Lesson 3: Brazing on Mild Steel

Fabrication and repair needs vary widely in agricultural mechanics. Brazing and braze welding processes provide valuable options for joining materials together. Before using these processes, it is important to understand how they work, the materials required, and the techniques used for producing a good joint. Your instructor must be present to demonstrate the step-by-step procedures for using these processes and guide you through them.

Safety Precautions for Brazing and Braze Welding

Before beginning to braze a joint, one should understand the various safety precautions associated with the process. The safety precautions that apply to cutting or welding with oxyacetylene also apply to brazing or braze welding with oxyacetylene. See Lesson 1 in this unit to review safety measures for welding. Below are safety precautions that are pertinent to brazing and braze welding.

- **Make sure the work area has excellent ventilation.** Fumes from the fluxes, filler metals, and base metal coatings may be toxic. They can harm the lungs, skin, or eyes. They can even cause death. Some fumes do not have an odor and the effects are not experienced until hours after exposure. Two examples of dangerous substances are zinc oxide (type of filler alloy) and cadmium (additive in some filler metals). A respirator may be required when these or other harmful substances are used. Consult the instructor and manufacturer's recommendations.
- **Avoid letting fluxes come into contact with skin.** Many fluxes are harmful to skin. Wearing protective clothing, gloves, and eye goggles will help eliminate the chances of contact. If fluxes do touch the skin, wash the area thoroughly with soap and water. If flux material gets in the eyes, rinse them thoroughly with water and seek medical attention.
- **Do not store or eat food in the work area.** Fumes from fluxes, filler metals, base metal coatings, and other chemicals may contaminate food, making it harmful to consume. Operators and others in the work area should wash their hands and face before eating or when finished with work.
- **Wear the same type of clothing and protective clothing when brazing as when welding or cutting.** This includes a long-sleeved shirt with collar and cuffs buttoned, long pants without cuffs, leather gloves and shoes, and other protective clothing as needed for brazing.
- **Wear goggles with filter lenses appropriate for the work being done.** To prevent eye burns from light rays, operators commonly wear lenses with shade no. 3 or 4 for torch brazing. Consult the instructor and manufacturer for specific recommendations.
- **Make sure that persons using acids or other cleaning solutions wear the appropriate protective gear.** Persons using acids or other chemicals to prepare the base metal for brazing and braze welding should wear rubber gloves, long sleeves, and goggles approved for use around chemicals.

Comparing Brazing to Other Processes

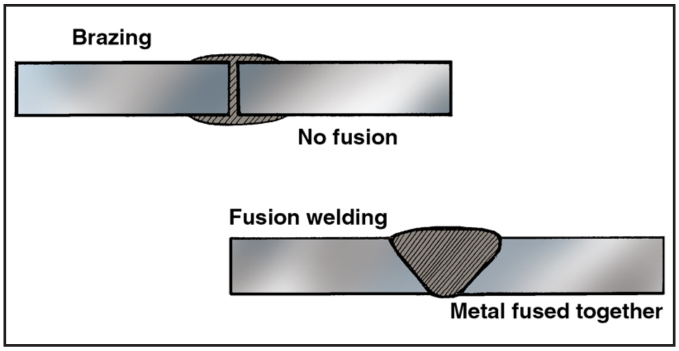
Many aspects of brazing, soldering, and braze welding are the same and sometimes these processes are referred to interchangeably. See Table 1 for the definitions and differences among the processes. The capillary action used in brazing and soldering is a physical process in which liquid filler metal is drawn into the space between

Table 1 – Differences Between Brazing and Other Processes

Process	Definition	Capillary Action	Melts Base Metal
Brazing	Joining materials by adding filler metal that becomes liquid at a temperature above 840° F but below the temperature at which the base materials start to melt.	Yes	No
Soldering	Same defnition as above, but the filler metal that is used becomes liquid at a temperature below 840° F.	Yes	No
Braze welding	Joining materials by running a braze pool to fill a groove or make a fillet.	No	No
Fusion welding	Joining materials by melting them together to form one piece.	No	Yes

two closely fitted surfaces. In braze welding, the filler metal does not fill the space in the joint by means of capillary action. Fusion welding, such as shielded metal arc welding and oxyacetylene welding, also are described in the table for comparison purposes. See Figure 3.1 for a comparison of brazing and fusion welding.

Figure 3.1 – Comparison of Brazing and Fusion Welding



Advantages and Disadvantages of Brazing

Common uses for brazing include producing joints that are leakproof, joining thin sheets of steel, and repairing broken or cracked castings. Knowing the advantages and disadvantages of brazing will help in deciding if it is the best process for the job.

Some of the advantages of brazing over fusion welding are the following.

- With brazing, a lower temperature can be used because the base metal does not have to melt. The lower temperature allows very thin parts to be joined together or thin parts to be joined to thick parts without damaging them. In addition, the heating time is reduced, there is less chance of warping the base materials, and stress in the joint is reduced.
- Dissimilar metals can easily be joined because the base metal does not have to melt. Two examples are joining copper to steel or cast iron to stainless steel. Nonmetals can also be joined to metals, such as a ceramic piece to steel.
- The joined pieces can easily be disassembled without damaging them. Reheating the filler metal allows the pieces to be pulled apart. Then the filler metal is wiped off and the parts can be reused. This capability is useful for realigning joints as well.

