REPORT

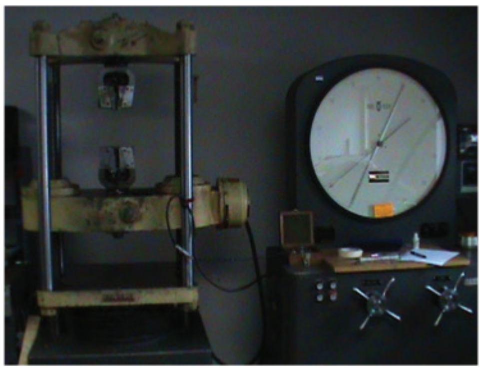
Tensile Strength Testing of Weld Joints on Stainless Tubing

www.axenics.com

AXENICS

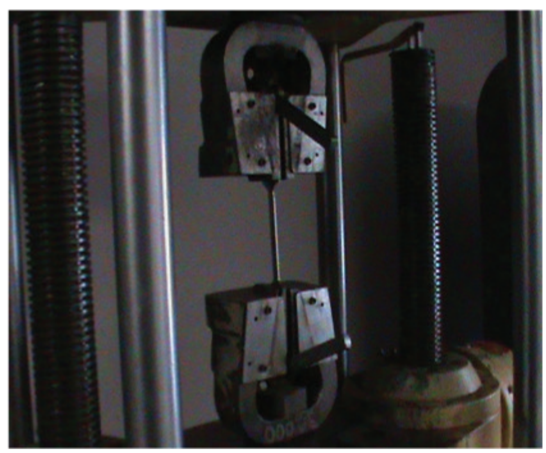
Subassemblies to Complete Systems

Axenics performs TIG and orbital welding services for the Semi-conductor, Medical, Life Sciences and Aerospace industries. Most of these sectors do not require any type of weld joint testing on a regular basis. Even though these welded assemblies have passed a standard helium leak test, a weld joint with lack of full penetration will not be detected. Inferior weld joints on tubing assemblies that might become installed into gas carrying systems have greater potential for failure over time. The welding technicians at Axenics take the extra step to fully penetrate all of the welds they do. We recently conducted a test to prove to ourselves, and our customers, the value of a fully penetrated weld versus a non-penetrated weld.



Tensile strength testing is an excellent way to show the importance of good welding practices. We took a trip to an independent testing lab where the equipment to perform this type of testing was available.

Ultimate Tensile Strength (often referred to as "Tensile Strength") is the maximum stress that a material is able to withstand before failing or breaking. This is accomplished by pulling or stretching the material to its breaking point.



We performed a Tensile Strength test on stainless steel tubing and recorded the results for this white paper. The material we tested was 316L Stainless Steel, 1.00" dia. x .065" wall tubing. The test was conducted on an equal sampling of both fully penetrated and non-penetrated weld joints. To prepare the sample, you must cut the tubing in half then flatten it. To measure the strength of the weld there is a calculation using the total area of the weld by the strength it took to break that weld. Consistency in the size of the weld or the tube does not matter. The formula is taking the width of your weld sample and measuring by the height of the weld. This gives you "area." Once the machine stretches the sample, the amount of force that is being applied is measured in pounds. When your sample ultimately snaps, and it will at some point, the machine will give you that measurement in pounds. At that point you take the "area" and divide by the pounds of force. This will calculate the number of PSI it took to break the weld.

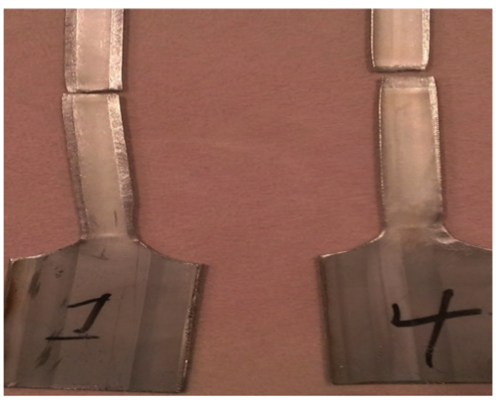
Picture 1

Picture 1 clearly shows the difference between a fully penetrated weld, and a non-penetrated weld.

