CORROSION BEHAVIOR ON THE TYPES OF WELD JOINTS

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ABSTRACT

Welding is joining two or more pieces of metal by applying heat, pressure or both with or without filler material to produce a localized union through fusion or recrystallization across the interface. There are many types of welds; Fillet welds, butt welds, lap welds, corner welds, edge welds etc. All of the metallurgical events like a corrosion of material are affected on welded joints. Main investigate can be upon on different types of welded joints which are affected by corrosion. For this reason we used metal materials which were jointed different types by welding on this experiment. Also various kind examinations were used to the corrosion behavior of these joint areas. These behaviors can be explained in terms of two counteracting effect, activating and inhibiting of welded joints on corrosion resistance. Result of this experiment was showed that correct welding procedure can be prevented corrosion on welded joints. These procedures are make dimensioned drawing, itemize your requirement and check availability and plan a “step to step” procedure.

1.INTRODUCE

In manufacturing industry usage of metal materials has been getting more common very rapidly as a result of technological developments. It is possible to use steel materials in a structure by integrating them on the basis of their design properties. Manufacturing method implemented with that purpose is considered as welding. Mainly welding is known as combination of materials by heat, pressure or both of them. There are plenty of welding methods. However, when evaluated actually they are found as melting and pressure welding methods.

Melting welding is most frequently implemented types. When process type is considered it reminds a casting process[4]. Heating additional metal closer to the melting temperature is solidification of that metal following a time period. During that period surface of main material is solidified mixing with additional metal melting to some extent. During that process regions heated in range of metal melting temperature up to various ambient temperature levels are provided [1].

On the other hand corrosion is a chemical alteration usually considered peculiar for metals however, seen in all materials scattered in nature. Corrosion is generally defined as a gradual deformation or as a deformation emerged in chemical and/or electro chemical reactions. Corrosion is also defined as metals anti-mechanical deformations thus, metal transforms into its natural composition present in nature.
Usually steel and iron; experience deformation in every environment where oxygen and water are present. Rate of corrosion is varied depending on ambient conditions. For example, in water it proliferates depending on water speed or acidity, movements of metal, increase of temperature and aeration, existence of some bacterial population or factors possessing other types of effects. On the other hand, it is delayed by corrosion protective layers (or films). Water alcalkylation level pulls down corrosion speed on steel surfaces. But for development of corrosion water and oxygen are always necessary. Both of them determine corrosion amount. For example in dry air corrosion does not emerge on steel. If humidity in air is below %30, in temperatures on normal level or below corrosion is infinitesimally low.

All metal structures under go corrosion at certain levels in natural environment. Bronze, brass, rustproof steel, zinc and aluminum experience very slow corrosion in some utilization conditions in which they are expected to resist to corrosion very long time without any preservation[ 6] . Structural corrosion of iron and steel improve very rapidly in case of failure to protect metal sufficiently. Susceptibility of steel and iron to corrosion is the focal point. Because, when their convenient costs and physical properties are taken into account very huge amounts are used. Annual lost in U.S.A. as a result of steel corrosion is closer 70 Billion Dollars value. Preserving steel and iron against corrosion is an indispensable branch of maintenance engineering.

On the other hand, due to combination of fluid tides with welding developing potential variation emerging in that region leading to electrical currents are based on contacts of fundamentally various metal conductors or concentration difference of solvents pertaining to oxygen which is generally dissolving in natural water. Also heterogeneity factor on metal surface or in solvent around it leads to potential variation. Thus, it may arise reactions which are capable to create corrosion. There are a lot of factors included but, all of those are described by electrochemical principles satisfactorily primarily including actual significant realities. It is not required to put a metal into solvent which experienced electrochemical corrosion but perhaps metal can have contact with wet soil or some region on metal can be wet. That is known as the major point in the explanation of corrosion over welded fields. In the science of corrosion corresponding emergence of that event is known as galvanic corrosion[ 3] .

Basically, such corrosion in welded regions known as different metal corrosion developing in unexpected regions and frequently creates most dangerous outcomes. As a result, also welded region is a sort of metal. In a same electrolytic environment galvanic sequence determines which of the metal found together with welding material at the same time will undergo corrosion.

