SAMIR M M ALREWAYEH. International Journal of Engineering Research and Applications
www.ijera.com
ISSN: 2248-9622, Vol. 12, Issue 11, November 2022, pp. 57-68

RESEARCH ARTICLE OPEN ACCESS

Defects resulting from fusion welding of metals and ways to prevent them

SAMIR M M ALREWAYEH
University TECHNOLOGY COLLEGE

ABSTRACT
This report discusses the defects that can result from the fusion welding of metals and ways to prevent them. It begins with a brief introduction to welding and the different types of fusion welding. It then discusses the various defects that can occur, such as cracks, porosity, and slag inclusion. Finally, it offers recommendations on how to prevent these defects from occurring.
Welding is a process of joining two pieces of metal together by heating them to a molten state and then cooling them, so they fuse together. There are many different types of welding, but the most common is fusion welding. In fusion welding, the heat is generated by an electric arc between the two pieces of metal. The heat from the arc melts the metal, and as the metal cools, it forms a bond between the two pieces.
Various types of fusion welding include arc welding, oxy-fuel welding, and laser welding. Each type of welding has its advantages and disadvantages, and each can be used to weld different types of metals. Welding can be a hazardous process if it is not done correctly. Many potential hazards include fires, explosions, and toxic fumes. Welding also produces much noise and can be very hot, so proper safety precautions must be taken.
One of the most common welding defects is cracking. Cracks can occur for many reasons, including improper welding techniques, incorrect metal preparation, and incorrect welding parameters. Damages can also occur if the metal is not cooled correctly after welding. Porosity is another common welding defect. Porosity is caused by gas bubbles that are trapped in the weld metal. Porosity can be caused by many factors, including improper welding techniques, incorrect gas mixtures, and incorrect welding parameters.
Slag inclusion is another common welding defect. Slag is a non-metallic material that is produced during the welding process. Slag can be trapped in the weld metal, which can cause the weld to be weak and porous. Slag inclusion can be prevented using correct welding techniques and parameters (Shatov & Steklov, 2016). Welding defects can be prevented using the correct welding techniques, properly preparing the metal, and using the correct welding parameters.

Date of Submission: 01-11-2022 Date of Acceptance: 12-11-2022

I. Introduction

Welding is joining two or more pieces of metal together by melting them and adding filler material. There are many different types of welding, but the most common is fusion welding. In fusion welding, the metal is melted, and the filler material is added to create a joint between the two pieces of metal.

The arc welding process is very versatile and can be used to weld many different types of metals. The most common type of welding is arc welding. In arc welding, an electric arc is used to heat the metal, and the filler material is added to the joint (Castro & Cadanet, 1975). Another type of welding is gas welding. In gas welding, a flame is used to heat the metal, and the filler material is added to the joint. Gas welding is often used for welding metals that are difficult to weld with an arc, such as aluminium.

Welding is a very versatile process and can be used to create a wide variety of products. Welding is often used to create structures such as buildings and bridges. Welding is also used to create various consumer products, such as cars, bicycles, and lawn furniture.

There are a few things to consider before welding. First, you must choose the right welding type for the job. There are many different welding types, each with its own advantages and disadvantages. Second, you need to choose suitable materials for the job. The type of metal you are welding will determine the type of welding you need to use. Third, you need to choose a suitable filler material. The filler material is used to fill the gap between the two pieces of metal being welded. Fourth, it would be best if you chose a suitable welding machine.

There are many different types of welding machines, each with its advantages and disadvantages. Fifth, you need to choose the right welding rod. The welding rod creates the arc between the two pieces of welded metal. Sixth, you need to choose a suitable welding gas. The welding gas is used to protect the weld from oxidation. Seventh, choose the right welding power source(Tarasankar DebRoy; Stan A. David; John N. DuPont; Toshihiko Koseki; Harry K. Bhadeshia, 2013). The welding power source is used to supply the power to the welding machine. Eighth, you need to choose the right welding safety equipment. The welding safety equipment is used to protect the welder from the dangers of welding. Ninth, you need to choose suitable welding consumables. The welding consumables are used to help the welder to weld the metal. Tenth, you need to choose the right welding environment. The welding environment is used to protect the welder from the hazards of welding.

