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Identification of Distortion in U-Bends of Tubes by Using T-Block Gauges

KEYWORDS: U-Tubes, Moderator Heat Exchanger, T-Block Gauge, Web, Flange.

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ABSTRACT *This paper provides a brief description on the T block gauge which can be used in tube insertion problem faced during the tube bundle assembly of a Moderator Heat Exchanger. In spite of technical advances in the assembly of moderator heat exchangers which remains a very specialized job involving highly skilled and qualified manpower, special machines, tools, jigs & fixtures etc to meet the technical requirements, there still exists a problem during the insertion of U-tubes. The gap between two consecutive U tube bends of the same row is not uniform because of the distortion which leads to touching of tubes to each other and also vibration in the working condition.*

INTRODUCTION

The stainless steel U tubes used in the Moderator Heat exchanger have diameter 12.6mm, thickness 1mm and length varying between 11 to 12 meters depending upon its location. Hence, these tubes have very less rigidity and therefore uneven bending of tubes become a common problem. Sometimes flexibility of pipe causes distortion or at times, it is a manufacturing defect, which causes non uniform gap in between the two consecutive tubes especially at U-bends. Many a times the distortion of a certain tube is identified after insertion of a number of consecutive tubes. [1] So it becomes highly difficult to correct distortion at that bend. The non-distorted consecutive tubes which are inserted needs to be removed for re-bending the distorted tube. Hence by using the T block gauge, the distortion can be identified at the time of insertion itself. This T-Block gauge is totally a new concept for problem discussed above.

PROBLEM STATEMENT

As shown in figure 1 all bends are correct except tube no.4. At times it is not possible to correct the distortion manually due to tube no. 5. Also if tube no. 4 requires re-bending then the tubes 5 and 6 need to be removed even if they are not distorted. So it is necessary to identify the problem at the time of insertion of tube 4 only. To identify the distortion either requires skills and experience or a system to set uniform gap between every tube bend. (On shop floor it was found that some tubes were having distortion like tube no 4 as shown in figure below and only slight manual adjustment was done.)

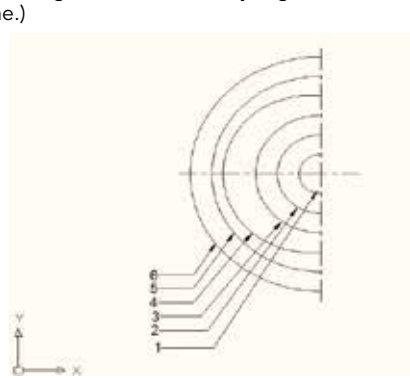

Figure 1: Distortion in U- bend.

CONSTRUCTION OF T-BLOCK GAUGE

Figure 2 shows construction of T-block gauge. It has T shape of extruded length. It will have rectangular slot at one side of its flange which mates with extruded portion of almost same size as that of slot on opposite side of head.

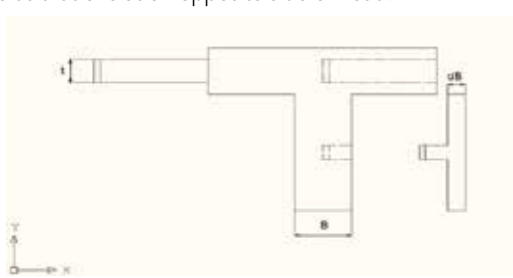

Figure 2: T-Block gauge.

Magnets are attached to two successive blocks. Web width B is increased using an attachment of width dB by magnets as shown in figure 2.

CONCEPT OF dB

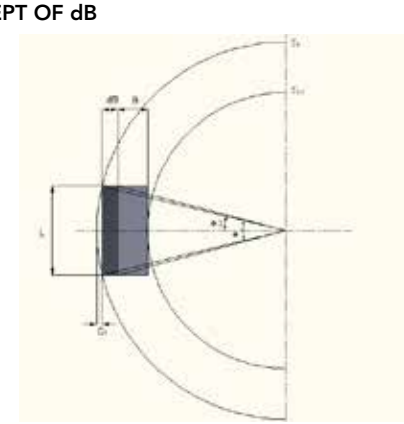

Figure 3: Gap between T web and U bend.

When bottom edge of T-block touches the U tube, gap C_1 exists between the web and U bend due to U-bend curvature. As shown in figure 3, this gap goes on decreasing as

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the radius of curvature goes on increasing. So the web width B has to be increased as radius of bend goes on increasing. For this purpose, an attachment is provided to increase the web width from B to B+dB.

A plate of rectangular area similar to that of the web of T-block of width dB is attached to the web with width B as shown in figure 2. A set of gauges of different widths of required range can be made available. [5]

SOFTWARE TO FIND dB

Figure 4: Software to find dB.

