Welding processes and its variations

Business, Work

Introduction

The purpose of this lab was to introduce students to several different types of welding processes that they will encounter in their future professional careers. This knowledge will help the student be able to understand not only how the processes work but also how long they may take, and also give the student some first-hand experience so they may be able to determine what is feasible in regards to welding going forward. (1)

Welding has been around for many centuries. It was originally done by means of a forge and was known as forge welding. This method dates back as early as the Bronze and Iron Ages, those civilizations who had a firm grasp of metal manipulation had a large advantage over those who did not. Not only could civilizations that mastered welding use this knowledge for city building, but also to create better and more lethal weapons. Forge welding would be the method in which these societies welded for many many years until the 1800s when the electric arc was discovered. The electric arc was discovered in 1803, but it wasn’t until 1881-82 when Russian inventors created the first electric arc welding method, which we now call carbon arc welding, which used carbon electrodes. This process was used for several years until 1890, when an American by the name of C. L. Coffin patented the metal rod/electrode arc welding process we still use to this very day. (2)

Gas welding would not become prominent for another decade or two. It was largely viewed to be volatile and dangerous compared to arc welding until the early 1900s when they decided to use oxyacetylene instead of hydrogen gas. Once again these processes were used for a wide range of purposes but were not really commercialized until the world wars. When WWI broke out, many countries needed large scale production of guns and vehicles. It was during this time that many companies and governments really harnessed welding effectively and (at that time) efficiently. These welding processes are still being employed today, and are the most common types of welding that one will encounter when they enter into the workforce. (2)

Discussion:

Arc Welding:

For our experiments we first started by measuring our materials. We measured each piece of metal to be welded as well as the electrodes used for our longitudinal welds. We first calculated weld time based on the parameters in our lab book, Table 1. Weld Parameters. The weight, length, and width was recorded for each piece of material that we were to manipulate in our experiments. This data was recorded in our lab manuals so that we could use it later for our necessary calculations. After all of our data was recorded we then had to prep our metals to be welded. We had to clean and rub the metals free of any oils that may have built up during handling. Once our data was recorded and our metals determined to be clean we then began the actual welding process. For each weld we would set the power source to the proper current for each experiment, perform the weld, and record the relevant data afterwards. The welded materials were once again cleaned and weighed, as well as the electrode. We recorded the time it took for each weld, as well as the length of the weld, and the longitudinal distortion. These figures were then used later on to make specific calculations in order to fill out the rest of our Table 2. Welding Data

The next part of our experiment dealt with transverse distortion. For this part of the lab we timed obtained 2 samples and positioned them for welding, we then tack welded the samples together and measured our weld's length, width, and root opening, and performed minimal calculations. We then measured our sample again after performing a full weld at 100A. We then denoted the difference in before and after the weld. This was done again using a current of 140A. We recorded the information in our Transverse Distortion table.

The third and final part of our experiment dealt with Angular Distortion. For this experiment we first set our machine to 140A. From there we clean and prepped our samples and oriented them in a T fillet weld fashion. We then tack welded our sample and measured the weld angle. After doing this, we then did a full 1/8 inch fillet weld on both sides of the T, and measured the angle's orientation after each side was welded. Once this was accomplished we did the experiment again at 100A.

Technical problems: Our actual weld times were way longer than our calculated weld times. This can be attributed to a lack of proficiency in welding, and nervousness on the part of some of the students in the experiment.

Relevant equations:

Weld time = [Length of Rod/Travel speed] * 60

Metal Deposited = Final Sample Weight – Initial Sample Weight

Deposition Rate = Metal Deposited/Actual Weld Time

Voltage = . 283(R) * Weld Current

Energy/Length = [Weld Current * Voltage * Actual Weld Time] / Weld Length

Gas Welding:

For gas welding we performed 2 different types of gas weld, the first consisted of weld design and oxyacetylene welding, the purpose of this was to design a welding joint so the joint would have a specific, desired strength. The second portion involved braze welding, and was done so that the student had a chance to build the joints in practice. Our gas welding experiment started in much of the same way as our Arc Welding experiment. We first had to clean, weigh, and record the dimensions for the pieces of metal we would be working with. For our 2T joint, we had to measure the thickness of the sample to make sure that the overlap distance between the pieces was 2 times that of the thickness of the metal. This was once again measured for our 4T joint, only this time it was measured to ensure it was 4 times the thickness of our materials. After our measurements were taken we could then set up our first experiment. In order to do this we had to first position our samples in the correct position for each weld, once this was confirmed to be correct by our lab instructor we then began to heat up the surface of the metals so that our weld could be properly done. Once our surface was heated up, we then applied our rod/welding material to the joint and performed the weld. Weld time was recorded during this process. Once our instructor confirmed our weld was indeed successful we then took our weld and submerged it into water to cool the weld so we could safely weigh our samples post weld.

For the second part of our experiment we performed Braze welding. For braze welding we were not really concerned about weld time, just the actual experience of performing braze welding so we did not record the time. The braze weld starts off the same way as the first part of our experiment, however instead of applying a steel filler rod to our heated surface metal to join our metals, we placed a brass braze welding rod directly to the surface of the metal, rolled it around to place the material on the metal surface and then applied our flame to the brass rod to join the 2 pieces of metal material.

After each of these 2 experiments were completed we then had to test the tensile strength of our welds. In order to accomplish this we put our welded materials into a vice and bent the metals back and forth over and over until either the weld or the base metal material broke.

Relevant Equations:

P = Tw * w * L

Aw = [s/sqrt(2)] * L

s = Weld Size, where L = Length

σw = P/Aw; where P = Load

Discussion: Questions & Answers

Which of the 3 primary variables had the greatest effect on deposition rate?