Aim

This report aims to discuss the defects that can result from the fusion welding of metals and ways to prevent them.

Content

Many different types of defects can occur when fusion welding metals. These defects include cracks, porosity, slag inclusion, and others.

Cracks can occur in the weld metal, the heat-affected zone, or the base metal. Porosity can occur in the weld metal or the heat-affected zone. Slag inclusion can occur in the weld metal.

Cracks:

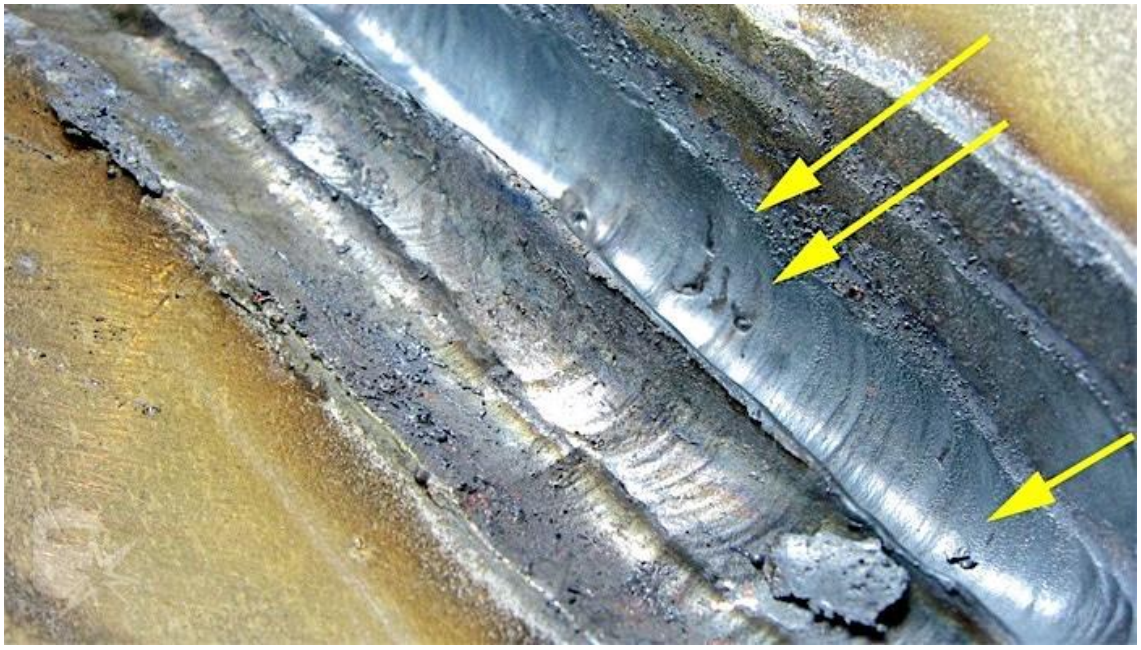
There are three leading causes of welding cracks: thermal, metallurgical, and mechanical stress. Thermal stress is caused by the expansion and contraction of the metal as it is heated and cooled during the welding process. Metallurgical stress is caused by the change in the structure of the metal as it is welded. Mechanical stress is caused by the forces exerted on the metal during the welding process.

Welding usually produces heat-affected zones (HAZs) in the base metal. These HAZs are susceptible to cracking if not appropriately cooled (Trykov et al., 2012). One way to prevent cracking is to use a low-hydrogen welding process. This will minimize the amount of hydrogen in the weld and make it less likely to crack. Another way to prevent cracking is to use a preheat before welding. This will help control the weld's cooling rate and prevent cracking. Finally, post-weld heat treatment can also be used to prevent cracking. This will help relieve the weld's stresses and make it less likely to crack.

Inclusions:

Inclusions are foreign materials trapped in the weld during the welding process. The three leading causes of inclusions are poor welding technique, contaminated welding materials, and poor cleaning of the welding area. Poor welding technique can cause the weld to be too hot or too cold, which can trap inclusions in the weld (Schneerson, 2021). Contaminated welding materials can also cause inclusions. Suppose the welding wire is contaminated with rust, for example. In that case, it can cause inclusions in the weld("Welding consumables. General product standard for filler metals and fluxes for fusion welding of metallic materials," n.d.). Poor cleaning of the welding area can also cause inclusions. If the area is not cleaned properly, dirt and other debris can be trapped in the weld.