Some of the disadvantages of brazing as compared with fusion welding are the following.

- Brazed joints may not be as strong as similar joints made by fusion welding. The filler metals used for brazing are not as strong as the base metals they join; therefore, joints should not be designed to depend on the filler for strength.
- The lower service temperature of filler metal in brazing precludes its use on assemblies that will be exposed to higher temperatures. The service temperature refers to the highest temperature at which the material can be used.
- Filler metal used for brazing may not be as resistant to chemical solutions as the base metal. This would be a consideration when the assembly will be exposed to chemicals that might corrode the filler.

Functions of Flux

Using flux directly on the base metal or as a coating on filler metal is an essential step in brazing. Flux is used to remove the oxides from the filler and base metals and protect the joint from oxidizing during brazing. Another function of flux is to help the filler flow, spread evenly, and adhere on the base metal, which aids the capillary action. This is known as "wetting." Without a flux, the melted filler metal will bead up and roll off the base materials.

Factors in Choosing Flux and Filler

There are many factors to consider when choosing flux and filler. All the variables should be weighed in order to achieve the best overall result. The various types of flux are designed to function with specific base metals, filler metals, and in certain temperature ranges. Filler metals are made of various alloys that have varying brazing and service temperatures and are compatible with certain base metals. The compatibility of the flux and filler with the base metal is an important consideration because using incompatible materials can result in joints that corrode, are brittle, and lack strength. For example, the combination of brass filler used on stainless steel can result in a weak joint if heated too long. Check the manufacturer's information about the flux because some types can be harmful to skin or produce toxic fumes.

Fluxes are available in various forms, including powders, pastes, liquids, and as coatings on some filler metals. Filler metals are available as preformed shapes, powders, and as bare rods, or rods with flux already applied.

Materials Used for Brazing Mild Steel

A flux with a base of borax or borax and water (boric acid) is commonly used for brazing on steel. Brass, an alloy made of copper and zinc, is a filler metal commonly used on steel and other ferrous metals. Brazing filler metals are designated with a "B" followed by the chemical symbols of the elements of the alloy. For example, brass filler metal is designated as BCuZn. Bronze is an alloy made of copper and tin. Some brazing rods are called "bronze," but are actually made mostly of brass, with only small amounts of tin.

Techniques for Brazing and Braze Welding

Before beginning to braze or braze weld, it is important to know the general techniques used for the processes.

- Check the fit and alignment of pieces before they are brazed or welded. For brazing, a close fit of the pieces is essential so that capillary action can occur. The recommended clearance between pieces is from .001 in. to .010 in. A joint with a clearance that is too small or too large will be weak and may break under force. For braze welding, rules for the fit are the same as those for fusion welding. Whereas joints to be braze welded do not require as close a fit as brazed joints do, a good fit will produce a stronger joint.
- Clean base materials before brazing or braze welding. This step is essential for successful results in either process. Clean surfaces allow capillary action to take place during brazing. The flux must be applied immediately after the surfaces have been cleaned to eliminate further contamination. Mechanical or chemical methods or both are used to clean surfaces.
    - o Mechanical cleaning: Surface dirt is removed by grinding, sanding, and wire brushing. After mechanical cleaning, the base material should be washed and dried to remove particles knocked loose while cleaning.
    - o Chemical cleaning: Oil and grease are removed so that they are not ground into the surface by mechanical cleaning. Acids or other solutions can be used to remove rust and scale. This process is called "pickling." Chemical cleaning should be followed by washing and drying of the parts.
- Adjust the flame properly when brazing with a torch. A carburizing flame produces a joint with a neat appearance, but its strength may be weakened. An oxidizing flame produces a joint that is strong, but it may be rough looking. The torch adjustment depends on the job; however, in general, a neutral flame gives the best results for brazing and welding under normal conditions.
- Prevent overheating of the base material, filler, or flux when brazing with a torch. Brazing is performed by heating a large area, whereas fusion welding and braze welding are performed by heating a localized area. Acetylene produces a flame with a very hot inner cone but a relatively cool outer flame. If acetylene is used, care must be taken to avoid overheating a small area instead of heating a larger area uniformly. It is recommended to keep the torch moving over the surfaces rather than have it in one spot for too long. Overheated flux can stop working and contaminate the joint. If this occurs, the flux must be removed before continuing.

Summary

The safety precautions that apply in oxyacetylene welding also are used in brazing and braze welding. Brazing joins materials by means of capillary action and not melting the base materials. Braze welding is similar to oxyacetylene welding, but the base materials are not melted. A major advantage of brazing over fusion welding is that the materials that are joined are not damaged because a lower temperature is used. A disadvantage of brazing is that the joints are not as strong as those created in fusion welding and this limits its application. Fluxes and filler metals used for brazing are available in various types and forms, which are designed for specific metals and temperature ranges. Techniques for brazing with a torch include aligning and fitting the pieces closely, cleaning the base materials before brazing, properly adjusting the flame, and preventing overheating of the base materials.

Agricultural Mechanics

Credits

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