Industrial Technology
Virtual Learning

Advanced Metals/Heat Affect Zones

May 11, 2020

Heat Affected Zones: May 11, 2020

Objective/Learning Target:

This lesson provides objective, informative and practical information about the causes and effects of Heat Affected Zone. At the conclusion of this assignment students will participate in a Five question quiz to show their understanding of the subject.

Bell Ringer

Ingredients

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- **Instructions**
- **This experiment involves flames and very hot metal, which may stay hot for longer than you expect. Please make sure the experiment is done by a responsible person, and you take sensible precautions.**
- Straighten out four paper clips to get a feel for how stiff they are. Put one of these to one side, so that you can come back to it later.
- Take one paperclip and, staying at one place on the metal, bend it back and forth a few times.
- Use pliers to hold a second paperclip, then use a flame from a blow torch, bunsen burner or lighter to heat the end until it glows bright orange. Allow this to cool slowly. The paperclip will still be very hot, even after it has stopped glowing, so leave it on a plate for a few minutes to ensure it is fully cooled and safe to handle.
- Repeat this process for a third paperclip, but instead of letting it cool slowly, drop the glowing orange clip into a cup of water.
- Once all three paperclips are cool, try bending them again to see how stiff they feel.

Bell Ringer

- **Result**
- You should find:
- The first paperclip, which was not heated but bent back and forth, will have become stiffer.
- The second paperclip, which was allowed to cool slowly, should now feel less stiff.
- The third paperclip, cooled rapidly in water, is likely to feel stiffer than it did to start with.

Heat-Affected Zone

- Most metal cutting techniques are based on localized melting of the material. The area between the melted part and the unaffected base metal undergoes chemical and structural modifications. It's called the heat-affected zone (HAZ).
- It often can be recognized by a series of brightly colored bands, also visible near welds. Colors caused by surface oxidation, are an approximate indicator of the temperature the metal reaches.

Table Explains the Oxidation Colors when Steel is Heated.

Color	Temperature
Light Yellow	550 degrees F/290 degrees C
Straw Yellow	640 degrees F/340 degrees C
Yellow	700 degrees F/370 degrees C
Brown	735 degrees F/390 degrees C
Purple Brown	790 degrees F/420 degrees C
Dark Purple	840 degrees F/450 degrees C
Blue	1,000 degrees F/540 degrees C
Dark Blue	1,110 degrees F/600 degrees C

Colors (Heat Tint) Caused by Surface Oxidation Depend on Four Factors.

- **Steel chromium content.** This metal increases the material resistance to oxidation, and therefore colors are less intense.
- **Oxygen level.** During welding, usage of protective gas and an electrode coating can reduce the coloration because they partly shield metal from oxidation.
- **Surface condition**. If the surface is rough, it oxidizes faster, causing darker colors.
- **Surface contaminants**. Substances like paint, oil, rust, and even fingerprints can alter heat tint, but do not affect the extension of the HAZ.

What Causes of HAZ?

- The most important factor that influences the creation of the HAZ is **Thermal Diffusivity**. Thermal Diffusivity is how fast heat can be transferred across the metal. Greater the value of thermal diffusivity, faster is the heat passes through the metal.
- The extension of the HAZ depends on three factors:
  - 1. Quantity of heat applied.
  - 2. Duration of exposure.
  - 3. Area affected.

  If large amounts of energy are provided for a long time and with wider beams, the HAZ is larger.

Effects Caused by Different Cutting Techniques

- **Shearing and waterjet cutting -** Does not provoke a HAZ because they do not overheat the sheet metal.
- **Laser cutting -** Generates the smallest HAZ among all thermal cutting techniques because it applies heat on a very small area.
- **Plasma cutting -** Generates an intermediate HAZ because the plasma pulse is wider than a laser beam. Higher currents allow for a higher cutting speed, reducing the duration of exposure and the width of the HAZ.
- **Oxyacetylene cutting -** Generates the widest HAZ of all thermal cutting systems because of the intense heat, slow speed, and wide flames.

The Effects of HAZ

- **Oxidation -** The process or result of oxidizing or being oxidized. The most noticeable and immediate change of HAZ. It is also responsible for the brightly colored bands resulting in an increased hardness and decreased weldability of the metal.
- **Corrosion** - Metal corrodes when it reacts with another substance such as oxygen, hydrogen, an electrical current or even dirt and bacteria.
- **Embrittlement** - Loss of ductility of a material, making it brittle. Gas diffuses through the metal reducing its tensile strength and toughness.

References

- https://www.thefabricator.com/thefabricator/article/shopmanagement/all-you-need-to-know-about-the-heat-affected-zone
- https://www.twi-global.com/technical-knowledge/faqs/what-is-the-heat-affected-zone
- https://fractory.com/heat-affected-zone-causes-effects-reduction/

Quiz

Question #One

#1. HAZ stands for?

A. Heavy Air Zone.
B. Half Affected Zone.
C. Heat Affected Zone.
D. Here At Zoo.

Answer

C. Heat Affected Zone.

Question #Two

#2. HAZ is recognized by a series of bright color bands? (True or False)

Answer

True

Question #Three

#3. Using the **Color Chart**, how HOT is metal that appears to be Dark Purple?

Answer

840 Degrees F/450 Degrees C

Question #Four

#4. Which Cutting Technique affects HAZ the least?

Answer

Shearing and Waterjet Cutting

Question #Five

#5. What three factors does HAZ affect in metal?

A. Corrosion, Explosion, Flexibility.

B. Oxidation, Corrosion, Embrittlement.

C. Oxidation, Corruption, Embrittlement.

D. Corruption, Oxidation, PeanutBrittlement.

Answer

C. Oxidation, Corruption, Embrittlement.