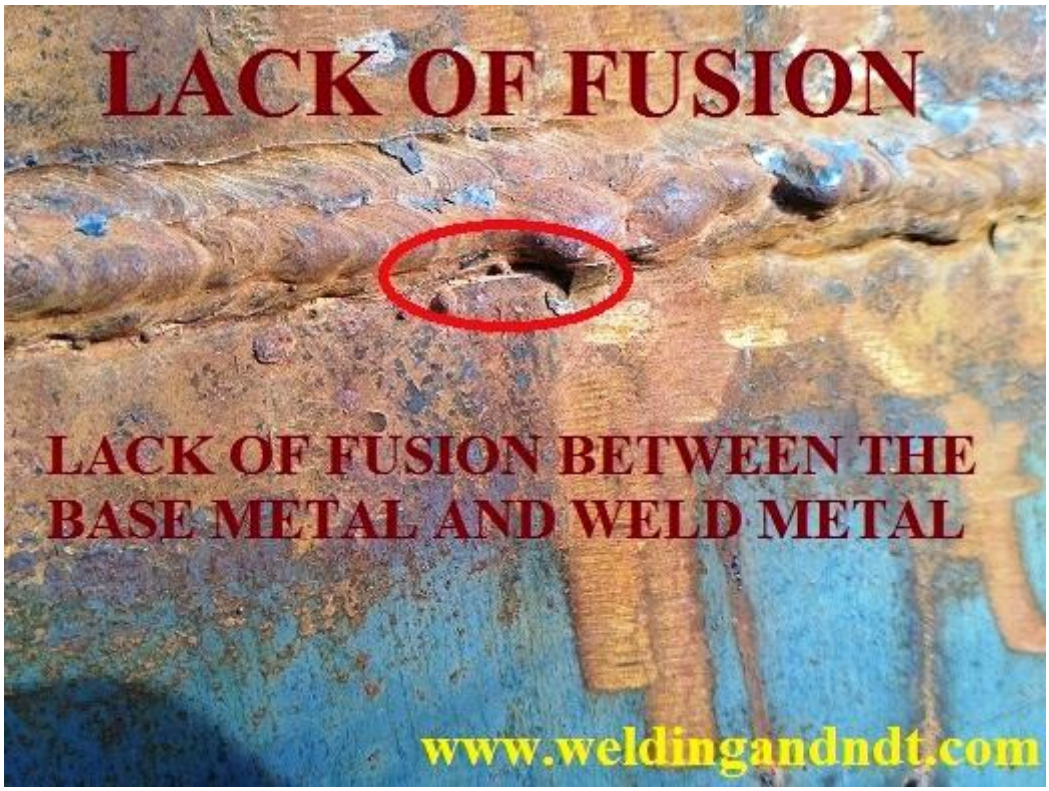
Inclusions are foreign materials that are present in the weld. Inclusions can cause porosity, undercuts, and poor penetration. Impurities can be in the welding wire or in the base metal contaminants. To prevent inclusions, it is essential to use a high-quality welding wire and to clean the base metal before welding.



Lack of fusion:

When the weld metal does not attach to the base metal or when the weld metal does not fuse with the base metal, we call this a lack of fusion, which is a welding fault. Weak welding methods, improper welding settings, and harmful materials are the main reasons for incomplete fusion ("Welding consumables. General product standard for filler metals and fluxes for fusion welding of metallic materials," n.d.). Due to improper welding technique, the weld may be too hot or too cold, inhibiting proper adhesion of the weld metal to the base metal. Lack of fusion can also be caused by using the wrong welding settings. The weld metal will not heat up sufficiently to effectively fuse with the base metal if the welding current is not high enough. Unfused welds can also be caused by using contaminated welding materials. Example: corrosion on the welding wire can prevent the weld metal from adequately adhering to the base metal.