Galvanic sequence of metals determines the way of galvanic current between two metals and in case of a contact between metals determines details about the one which is going to be deformed. In that sequence metal carrying more negative electrical potential undergoes corrosion. When evaluated from that respect, despite more resolute metal component on materials situated over welded region corrosion develops based on more negative electrode potential.

Again variations such as humidity and resistance lead to creation of anodic and cathodic regions. On a ground having contact with metal situated in different locations corrosion cells develop on regions where oxygen concentration varies. In some points where oxygen concentration is gradually high it functions, develops as cathode when it is low as anode.
Highly stressed parts of metal have a tendency to have anodic unstressed parts have tendency to have cathodic property. [7]

Anodic (underwent corrosion) surface is quite smaller than cathodic (protected) surface its tendency to have concave property rises up. It is more frequently expected over welded regions, along rest of the protective material breaks are emerged. In addition, concave properties are also emerged on pure, refined welding regions due to irregular properties in physical and chemical structure of metal.

Again in the same way, on welding regions pores which are possible to develop provide some properties contributing to corrosion. On the other hand, connection types with different welding methods are used (Figure 1).

Certainly welding regions must be known very well. That region undergoes highest corrosion during welded connections[5]. Particle exchange area in the pathway between main material and welding region is possible to undergo corrosion damage at secondly important magnitude. [2]. Because, from galvanic sequence between main material and itself it provides less influence compare to galvanic sequence on welding region. (Figure 2)

So in all applications welding technology must be known well in metal combinations. In the present study considering above mentioned main points investigation of corrosion in various welding types has been considered as the main topic.
2. MATERIAL AND METHOD

In present study, 4 mm thick steel sheet metal materials each of them in 50x50 dimensions which are going to be connected were used. Then each of the components was combined implementing MIG/MAG welding method in selected butt, corner, T, lap and edge types(Figure 1)

![Macro image on different type welded material at the beginning of corrosion](image1)

2.1 Potential measurements at galvanic sequence formation region

Protection magnitude may be measured quantitatively measuring the potential of preserved structure. That measurement is usually considered as a criterion and used by corrosion engineers. Fundamental of that measurement is based on the fact that if preserved structure is polarized to local impact cell open system anodic potential cathodic protection is considered completed. For that measurement it is necessary it must be located as close as possible to the preserved establishment for eliminating or lessening the fault originated from reference electrotomic decrease (Figure 2).

![Galvanic cell](image2)

In the experiments electrolyte solvent was composed using 35 g NaCL in 1 lt water. Each of the welding type was sunk into that electrolyte. Saturated calomel electrode was utilized as cathode. Following this welded materials composed of different combination shapes were inserted as anode material. At the end of 72 hours holding period potential variation between anode and cathode was determined as mV.
2.2. Investigation of macro and micro structures

After completion of MIG welding precorrosion macro and micro structures of welded materials were found by SEM. At the end of the completion of corrosion again by taking the photos of macro and micro structures effect of corrosion was attempted to determine.

2.3 Determination of traction strength values

All of the welded materials were measured for determining their values before and after traction strength and impact of corrosion effect in that way were determined.

4. RESEARCH OUTCOMES

Table 1 depicts potential variations provided of welded components which are composed of different combination structure provided from MIG welding method at the end of leaving in a corrosive environment.

<table>
<thead>
<tr>
<th>Combination form</th>
<th>Cathode</th>
<th>Anode</th>
<th>Potential difference (mV)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Butt</td>
<td>Fe</td>
<td>Cu</td>
<td>132</td>
</tr>
<tr>
<td>Corner</td>
<td>Fe</td>
<td>Cu</td>
<td>185</td>
</tr>
<tr>
<td>T</td>
<td>Fe</td>
<td>Cu</td>
<td>193</td>
</tr>
<tr>
<td>Lap</td>
<td>Fe</td>
<td>Cu</td>
<td>227</td>
</tr>
<tr>
<td>Edge</td>
<td>Fe</td>
<td>Cu</td>
<td>212</td>
</tr>
</tbody>
</table>

