High Carbon Steel Welding

A Quick Insight Into Problems When Welding High Carbon Steels

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CARBON STEELS

WHAT IS CARBON STEEL?

- Carbon Steel is principally a mixture (or Alloy) of Iron and Carbon with small amounts of silicon, sulphur, phosphorous, and manganese. Other elements may be added to the steel to impart a specific quality to enhance its usefulness.

- An Alloy may be thought of as a recipe, similar to a recipe for chicken soup that has ingredients to enhance the flavour, Iron has other elements or ingredients to enhance the properties of the Iron.

- In plain carbon steels it is the Carbon additive that has the greatest effect on the strength and weld-ability of the steel.
CARBON STEELS

- The carbon is added to the Iron in varying amounts to harden or strengthen the steel. As carbon content increases the hardness and tensile strength increases and the ductility, plasticity, and malleability will decrease.

- The reason the carbon content or carbon recipe varies is to produce a family of steels that exhibit the desired characteristics for a given application.
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• HOW DOES THE AMOUNT OF CARBON AFFECT WELDABILITY OF STEELS?

• In general as the carbon content increases the weldability (how easily welded) decreases. In other words the higher the carbon content the more likely special procedures such as preheating, inter-pass temperature control and post-heating are necessary.

• The following chart groups carbon content, typical uses and weld-ability
<table>
<thead>
<tr>
<th>Group</th>
<th>Carbon Content %</th>
<th>Typical usage</th>
<th>Weldability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low carbon steel</td>
<td>0.15 Maximum</td>
<td>Welding electrodes, rivets and nails softer easily formed shapes.</td>
<td>Excellent weldability with all processes usually no preheat interpass or postheat necessary</td>
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</tbody>
</table>
# CARBON STEELS

| Medium carbon steel | 0.30 to 0.50 | Used for Machine parts, gears, and where parts may be hardened by heat treating. | Parts may be readily welded with all process if preheat, interpass temperature controls, and post heat recommendations are followed. Use Low hydrogen Electrodes and appropriate filler wire. Heat treating after welding may be applied. |
## CARBON STEELS

| High carbon steels | 0.50 to 1.0 | Springs, Dies, Railroad Track, Many tools, Band saws, and Knives. Also used where a sharp edge is required. | Usually require preheat, interpass temperature control and postheat. Special heating and cooling procedures in a furnace such as normalizing may be required to restore the properties of the metal after welding. High carbon Electrodes designed for welding tool steels or the specific alloy are readily available from welding supply companies. |

Note: As carbon increases steel toughness and welding precautions increase
The Heat Affected Zone (HAZ)

- WHAT IS THE HEAT AFFECTED ZONE AND HOW DOES IT AFFECT WELDABILITY?

- The heating and cooling action that occurs when welding is a form of heat treating in the localized area of the puddle and weld joint that may result in changes to the mechanical properties of the base metal and surrounding area.

- The area most affected by heating and cooling during welding is called the HEAT AFFECTED ZONE (HAZ)
The Heat Affected Zone

- The heating and cooling rate of welding directly under the arc is from the melting temperature to normal temperatures and may occur relatively quickly or methods may be used to slow the cooling rate of the joint. These methods include postheating the weld area with an oxy-fuel torch, blanketing the weld area, or using a precise heating and cooling method in a furnace or industrial setting.

- The more expensive and precise method of using a furnace under controlled conditions restores the mechanical properties of the weld joint and the surrounding base metal.

- The area surrounding the joint is heated to various temperatures depending on the distance from the arc, the heat input of the process and the number of weld passes.
The Heat Affected Zone

- The grains structure in the melted weld area may form a desirable size and shape, while the grain structure of the surrounding heat affected area may change to a less desirable shape and size and may cause cracking when welding on medium or high carbon steels.

- Often when welding a hardenable steel the heat affected area can harden to undesirable levels, while welding an already hardened steel may result in a softened heat affected zone with loss of desired hardness.
The Heat Affected Zone

- The heat affected zone may also have locked in stresses that can lead to problems when the welded structure is in service.
- Some industries employ a heat treating process called stress relieving to relieve residual stresses due to working or welding the structure.
- There are heat treating options such as annealing or normalizing that may be used to restore the grain structure of the welded piece.
The Heat Affected Zone

• **Characteristics of welded joints.**

• A welded joint contains a number of zones formed in the material of the welded components.

• These zones differ from the base material and among themselves in chemical composition, structure, physical and mechanical properties, microstressing, and macrostressing.
The Heat Affected Zone

- A welded joint made by fusion welding (Figure 4,a) exhibits a zone containing the weld metal, a fusion zone, a heat-affected zone, and a zone where the properties and structure of the base (parent) metal remain unchanged.
The Heat Affected Zone

- A welded joint formed by pressure welding (Figure 4,b) does not have a zone containing weld metal or a fusion zone.
- It consists of a joint zone, in which interatomic links have been formed between the joined components, a mechanically affected zone, and a zone of the adjacent base metal.