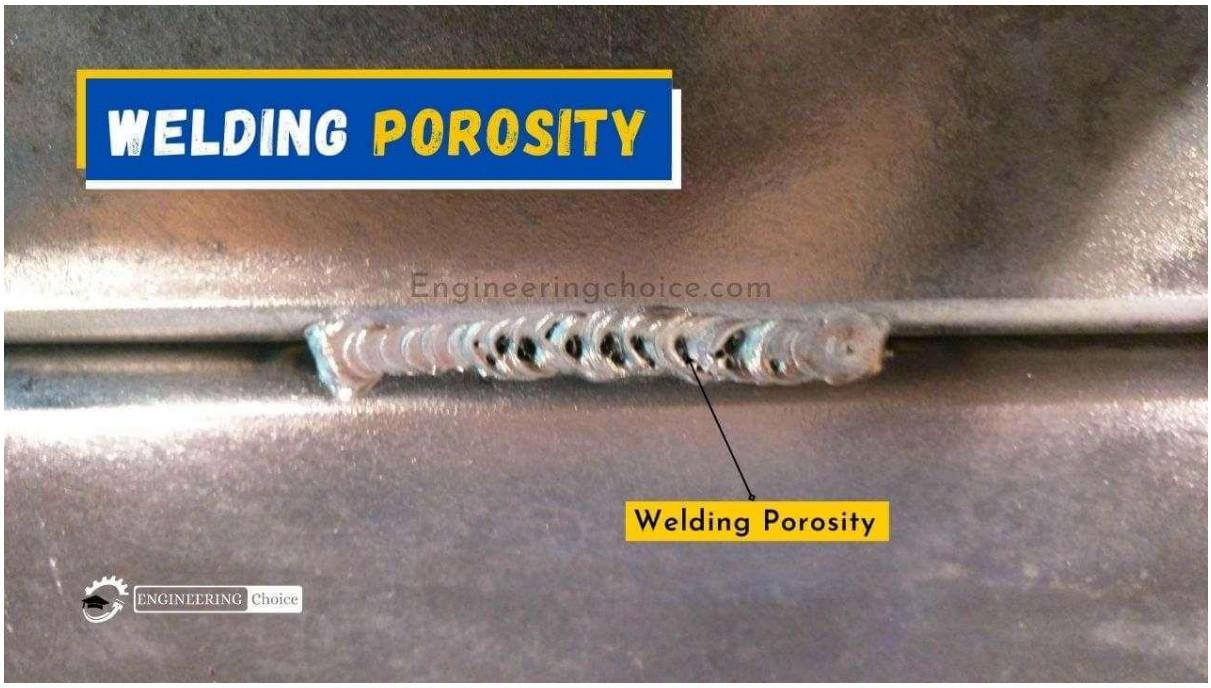
A lack of fusion occurs when the weld metal fails to fuse with the base metal during the welding process fully. Incorrect welding procedures or using a welding wire that is incompatible with the base metal might lead to this problem. A lack of fusion may be avoided by employing correct welding procedures and a welding wire compatible with the base metal.



Porosity:

Porosity is a welding defect when gas bubbles are trapped in the weld metal. The three leading causes of porosity are incorrect welding parameters, contaminated welding materials, and poor cleaning of the welding area (Lester & LABS., 2022). Incorrect welding parameters can cause porosity if the welding current is too high or the welding speed is too low. Contaminated welding materials can also cause porosity. If the welding wire is contaminated with rust, it can cause gas bubbles to be trapped in the weld metal. Poor cleaning of the welding area can also cause porosity. If the area is not cleaned properly, dirt and other debris can be trapped in the weld metal.

