Review Paper on Optimization of Meter Body with Flanges

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Abstract- *Daniel flow meters are optimized for the thickness in the meter body. The meters are of different types starting from the 2" size to 36" size. Mainly used for liquid and Gas flow in the industrial application. The meter body is evaluated for the thickness measurement for the assigned pressure.*

The meters are designed as per ASME standards. The newly Designed eight path (4+4) and six path (4+2) Gas and liquid ultrasonic flow meters are having reduced weight and thickness at the center section of the meter body. Due to its reduced weight the need of Analyzing the center section is raised.

In the current project the meter body with the flanges is tested for the assigned pressure of 1800 psi and checked at three different sections along with the welded flanges and the bolts. The Bolts are having the pretension and selected as per ASME. Methodology adopted to achieve objectives

The meter Body is analyzed as per ASME Section VIII - Elastic plastic method and the linear solution is obtained and the stress developed at three pleases

1) Transducer mounts area
2) Bolt which is having pretension
3) Welding joint at flange and meter body joining section is evaluated

***Key Words*:** Optimization. Flanges and bolts, ultrasonic Flow meter. ANSYS, UG-NX,

I. INTRODUCTION

Ultrasonic flow meter used for determining fluid flow velocity within a conduit by determining the difference in transit time between interrogating ultrasonic pulses transmitted upstream between a pair of transducers and transmitted downstream between them. A high frequency clock pulse operating for one or more cycles of interrogation allows for accurate digital computation

A flow meter includes a meter body through which the fluid is passing. Bracket is used to mount the electronic enclosure assembly .The bracket is mounted on the top of the meter body through which the cables are routed till the electronic enclosure assembly. The meter body is welded by two flanges on the side. These flanges are then connected to the lined pipe flanges.

Fig. 1- Daniel Liquid and Gas Ultrasonic flow meters
Source: Emerson product catalogue

Daniel Model 3415 (4+1) and 3416 (4+2) Gas Ultrasonic Meters combine a four-path fiscal meter with an added check meter, while the 3417 (four-path plus four-path) meter provides two fiscal meters for full redundancy and equal accuracy in one meter body.

Trending data from two independent transmitters help extend calibration cycles, enabling maintenance to be condition-based instead of calendar-based. With built-in diagnostics, operators can easily track meter performance to baseline to help streamline maintenance and reduce inspection in the field for significant cost savings.

In the construction of the meter it consist of meter body to which flanges are welded and the flanges are subsequently attached to the pipeline.

II. FLOW MEASUREMENT PRINCIPLE

Fig. 1 shows the general representation of ECAP process. As we can see there are very less components required for this process like die and plunger with press.

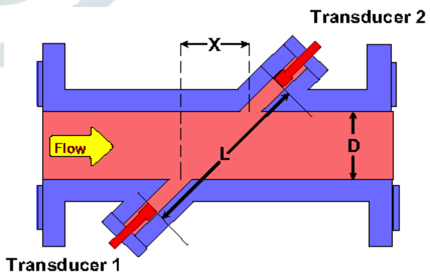

Fig 2 - Showing the mathematical form of fluid calculation in ultrasonic flow meter
Source : Emerson online catalogue

Ultrasonic flow meters measure the difference of the transit time of ultrasonic pulses propagating with and against flow direction. This time difference is a measure for the average velocity of the fluid along the path of the ultrasonic beam.

By using the absolute transit times both the averaged fluid velocity and the speed of sound can be calculated. Using the two transit times tup and tdown and the distance between receiving and transmitting transducers and the inclination angle L one can write the equations:

$$v = (L / \cos(\alpha)) \times (tup - tdown / tup \times tdown)$$
$$C = (L / 2) \times (tup + tdown / tup \times tdown)$$

Problem statement

Meter body is designed and evaluated for the applied pressure of 1800 psi. Its evaluation is done to satisfy the meter strength and to study the effect of pressure on the different cross sections. The meter body thickness is reduced, due to reduction in thickness extra amount of stress may be applied to the bolts so to understand the bolt behavior under pretension Fluid with certain pressure is flowing through the meter body and flanges are welded to the meter body. Pair of transducer is also attached to the meter body. To evaluate & study the effect of fluid pressure on the weld, transducer mount area and flanges attached to it at temperature of -425 to 100°F. How the weld joint behaves under the action of applied pressure this study is done The flanges are joined to the pipe with pipe flange So to Check the weld joint between flange to body center section at 1800 PSI applied working pressure and bolt pretension of 79406 lbf Understand the stresses developed at transducer mount area this study is done

