Thermal & Structural Analysis in Welded Pipe Flange Joints with Help of FEA

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Abstract— for large components it is very difficult to produce castings. Fabrication process is referred over casting because of its ease and simplicity in producing welded joints for large vertical turbine pumps. Fabrication involves welding of components like pipe to flange, motor stool, discharge head, connection of piping with different welded joints. During welding process stresses are developed in weld elements. The stresses can have important consequence on performance of engineering components. Weld stresses have a significant effect on corrosion fracture, corrosion resistance and fatigue performance. The reduction of these stresses is desirable. The nature of stresses in weld structures is considered in terms of their magnitude, direction, spatial distribution, range and variability. Welding of pipe to flange results in stresses built up and distortions which provide negative efforts on structural integrity and sealing capability of pipe flange joints. The effect that occurs are stress corrosion cracking, brittle fracture, reduced fatigue and creep strength, poor sealing performance and reduced buckling strength etc. Therefore it becomes very essential to determine stresses induced in elements. The Paper gives the brief look on the investigation the extent and distribution of stresses & flux built up and distortions in welded pipe flange joints.

Key words: Thermal & Structural Analysis, Welded Pipe Flange

I. INTRODUCTION

For any engineering industry, it is very essential to assess the performance suitability of goods produced by them for required application. For large components it is very difficult to produce castings. Fabrication process is referred over casting because of its ease and simplicity in producing welded joints for large vertical turbine pumps. Fabrication involves welding of components like pipe to flange, motor stool, discharge head, connection of piping with different welded joints. During welding process stresses are developed in weldments.

Stresses are supposed to be act balancing within bulk. All manufacturing processes such as casting, forging, rolling, punching, cutting, bending, heat treatment, surface treatments, welding, machining and grinding, etc are sources of stresses. A stress that arises in welded joints by rapid heating and cooling is considerable factor in fatigue assessments of welded structures. Stresses are formed in weld structures primarily as a result of differential contractions which occur as a weld metal solidifies and cools to ambient temperature. It is observed that tensile stresses in weld structures can be as high as yield strength of material. This tensile stresses have detrimental effect on fatigue life of component. Conversely, compressive stresses can have a favorable effect on fatigue life.

II. LITERATURE REVIEW

At present need is arises for determination of stresses because to avoid harmful effects of fatigue failure and distortion of welded components. Generally distortion is measured in terms of dimensions. This conventional method and it is not a reliable. Because more accurate values of stresses and distortion are to be expected in welding process. Following is a brief review of the available literature for the accomplishment of measurement of residual stresses in welded pipe flange joints.

J.R. Cho, et al. [1] had focused on investigation of stress. The stress distribution after welding and after post heat treatment has been determined by a finite element transient heat flow analysis in conjunction with coupled thermal mechanical analysis. To verify the numerical results, the surface stresses of a multi-pass butt weld were measured by hole-drilling technique and compared with a Finite Element Method analysis.

Z. Barsoum [2] discussed on stress analysis and fatigue assessment of welded Steel structures. Many techniques have been used for measuring stresses in metal. These are categorized as destructive and semi destructive or non destructive methods. In a destructive or semi destructive stresses are measured by means of stress relaxation, by measuring the elastic strain release that takes place at when a sample is sectioned, drilled or milled using electrical or mechanical strain gauges, detachable Extensometer and photoelectric surface layers are mainly used for measurement in practice.

III. DEVELOPMENT OF EXPERIMENTAL SYSTEM

For automatic circumferential welding of a pipe flange joint, a DC powered conventional lathe with open loop continuous speed controller is synchronized with a welding power source. Synchronization is achieved through an Figure Pipe-flange joint configuration.

Finite Element Method can be defined as, a technique used to stimulate loading conditions on a design & to study the responses of the design to those loading conditions. Every product is discretized into small units of buildings blocks called nodes. Every node has a certain equation that describes how it responds to certain node. Summation of or integration of response of all the loads gives total result. Finite Element Analysis is a technique whereas Finite Element Method is the method which is used for Finite Element Analysis. ANSYS is the Finite Element Method we are used for analysis.

Pre-processor = Pre-processor is the primarily step in FEM. Pre-processor includes Geometry creation or 2D geometry import from the CAD software. Though in ANSYS we can create the 2D model of the component but as it is basically an analysis software it becomes very difficult to create 2D model so it is better to use any CAD software to create 2D model. Second step in the Pre-processor is the Mesh generation. In this step the geometry is divided into small elements. Then Governing equations for each element are calculated & then assembled to give the system equation. Third step is applying boundary conditions. In this step Boundary conditions are applied to the problem. Solution Phase = In the Solution phase the software solves the Linear & Non linear algebraic equations simultaneously to obtain nodal results such as displacement at different nodes, Temp at different nodes etc. in each transfer problem.

Post-processor = In the Post-processor we Can obtain other important information’s at this point you will be interested in the values of principal stresses, heat fluxes, strains, etc. So in this step various secondary quantities are computed from the obtained solution. This is the last step in the Finite Element Analysis.
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V. RESULTS AND DISCUSSIONS

<table>
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<tr>
<th>TEMPERATURE</th>
<th>ANALYTICAL</th>
<th>THEORATICA</th>
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<tr>
<td>E</td>
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<td>-q₀</td>
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<tr>
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<td>1.91</td>
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</tbody>
</table>

Table 1.

From the result table it is seen that the analytical and theoretical results are nearly equal but the FEM analysis gives the more accurate results.

VI. CONCLUSION
- For different temperatures there are changes in thermal stress and flux of welded pipe flange joint
- FEM analysis is best way to calculate stress generated, deformation in welds and flux induced in the weld
- There is good agreement between calculated and FEM analytical thermal flux generated in welded pipe flange joint.

VII. FUTURE WORK
There can be many promising techniques and research areas. For welding simulation it is assumed that surrounding temperature is a constant but in actual practice it is variable. Requirement is simulation at variable surrounding temperature. Here analysis is done for only one root gap position, but requirement is simulation at different root gap positions.

Here welding parameters (speed, feed, tag orientation, etc.) are not taking in consideration, but requirement is simulation by considering all welding parameters.

REFERENCES