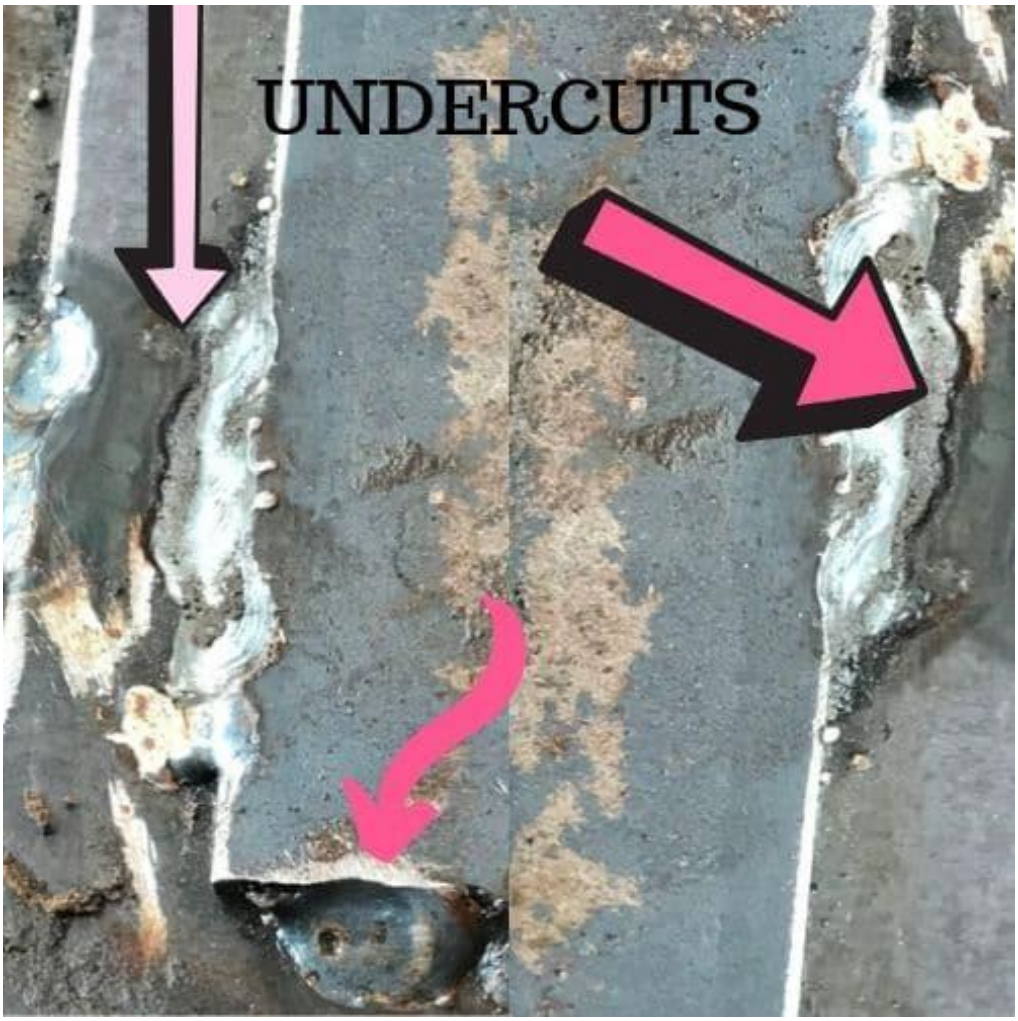
Porosity is when there are voids in the weld metal. Porosity can cause undercuts, poor penetration, and burn-through. Impurities can cause this in the welding wire or the base metal contaminants. To prevent porosity, it is essential to use a high-quality welding wire and to clean the base metal before welding.



Undercut:

The undercut is a welding defect when the weld metal does not extend far enough into the base metal. The three leading causes of undercut are incorrect welding parameters, contaminated materials, and poor welding technique. Incorrect welding parameters can cause an undercut if the welding current is too low or the welding speed is too high. Contaminated welding materials can also cause undercut. For example, if the welding wire is contaminated with rust, it can prevent the weld metal from extending far enough into the base metal. Poor welding technique can also cause undercut. If the weld is not deposited evenly, it can cause an undercut.

The undercut is when the weld metal does not properly fuse with the base metal. This can be caused by improper welding techniques or a welding wire incompatible with the base metal. To prevent undercut, using the proper welding techniques and a welding wire compatible with the base metal is essential.



Poor penetration:

Poor penetration is a welding defect when the weld metal does not penetrate deeply enough into the base metal. The three leading causes of poor penetration are incorrect welding parameters, contaminated welding materials, and poor welding technique. Incorrect welding parameters can cause poor penetration if the welding current is too low or the welding speed is too high. Contaminated welding materials can also cause poor penetration. For example, if the welding wire is contaminated with rust, it can prevent the weld metal from penetrating deeply enough into the base metal. Poor welding technique can also cause poor penetration. If the weld is not deposited evenly, it can cause poor penetration.