Scope and Methodology

Liquid Ultrasonic Meter is a device which is used to measure the liquid flow rate through pipes. Meter needs to evaluate for its strength. This product should be in compliance with ASME BPVC, Section VIII, Division 2, and Part 5. As per the ASME requirement, thick vessels should be evaluated for strength as per following clauses:

This problem is solved by two types Type-1: Linear Analysis of Flange and meter bodies against the applied pressure validated by analytical method, & supported by experimental methods
Type-2: 5.2.4: Elastic-Plastic Analysis Method for protection against plastic collapse 5.3.3: With acceptance criteria for protection against local failure

III. LITERATURE REVIEW

[1 Stress analysis by elastic plastic method had described many researches in past many years, these methods help the engineers to identify the area of coarsen. [1] Discussed an overview of working principal and over all view of the meter from the catalogues of Daniel Measurement control to understand the product categories and the working methodology as well as the construction of the product

[2] Patent of Daniel measurement control by Padmanabh Joshi on the meter Flow Meter having electronic enclosure assembly to understand the changes in the existing meter, An ultrasonic flow meter includes a meter body having a central conduit that serves as a fluid passageway for conducting the fluid (liquid or gas) that is being transported in the pipeline, and a pair of flanges for connecting the meter between aligned sections of the pipeline. The body of the flow meter may also be referred to as a spool piece. The ultrasonic flow meter further includes two or more transducer assemblies, each secured in a dedicated port that is formed in the meter body. To measure fluid flow through the meter, the transducer assemblies of the pair are positioned such that the piezoelectric elements of the transducers are adjacent to the inner surface of the spool piece, and such that each transducer faces the other of the pair, which is positioned on the opposite side of the fluid passageway. The transducer assemblies transmit and receive electric signals back-and-forth across the fluid stream. Understanding of construction of meter is done through this paper.

[3] Wiley-ASME Press Series List from Maan H. Jawad regarding the ASME codes studied the chapter 3 and chapter1 regarding the stress distribution and the membrane stress developed in the cylindrical shell.

[4] ASME section 5.3.3 and 5.3.2 is studied for the Elastic analysis and elastic plastic analysis it states that use of elastic stress analysis combined with stress classification procedures to demonstrate structural integrity for heavy-wall pressure containing components may produce non conservative results and is not recommended".

[5] Thesis of Frode Tjelta on "comparison study of pressure vessel design" using different standards due to a recent pressure vessel design error the design methods used for pressure vessel design is investigated. Several codes are currently available for design and analysis of pressure vessels. Two of the main contributors are the American Society of Mechanical Engineers providing the ASME VIII code, and the Technical Committee in Brussels providing the European Standard.
Methods written in bold letters will be considered in this thesis .The ASME VIII code contains three divisions covering different pressure ranges:
Division 1: up to 200 bar (3000 psi)
Division 2: In general
Division 3: for pressure above 690 bar (10000 psi)
In this thesis the ASME division 2 Part 5 will be considered. This part is also referred to in the. Here different analysis methods are described, such as:
Elastic Stress Analysis Limit Load Analysis
Elastic Plastic Analysis. The Elastic Stress Analysis method with stress categorization has been introduced to the industry for many years and has been widely used in design of pressure vessels. However, in the latest issue (2007/2010) of ASME VIII div. 2, this method is not recommended for heavy wall constructions as it might generate non-conservative analysis results. Heavy wall constructions are defined by ($R/t \leq 4$)

[6] Paper on The e valuation of nuclear components using finite element analysis (FEA) does not generally fall into the shell type verification adopted by the ASME Code. Consequently, the demonstration that the modes of failure are avoided sometimes is not straightforward. Allowable limits, developed by limit load theory, require the Computation of shell membrane and bending stresses. How to calculate these Stresses from FEA are not necessarily self-evident. One approach to be considered is to develop recommendations in a case-by-case basis for the most common pressure vessel geometries and loads based on comparisons between the results of elastic and plastic FEA.

IV. CONCLUSION

Meter Body with pair of flanges is safe under the application of 1800 PSI internal pressure and bolt pretension of 79406 lbf

The Flange joint area under the bolt pretension and the transducer mount area are safe and justified by ASME

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[4] ASME section 5.3.3 and 5.3.2 is studied for the Elastic analysis and elastic plastic analysis it states that use of elastic stress analysis combined

[5] A Comparison Study of Pressure Vessel Design Using Different Standards

[6] Investigating ASME allowable loads with Finite element Analyses