Why Do Weld Joints Fail?

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There are three approaches to joining metals: soldering, brazing, and welding. The first two are often mistaken for a welding technique, but are actually completely different approaches. When metals are soldered together the two metals touch and a third metal is added, almost like glue, in-between the joined parts. Brazing is similar but it occurs at a much higher temperature and usually happens with brasses. Welding is different. In welding the two metals are melted at high temperatures and actually fused together at the atomic level.

While weld joints are an excellent way to join metals there are situations in which weld joints fail. This can lead to financial loss for companies, hardships for consumers, and sometimes injury. It is critical to understand common reasons weld joints fail and work to ensure prevention of these failures.

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1. You've likely heard the saying, "some like it hot," this is true when it comes to weld joints. If the joints are not heated hot enough, when they are being formed, problems will ensue. You can't weld a hot object to a cold object; they have to be hot at the same time that you weld. Failing to properly heat both components of the joint would result in a weak weld.

2. Cracking is a common defect that occurs within weld joints. Typically cracking occurs because of the built up stress that accumulates when a heated metal is

rapidly cooled. In order to prevent this form of defect the metal should be annealed. This is a type of stress relief that occurs by heating the weld again, to a lower temperature, and then letting it cool down naturally. Annealing relieves the stress that was initially built up by the contrasting temperatures.

3. Sometimes the issues with a weld joint aren't so much the joint themselves, but the surrounding area. This materials science example of "guilty by association" occurs if areas of an object other than the weld location are heated, resulting in distortion of those areas which can cause improper alignment of the welded parts or undesired stresses in the material. Fortunately, if you identify this has occurred you can try to correct for it, but ignoring distortion can result in the weld joint failing.

4. An additional bad boy of weld joints is oxidation, as oxides can prevent a good weld from forming. Hot metals like to oxidize, and metal must get very hot to form a proper weld joint. The common approach to preventing oxidation from occurring is using a "shield" gas, which is a non-oxidizing gas such as Argon that is introduced into the welding area. This shield gas prevents oxygen from being present when the metal is heated, thus preventing oxidation. Another way to prevent oxidation is to use a rod with carbon inside (called a flux). The carbon in the flux preferentially bonds with the oxygen before the metal does and prevents oxidation.

5. Slag is another trouble maker when it comes to weld joints. This includes things such as dirt, debris, and oxides that are on the parts when welding occurs. If the parts are not clean when welding occurs the weld joint will lack uniformity and could also contain porosity around the debris. Porosity is very bad for materials if you need them to be strong. Think about packing peanuts for example, they are filled with pores in order to create a comfortable cushion. As a result, the packing peanuts lack strength.

6. Chemical degradation, or corrosion, is another culprit of weld joint failures but occurs over a long period of time. It weakens the metal to the point where it cracks when it wouldn't have otherwise because it attacks the metallic bonds and destroys them. Rust is the most common example that we have all probably seen on a daily basis. Think about an old car sitting in a puddle, it would rust preferentially at all the weld joints before it would rust at the non-

welded because the ‘heat affected zone’ adjacent to the weld is particularly sensitive to corrosion.

7. Bubble pockets in weld joints are bad news–you don’t want a bubble or void in the metal. They are caused by moisture or by the mixture of the carbon and oxygen, which turns into CO_2. The metal parts need to be dry to help prevent any porosity from forming during welding. While these seven reasons for weld joint failures may leave you feeling a bit melancholy do not despair! The good news is that it is possible to pinpoint the root cause for a weld joint failure and determine a solution for how to move forward in a way that prevents these same failure modes from occurring again. Talking with a weld expert or an engineer with metals knowledge is the best starting point.

Understanding these failure modes is important for products and materials that perform as expected. We invite you to reach out to us to discuss your weld joint issues and testing needs.