Poor penetration occurs when the weld metal does not fuse properly with the base metal. This can be caused by improper welding techniques or a welding wire incompatible with the base metal. To prevent poor penetration, it is essential to use the proper welding techniques and a welding wire compatible with the base metal.

Burn through:

Burn-through is a welding defect when the weld metal burns through the base metal. The three leading causes of burn-through are incorrect welding parameters, contaminated materials, and poor technique. Incorrect welding parameters can cause burn-through if the welding current is too high or the welding speed is too low. Contaminated welding materials can also cause burn-through. If the welding wire is contaminated with rust, it can cause the weld metal to burn through the base metal. Poor welding technique can also cause burn-through. If the weld is not deposited evenly, it can cause burn-through.

Burn-through is when the weld metal does not properly fuse with the base metal. This can be caused by improper welding techniques or a welding wire incompatible with the base metal. To prevent burn-through, using the proper welding techniques and a welding wire compatible with the base metal is essential.

Under-fill:

Under-fill is a welding defect when the weld metal does not fill the joint. The three leading causes of under-fill are incorrect welding parameters, contaminated materials, and poor technique. Incorrect welding parameters can cause under-fill if the welding current is too low or the welding speed is too high. Contaminated welding materials can also cause under-fill. For example, if the welding wire is contaminated with rust, it can prevent the weld metal from filling the joint. Poor welding technique can also cause under-fill. If the weld is not deposited evenly, it can cause under-fill. Under-fill is when the weld metal does not properly fuse with the base metal. This can be caused by improper welding techniques or a welding wire incompatible with the base metal. To prevent under-fill, using the proper welding techniques and a welding wire compatible with the base metal is essential.

Excess reinforcement:

Improper welding conditions, toxic materials, and sloppy artistry are the three most common reasons for too much reinforcing material. Weld defects, such as excess reinforcement, arise when the weld's metal extends over the joint's boundary. If the welding current is too high or the welding speed is too slow, the result will be an overabundance of reinforcement. Excessive reinforcing may also result from the use of contaminated welding materials. For instance, rust in the welding wire might lead to the weld metal spreading beyond the joint's border. Excess reinforcement might also be the result of sloppy welding. Uneven weld deposition might lead to unnecessary reinforcement.

When the weld metal fails to fuse with the base metal fully, the result is excessive reinforcement. This can occur if the welding process is carried out incorrectly or the welding wire is unsuitable for the base metal used. It is crucial to employ the correct welding procedures and a welding wire suitable with the base metal to avoid over-reinforcing the material.

Spatter

Droplets of weld metal are released from the weld, creating a defect known as a spattering. Incorrect welding settings, contaminated materials, and poor technique are the three most common reasons for spattering. A spatter will result if the welding current is too high or the welding speed is too low (Klaus Walter, 2022). Spatter can also be caused by using welding supplies that are contaminated. Droplets of weld metal can be discharged from the weld if, for example, the welding wire is rust-contaminated. A splatter may also result from sloppy welding. Uneven weld deposition can result in spatter.

This is known as a spattering whenever the weld metal fails to fuse completely with the base metal. If you want to avoid spatter during welding, you must utilize the proper welding procedures and a welding wire suitable for the base metal. Incorrect welding procedures or using a welding wire that is incompatible with the base metal might lead to this problem.

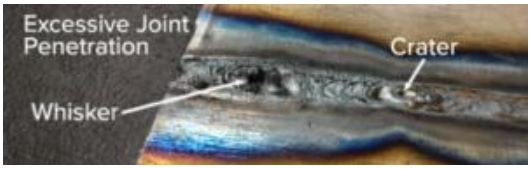
Over-roll/Overlap:

The welding flaw of over-roll or overlap occurs when the weld metal rolls or overlaps past the edge of the connection. Incorrect welding settings, contaminated materials, and poor technique are the primary reasons for over-roll/overlap. Over-roll/overlap can be caused by incorrect welding settings, including a high welding current or a slow welding speed. Over-roll and overlap can also be caused by using contaminated welding materials. The weld metal may overflow the junction if, for instance, rust contaminates the welding wire. Over-roll and overlap might also be the result of sloppy welding. For instance, over-roll/overlap might occur if the weld is not applied uniformly.