In the present study, having different form structural alteration on welding region was led to change in the galvanic sequence. Magnitude of potential variation is an indication of corrosion speed generated in anode. Intensity of corrosion is as high as voltage. under such consideration development of corrosion mainly is seen at welded components provided by overlapping parts at the top of each other. In the combination generated by bringing them facing each other lowest potential variation was provided. That points out to slow corrosion rate on such components. In addition, due to any kind of corrosion protection implementation for main material it was observed that potential is intensified by welded region. Table 2 depicts traction strength values of all components used in the experiments before and after corrosion.

<table>
<thead>
<tr>
<th>Combination form</th>
<th>Traction strength before corrosion (Mpa)</th>
<th>Traction strength after corrosion (MPa)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Butt</td>
<td>223</td>
<td>208</td>
</tr>
<tr>
<td>Corner</td>
<td>217</td>
<td>196</td>
</tr>
<tr>
<td>T</td>
<td>245</td>
<td>216</td>
</tr>
<tr>
<td>Lap</td>
<td>264</td>
<td>232</td>
</tr>
<tr>
<td>Edge</td>
<td>254</td>
<td>247</td>
</tr>
</tbody>
</table>

When those strength values are evaluated it is possible to suppose that corrosion usually drops down strength traction. When welded components are evaluated for which various combination methods is generated highest rational decrease was observed in overlapping combination lap type. Also that result approves the result provided in Figure 1.
Figure 3 depicts macro images of all components taken into experiment at the end of corrosion. Again when micro images provided at the end of corrosion are observed it is seen that holes developed on welded regions and pores in the structure are the effects of rapid corrosion. In the figure influential points of the corrosion in butt type are depicted(Figure 4).

![Figure 3. Macro images of components at the end of corrosion](image1)

FIGURE 3. Macro images of components at the end of corrosion

![Figure 4. Points where corrosion can be more influential in butt type implementation](image2)

FIGURE 4. Points where corrosion can be more influential in butt type implementation

In the present study it was determined that main factors capable to generate corrosion in MIG/MAG method are primarily the pores and hollows. Corrosion originates from those
points and expands. Influential factors in the formation of pores and surface cracks are presented down. Those are:

- Inconvenient gas-wire combination
- Factors emerged from arc blow
- Factors originated from squeezed gas in internal section
- Factors emerged due to faulty rust shape
- Factors caused by inconvenient air flow
- Factors caused by contaminated layer located on component surface
- Factors caused by excessively inclined position of the torch
- Low or excessive protecting gas
- Too long length of free wire
- Curved shape mounting of contact tips

Preventing those factors will enable to delay corrosion. In addition, excess notched structures on welding regions are known to create regions creating corrosion regions.

Changes in weight must be considered in order to specify the rate of corrosion at corrosion tests. In this experiment, no significant change was noted in this respect during the 30 days trial of the materials. But some weight reduction was noted, though very slight, in 4 mm material. However we were unable to determine exactly whether it originated from the metal itself or the welded area.

5. CONCLUSION

Under the framework of the findings of this experiment, we understand the physical effects on the welded materials played a great role in the occurrence of corrosion. Thus:

- The local porosities on the welded area cause corrosion (single dimensional corrosion)
- The corrosion spread out to the entire surface starting from the welded area (two dimensioned corrosion)
- The structures like cracks, occurring on the welded area because of the different effects of the main and auxiliary welding materials depending on the welding type employed, start corrosion inside the metal through penetration or acting among the grains of the structure
- Galvanic corrosion occurring because of joining of two same, or different metals and large scale defects on the surface like flaking further enhance corrosion
- Structural and dimensional changes in the welded area are effective on the occurrence of corrosion
- The welding method employed is effective on occurrence of corrosion; therefore welding temperature and type of gas used determine the corrosion resistance
- Pre-welding surface characteristics (as grease, rust etc) play an important role on the occurrence of corrosion
- Welding seam type, single or double sided welding, welding design methods, welding temperature, gas-metal reactions and the properties of the base material are significantly effective on corrosion.
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