In our experiment the travel speed had by far the greatest effect on the deposition rate, in our experiment we had an outlier or two due to poor technique. This can be seen in the graph below.

What is the calculated value for the weld distortion and how does it compare with the measured values of longitudinal distortion?

In order to calculate the theoretical weld distortion, we must use the equation:

Δ = . 005*(Aw*d*L^2)/I

Using this equation, we calculated our theoretical distortion for each weld, and then compared with our actual measured distortion. This can be seen below:

Our values are significantly different than those that were calculated theoretically. I believe this can be attributed to a lack of proficiency in our welding technique. We did pretty poorly on that portion of the welding lab.

How does distortion vary with current?

Current and distortion directly impact one another. The higher the current in the experiment, means more heat during the experiment, which leads to a higher distortion. This is the general rule, due to inconsistencies in our welding technique our data does not show this 100%. You can see this in the graph included below:

How does distortion vary with sample thickness?

For our experiment, distortion, with all other variables being held constant, will decrease with an increase in sample thickness. In order to determine this, we once again had to use the equation from above: Δ = . 005*(Aw*d*L^2)/I

What is the OEF for the SMAW process from your data?

Using the equation OEF = [(Actual Weld Time/Calculated Weld Time) * 100] and the data we obtained in our experiment, we calculated our OEF values to be:

What is the calculated value of weld distortion for transverse contraction?

To calculate these values, the second expression from page 6 was used, this expression is. St = . 10*[Aw/t] ;

Where Aw is the Weld Area, and t is the material thickness.

The values are found in the table below:

The Operator Duty Efficiency or Operator Factor (OF) can be as high as 85% or 90% for continuous welding operations such as MIG. What was your OF? What reasons can you think of that the electrode yield is not close to 100%

Our OF can be found in the table below, in order to calculate our OF, we had to account for cleaning up and properly handling our welds into our actual Labor Time, where the Weld time is the actual amount of time it took to perform our weld.

Our OF is pretty poor, in only one instance do we come within 10% of the average given in our question. I think this is partially due to the groups welding proficiency. As stated above in the report, there was a lot of nervousness and lack of efficiency in our welding process. Factoring in this we can see why our efficiency is not that high.

What is the effect of current upon deposition rate?

Whenever one applies more current to the weld it will cause the electrode to not only melt faster, but to deposit a greater amount of material on the welding surface. Due to this, current should have the highest effect on deposition rate. You can see our results below:

What is the effect of travel speed upon deposition rate?

Generally travel speed does not play much of a factor in the deposition rate, however as stated above, our welds were not performed by experts or by people with the most steady of hands. You can see in our experiments that travel speed played a significant role in the deposition rate.

What is the weld deposition rate in grams per minute for the longitudinal and transverse welds?

The deposition rate can be found in our table below, in order to calculate these values we used the equation

Deposition Rate = [ΔWeight/Weld Time] * 60s/1min

W2 Questions:

What is the travel speed in inches/min for welds? How do these speeds compare to those in W1?

The travel speeds for gas welding are generally much slower than those for arc welding. Our values are found in the table below using the following equation:

Travel speed (ipm) = Lw/t * 60s/1min

What are the deposition rates for the process in kg/hr?

The deposition rates for our process were acquired using the following equation:

Deposition rate (kg/hr) = [Δweight/1000g] * [Actual Weld Time(s)*1hr/3600s]

What loads would be required to cause a fracture in the base metal?

In our experiment every weld failed at the base metal except for our " V" weld, from this we can conclude the base metal is no stronger than the weakest load applied to cause fracture.

4.) If the braze metal has a shear strength of 50, 000 PSI and a tensile strength of 80, 000 PSI, where will the failure occur if the base metal has a strength of 70, 000 PSI? Justify for V and 2T Joints.

Failure will occur in the braze weld of the V shaped joint due to the 50, 000 PSI shear strength. This strength is less than the 70, 000 PSI found in the base metal, thus the failure happens at the weaker material, or at the weld.

In our 2T lap joint the failure also occurs at the weld because when you pull the load it causes shear stress at the braze weld.

Explain why fillet welds are not desired when brazing?

Fillet welds are generally very weak when done with braze welding. This can be attributed mostly due to the technique of braze welding, we are only adding filler material to the weld and not joining the actual metal plates together.

Process Comparison Table:

Conclusions:

As stated in the introduction the purpose of this lab was to give students a general idea of how both gas and arc welding processes worked. Over the course of the lab both processes advantages and disadvantages became somewhat apparent in the experiments we were required to perform. Arc welding proved to be a much speedier process than the gas welding for my group. Although there were initially some safety concerns by my group member over the arc welding process in regards to his vision, once he become comfortable enough to perform the weld the process was pretty quick and painless compared to gas welding. The gas welding process was partially marred by a faulty dial on the gas welding torch. This dial made it hard for us to set the levels properly and overall led us to taking a much longer time to perform the simple welds we were required to perform. Not only this, but trying to turn the dials and get all of the materials ready and able to use proved to be a lot harder as you were juggling several different materials to even get the process started. I believe that both of these processes were still valuable to learn, however. As an industrial engineer I will be asking people to perform specific jobs for me and having an idea of what it actually takes to perform those jobs will greatly aid me in designing functional and feasible systems going forward.

From our data we can gather that current and travel speed are very important factors in welding. These two factors can have effect deposition rate and distortion greatly, and this is one of the main points that should be taken from this lab. It is also to be understood that welding is not only a useful skill but can also be seen as somewhat of an art form. I myself was terrible at welding, and would take a lot of time to become proficient at it.