When the weld metal fails to fuse properly with the base metal, a condition known as over-roll or over-lap develops. It is crucial to utilize correct welding procedures and a welding wire suitable with the base metal to avoid over-roll/overlap. Incorrect welding procedures or using a welding wire that is incompatible with the base metal might lead to this problem.

Whiskers:

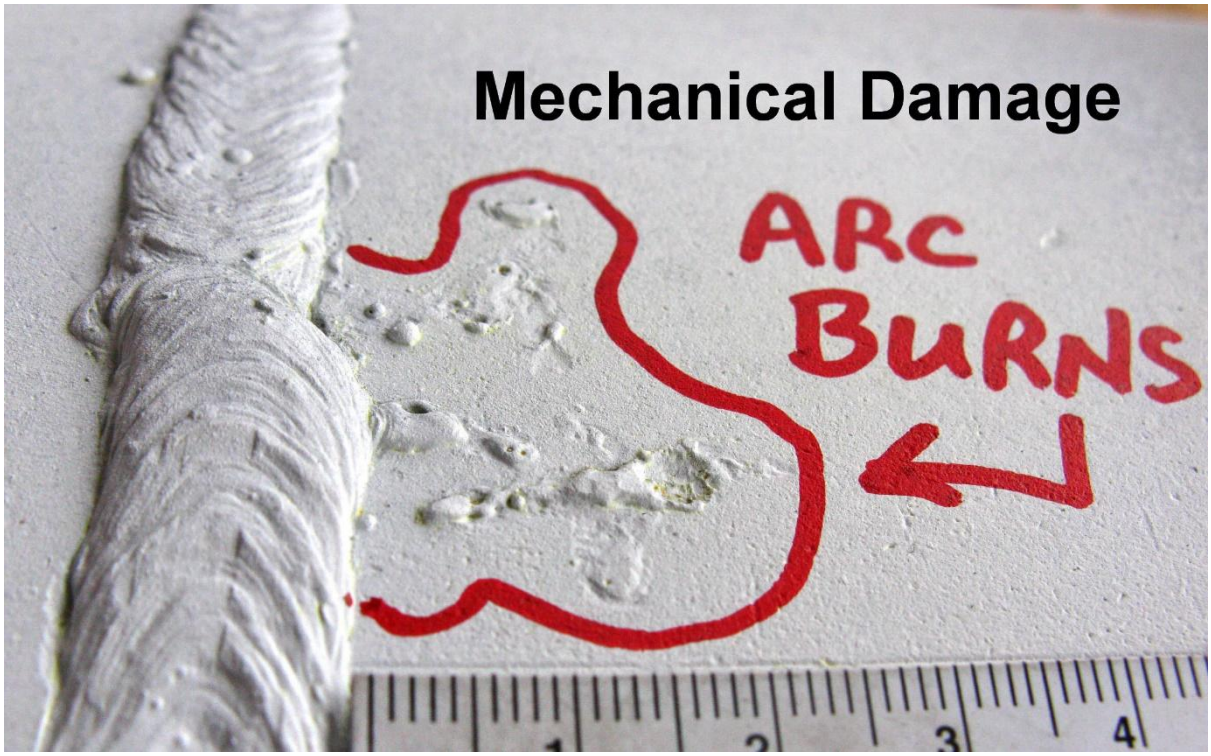
Whiskers, also known as long, thin strands of weld metal, emerge from the weld. Incorrect welding settings, contaminated materials, and inadequate technique are the primary causes of whiskers. When welding, if the current is too strong or the pace is too slow, it might generate whiskers. Contaminated welding supplies can also bring on Whiskers. Using rust-contaminated welding wire might result in the protrusion of long, thin strands of weld metal. Whiskers may also be the result of sloppy welding. Whiskers appear if a weld is not placed consistently. Whiskers appear when the welded metal does not entirely melt into its base metal. The employment of incorrect welding procedures or a welding wire incompatible with the base metal might lead to this. Whiskers can be avoided by employing correct welding procedures and using welding wire suitable for the base metal.