Sample #4 is fully penetrated, as indicated by the thick weld joint. Sample #18 is non-penetrated. You can see the thin line that represents the weld.

The purpose of this test was to discover how a lack of weld penetration can ultimately affect tensile strength. Another result we proved was that in some cases the welded area could be stronger than the material itself.

The test results show that the fully penetrated samples broke at a much higher Ultimate Strength (PSI) than the partially penetrated samples. On all of the samples we tested, the breaking point on the non-penetrated welds was at the weld joint. On the full penetrated samples, the point of the break was generally located outside of the weld joint itself; on the heat affected area of the tubing. There were a few cases where the point of the break was not even close to the weld, which was surprising to us.



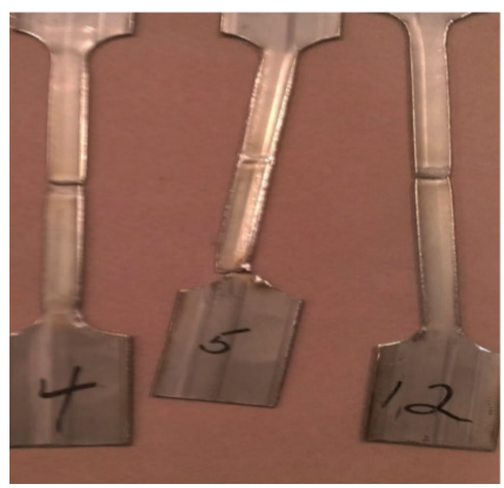
Picture 2

Sample #1 (Picture 2) is the non-penetrated weld. It broke right at the weld line. Sample #4 (Picture 2) is fully penetrated and you can see the sample has broken just above the weld line, in the heat affected area.

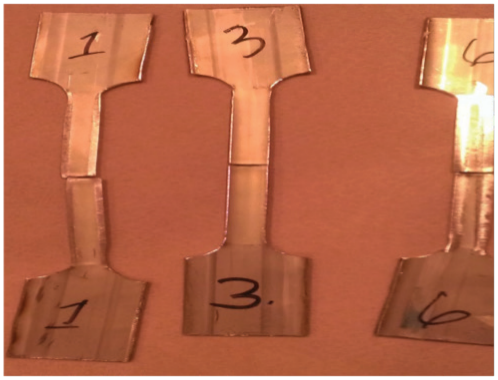
Ultimate Strength (PSI) Results

We tested a larger-size sampling and came up with the following breaking points measured in PSI:

The samples having fully penetrated weld joints separated at induced pressures ranging from 87,819psi---102,781psi. As you can see in the Picture 3 samples #4 and #12 broke in the heat affected area of the welds. Most of the fully penetrated samples broke in this general area. We had a few cases where the break was not located near the weld at all, as in Sample #5.



Picture 3



Picture 4

Picture 4 are examples of non-penetrated welds. These samples experienced separation at induced pressures ranging from 59,925psi---80,721 PSI. You can see that the separation in these samples happened right at the point of the weld. This was the case in all of our non-penetrated samples.

This exercise demonstrated that the welding process for the various sizes and types of tubing assemblies used in gas carrying systems, as well as all other applications, needs to be performed at the highest quality level. This will insure that none of the equipment is compromised by catastrophic tube failure.

In a future white paper we will discuss the importance of purge gasses. Here we explain various methods that will give you an understanding of how a weld joint can be affected by using improper purging procedures.

Here is some video footage of our testing, because everyone likes to see stuff break! The links are to Youtube.com and you can view other educational videos we have posted.

This video is the last 20 seconds of our pull test that lasted 12 minutes and 48 seconds. This was a non-penetrated weld, but you will not be able to tell in the video.
http://www.youtube.com/watch?v=_j-5GCE7Epc

In this clip we slowed down the breaking point of our sample. This is a fully penetrated weld joint and this sample took about 14 minutes to pull apart.
http://www.youtube.com/watch?v=BnRnD4RM8b8

This final video is a lengthy minute and half. It is about 13 minutes of the video sped up.
http://www.youtube.com/watch?v=I1UB14sCJpw&feature=youtu.be

To learn how Axenics can help you with your manufacturing or design needs, **Contact us** for a quote or to discuss a project in development.