph of the stress versus time shows that unsteady operating conditions, components analyzed in the paper, especially in the case of boiler restarts, may operate with transient thermal stresses values higher than a yield point. Frequentaly thermo-mechanical fatigue process takes place in the materials of the components. The results presented in this paper were obtained in research work co-financed by the National Centre of Research and Development .

2.6) Prabir K. Sen et.al. A new steel expansion joint for industrial plants as Bubble joint. which present that in power, steel, chemical and other industrial plants, ducts are required for carry air and effluent gases. duct are design such way that any temperature it should be expand or contract given tharmal stress . To allow for free movements of expansion joints are introduced at that points of dust should be long run and change in direction .

2.7) YasharJavadi et.al. Ultrasonic stress evaluation through thickness of a stainless steel pressure vessel. present the this paper for finding the stress of presure vessel by using ultrasonic machin. Longitudinal critically refracted (LCR) waves are introduced in to measure the welding residual stresses in a pressure vessel which are constructed from austenitic stainless steel 304L. Hoop and axial residual stresses are finding by using different frequency range of ultrasonic transducers. by using 3-D finite element model we are simulated the shall or cap of pressure vessel. which is validated by hole-drilling method. this residual strss calculated from FE simulation are compaired with result obtained from ultrasonic mesurment.

III. DISCUSION

3.1 Finite element analysis:-

3.1.1 Preprocessing:

The preprocessing step is generally described below:

- Define the physical constraints i.e boundary conditions
- Define the element type(s) to be used.
- Define the material properties of the elements
- Define the geometric domain of the problem..
- Define the geometric properties of the elements (length, area, and the like).
- Define the element connectivity
- Define the loadings.

3.1.2 Solution:

A computed values are used by substitution to compute additional, derived variables, such as reaction forces, element stresses, and heat flow. During the solution phase, finite element software used the governing algebraic equations in matrix form and computes the unknown values of the primary field variable.

3.1.3 Post processing:

Examples of operations are Plot deformed structural shape, Animate dynamic model behavior, Produce color-coded temperature plots.

- Check equilibrium by SFD, BMD, AFD.

Analysis and evaluation of the solution results is referred to as post processing. Post processor software contains special routines used for sorting, printing, and plotting selected results from a finite element solution**.**

3.2 Displacement sensor:- An oscillator electronics excites the primary coil with an alternating current of constant frequency. as compare to the core position alternating currents are induced in both secondary coils and A displacement of the core yields and a lower voltage in the one coil and higher voltage in other secondary coil .The difference between both secondary voltages is proportional to the displacement. At the mechanical zero point the signal in the two secondary coils is cancelled out due to the position of the plunger. The sensor provides the signal 0 volt. The mechanical zero point is the center point of the linear measuring range (± measuring range). The range of the plunger movement is considerably larger than the linear measuring range, and it depends on the sensor. Strain gauges are intended for measure of strain. The results of such measurements may be used for statements for concerning the material stresses in the specimen, the nature and amount of forces acting on the specimen etc. However a strain gauge can only perform its task properly if the strain to be measure is transferred faultlessly and free of loss. For that purpose, an intimate connection required between strain gauge and object to be measured. The required intimate, plane connection between specimen and the strain gauge is performed by special adhesive. Other bonding agents and methods are limited to special application area, e.g. ceramic bonding agent for high temperature installation and spot welding for applications on steel construction.

The mechanical zero point is different in every sensor, one time measurement with a caliper square is not sufficient so that even with several sensors of the same type .and transforms the differential signal of the two secondary

coils into a stable direct voltage output signal by an electronic signal conditioning unit .

3.2.1 Inductive sensors, LVDT series, are available in two versions:

1) Displacement sensors with freely movable plungers. The plunger is not joined to the sensor. It is mounted directly on the measurement object.
2) Gauging sensors --The plunger is implemented as a probe tip. The built-in spring presses the probe tip onto the measurement object. The plain bearing provides guidance for the probe tip.

3.3 Ultra sonic Test:-

In To detect internal flaws or to characterize materials by using a ultrasonic testing m/c (UT) in which very short ultrasonic pulse-waves with occasionally up to 50 MHz and center frequencies ranging from 0.1-15 MHz are transmitted into materials

In ultrasonic testing, an ultrasound transducer connected to a diagnostic machine is passed over the object being inspected and the transducer is typically separated from the test object by a couplant such as oil or by water, as in immersion testing. However, the use of couplant is not required when ultrasonic testing is conducted with an Electromagnetic Acoustic Transducer (EMAT). reflection and attenuation are two methods of receiving the ultrasound waveform In reflection (or pulse-echo) mode and the transducer working as both the sending and the receiving of the pulsed waves as the "sound" is reflected back to the device. Reflected ultrasound wave are comes from an interface such as the back wall of the object .The diagnostic machine displays these results in the form of a signal .and signal amplitude representing the intensity of the reflection and the arrival time of the reflection representing the distance.and reduce the amount of sound transmitted by Imperfections and other conditions in the space between the transmitter and receiver

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