The authors have developed user friendly software to find the dimensions of dB for various radii of U-tubes as shown in figure 4 below. The software has been developed by using the Visual Basics 10.0 The dimension to find the dB attachment can be calculated with the help of software. [2], [3], [4]

T BLOCK GAUGES CALCULATION

For 1st tube

l=21.41mm
B=2mm
C=1mm
Gap=4mm
dB=0

For 2nd tube to t_n

R1=Rc-tn×0.5×D
R2=Rc+ (tn+1)0.5D
Where RC=Radius of innermost bend.
= (l/2R2)
Sin-1 (l/2R2)
tan ()={l/2(+B+R1)}
2+2θB+2R1=1/tan ()
2= {l /tan }-2B-2R1
∴= {l/2tan}-B-R1
ΔB=A-B-R1
Where A= {l/2tan (θ/2)}
C=R2-E
E=ΔB+B+R1

PROCEDURE TO USE T-BLOCK GAUGES

1. Insert the innermost radii tube T1, and then insert next tube T2 by keeping proper gap of distance B by inserting T-block (S1) between T1 & T2.
2. Assemble the T-blocks as shown in the figure i.e. mesh the two T-blocks using the slots and magnets provided.
3. Continue the same procedure for three axis spaced 450 on both sides of centre axis as shown in figure 4. When requirement of gauge width increases, dB attachment should be attached to the web of T-block. General symbolic sequence of this procedure can be represented as follows:

$T_1 \rightarrow S_1$ (B) $\rightarrow T_2 \rightarrow S_2$ (B+dB_1) $\rightarrow T_3 \rightarrow S_3$ (B+dB_2) $\rightarrow$....

4. After completion of tube insertion, all engaged set of gauge can be used in upper row and tube bends of appropriate gap will remain the same. The only precaution that needs to be taken during tube insertion is that the tube should touch only the gauge & should not press it; else it would create problem during removing gauges.

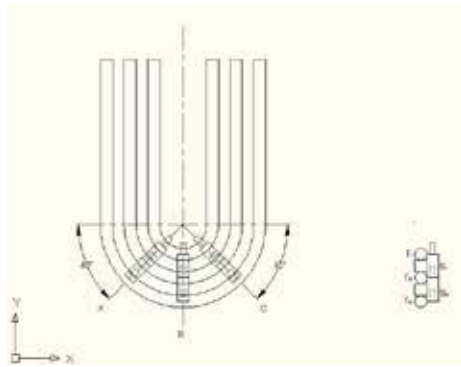

Figure 5: Procedure to use T-Block Gauges.

HOW THE PROBLEM WILL BE SOLVED?

Using these gauges, the portion of U bend where the profile is distorted can be identified as shown in figure 6. In this case T_1 is not distorted whereas T_2 is distorted. By observing whether the U tube is in contact with the gauge or not, distortion can be identified.

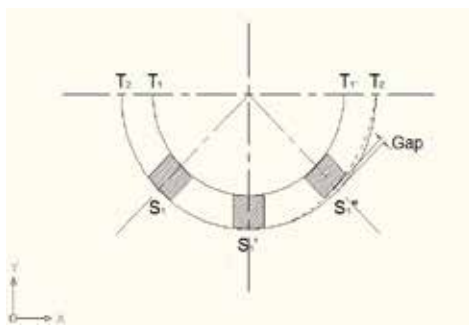

Figure 6: Identification of distorted profile.

As shown in figure 5 there is gap between gauge S_1'' & tube T_2 but there is no gap at gaugesS_1, S_1' and tube T_2. This shows that profile is wrong only at S_1''.This is an example wherein the bend is incorrect only at one location as shown in figure 5. The same methodology can be used to identify and rectify the multiple distortions on a single profile of U-bend

CONCLUSION

Many a times, the bend can have a distorted profile at various locations and without any gauges it becomes difficult to know the location of distortion and where adjustment is required. The profile where manual adjustment is not sufficient, re-bending becomes necessary. Use of gauges makes it easier to identify whether re-bending is required or not. If re-bending is needed, then such decisions can be taken before inserting the consecutive tubes (i.e.T_3, T_4 etc as shown in figure 5) which saves time & efforts of removal and re- insertion of these consecutive tubes. The cost of T-blocks will be a complete new investment which will reduce the time required for tube insertion. It will also reduce the problem faced because of distorted bends.

REFERENCE [1] Training manual on heavy water heat exchangers by Maneesh. R. S. Saxena and A.K. Rastogi, Nuclear Power Corporation of India (NPCIL). | [2] Visual Basic 6 by Steven Holzmer, Fourth Edition July 2006. | [3] Muarch's Visual Basic 2005 by Anne Boehm, Fourth Edition December 2006.