Mechanical damage:

Mechanical damage is any damage to the weld caused by the forces exerted on the weld during the welding process. The three leading causes of mechanical damage are poor welding technique, incorrect welding parameters, and poor welding equipment. Poor welding technique can cause mechanical damage if the weld is not deposited evenly. Incorrect welding parameters can also cause mechanical damage. If the welding current is too high, for example, it can cause the weld to be too hot and can cause the weld metal to flow. Poor welding equipment can also cause mechanical damage. If the welding torch is not correctly aligned, for example, it can cause the weld to be misaligned and can cause the weld metal to flow.

Mechanical damage occurs when the weld metal does not fuse with the base metal properly. This can be caused by improper welding techniques or a welding wire incompatible with the base metal. To prevent mechanical damage, it is essential to use the proper welding techniques and a welding wire compatible with the base metal.



II. Conclusion

Fusion welding of metals can result in various defects, such as cracks, porosity, and slag inclusion. These defects can be prevented by using the proper welding techniques and materials

Fusion welding of metals can result in various defects, such as cracks, porosity, and slag inclusion. These defects can be prevented by using the proper welding techniques and materials For example, when welding aluminum, it is essential to

use a filler metal with a low melting point, such as 4043. This will help to prevent cracks from forming. Additionally, using a lower welding speed can also help to prevent defects. When welding steel, it is essential to use a high-carbon content wire, such as ER70S-6 (Deyev, 2015). This will help to prevent porosity. Additionally, it is essential to use a gas that will not cause porosity, such as CO2.

Finally, using the proper welding technique is essential. For example, when welding thin steel, it is vital to use a pulsed welding technique to prevent porosity. In general, fusion welding of metals can be made much safer and more reliable by using the proper techniques and materials. By doing so, welders can help to prevent defects and ensure that their welds are of the highest quality.

III. Recommendations

It is essential to use the proper welding techniques and materials to prevent the defects that can occur when fusion welding metals.

The most common way to weld metals is by using an electric arc. This process uses an electric current to create an arc between the metal welded and the electrode. The heat from the arc melts the metal, which is then welded together. To prevent defects, it is essential to use the proper welding techniques. For example, when welding two pieces of metal together, it is essential to use a technique that will not cause the metal to warp. Additionally, it is essential to use the proper welding materials. For example, it is vital to use an aluminum welding rod when welding aluminum.

In addition to using the proper welding techniques and materials, it is also essential to properly prepare the metal before welding. The metal should be clean and free of any contaminants. Additionally, the metal should be appropriately positioned before welding. If the metal is not positioned correctly, it can warp during the welding process. Finally, it is essential to have proper ventilation when welding. The fumes from the welding process can be harmful if inhaled.

References

[1]. A non-destructive testing atlas-classification of defects in metallic fusion welds, with explanations. Indian Welding Journal, 14(4), 143. https://doi.org/10.22486/iwj.v14i4.148514

[2]. Castro, R., & Cadanet, J. J. (1975). Welding metallurgy of stainless and heat-resisting steels. In undefined. CUP Archive.

[3]. Day, G. (2015). Surface phenomena in fusion welding processes. In undefined. CRC Press.

[4]. Klaus Walter. (2022). Management in Practice (Week 3).

[5]. Lester, H. H., & LABS., W. A. (2022). Defects in metal ARC fusion welding are shown in radiographic negatives. In undefined.

[6]. Schneerson, V. (2021). Constructing a theory of weld formation in fusion welding of metals (Part 1). Welding and Diagnostics, (5), 34-41. https://doi.org/10.52177/2071-5234_2021_05_34

[7]. Shatov, A. P., & Steklov, O. I. (2016). Formation of lack of fusion defects and hot cracks in welding steel structures with a corrosion-resisting zinc coating. Welding International, 30(12), 945-947. https://doi.org/10.1080/09507116.2016.1157334

[8]. Tarasankar DebRoy; Stan A. David; John N. DuPont; Toshihiko Koseki; Harry K. Bhadeshia. (2013). undefined. ASM International.

[9]. Trykov, Y. P., Shmorgun, V. G., Arisova, V. N., & Ponomareva, I. A. (2012). The behavior of magnesium alloys during explosion welding and ways to prevent their failure. Russian Journal of Non-Ferrous Metals, 53(2), 139-144. https://doi.org/10.3103/s1067821212020149

[10]. Welding consumables. General product standard for filler metals and fluxes for fusion welding of metallic materials. (n.d.). https://doi.org/10.3403/03196945