TORCH BRAZING FOR BRAZED HEAT EXCHANGERS

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Abstract: Torch brazing is commonly used on copper, brass, and other copper alloys, as well as steel, stainless steel, aluminum, carbides, and various heat-resistant materials. Brazing can be described as the joining of two components by a coalescence of the surfaces in contact with each other.

Keywords: brazing, filler metal, heat, exchanger

1. INTRODUCTION

Torch brazing utilizes a fuel gas flame as the heat source for the brazing process. The fuel gas is mixed with either air or oxygen to produce a flame, which is applied to the work piece until the assembly reaches the proper brazing temperature. Then, preplaced filler metal will be melted or hand-fed wire can be introduced.

Torch brazing is used with various base metals and on many different sizes of assemblies. The process offers any advantages, including:

- flexibility, in that one torch with multiple tips can be used to braze a variety of assemblies;
- low capital equipment cost (manual torch brazing);
- entire assembly does not have to be heated; small joints on large assemblies can be heated locally;
- automation is possible in many cases;
- most base metals and combinations of base metals can be torch brazed if a suitable flux is available.

Although the process provides versatile, low-cost heating for brazing, its limitations include:

- oxidation/discoloration can occur on surfaces of the assembly not covered with flux, because process is conducted in air;
- flux residues need to be removed after brazing;
- highly reactive materials, such as titanium and zirconium, cannot be torch brazed, because no flux is available;
- large assemblies can be difficult to heat, because of the localized nature of flame heating.

2. APPLICATION, EQUIPMENT AND TECHNIQUES

Torch brazing is commonly used on copper, brass, and other copper alloys, as well as steel, stainless steel, aluminum, carbides, and various heat-resistant materials. Most combinations of these materials can also be torch brazed. It is necessary to use flux with these materials, except when a phosphorus brazing alloy is used to braze pure copper parts. In this case, the phosphorus acts as the flux. The low-temperature silver-base and silver/copper/phosphorus filler metals are commonly used with torch brazing. Various other copper-base and gold-base filler metals can also be used with this process.

Torch brazing is often used to join copper and Bundy steel tube assemblies for the heating, air conditioning, and refrigeration industries. The process is also commonly used when brazing heat exchangers, bicycles, furniture, carbide tools, plumbing components, automotive subassemblies, medical instruments, and many other work piece types. A wide range of components can be torch brazed, including small joints for jewelry parts, large-diameter (75 mm, or 5 in.) tubes, and fitting joints. The process provides strong, leak-tight joints on a wide variety of base materials.

The equipment for torch brazing has several components. Single torches are typically used for hand brazing, whereas multiple torches can be used in an automated system. The gas-oxygen is mixed in the torch body and is adjusted using the needle valves on the torch. Gas-air combinations can be mixed at the torch or, alternatively, a central mixing system can be used to supply many torches, particularly in automated applications.

The typical fuel gases used in torch brazing are acetylene, propane, and methane (natural gas). Various flame temperatures and heat contents are given in Table 1.

Common fuel gases used in torch brazing - Table 1.

Fuel Gas	Formula	Raportul Oxigen-gaz de combustie	Flame temperature for oxygen	Heat content
			°C	mJ/m^3
Acetylene	C_2H_2	2,5	3087	55
Propane	C_3H_8	5,0	2526	104
Methane	CH_4	2,0	2538	37

An automated brazing system that can braze up to 40,000 heat-exchanger return bend joints per hour is shown in Fig. 1. Multiple torches are used to provide the necessary heat.

Fig. 1 Automated torch brazing system

Torch brazing gases are normally supplied from bulk sources. An individual gas cylinder may supply one torch, whereas large bulk tanks are used to supply many torches or an automated system utilizing many burners. In all torch brazing systems, regulators are used to safely control the gas distribution. Individual regulators are used on the gas and oxygen lines. Standard safety precautions should be utilized when handling the equipment, and operators should be thoroughly trained in safety practices related to the use of compressed and combustible gases.

The key to torch brazing, as in all methods of heating, is to heat evenly the components to be brazed. This may require directing the torch primarily on a large, rather than small, component. Because the filler metal will flow

to the hottest portion of an assembly, the flame should be applied in such a way as to flow the filler metal in the required direction.

When preplaced (preform or paste) filler metal is used in torch brazing, the operator need only know where and how much heat to apply. When the operator is also responsible for the filler metal, he must not apply it until the assembly has reached brazing temperatures. This may require practice and experience. Torch brazing is a skill that can be attained relatively quickly with the proper training.

3. SCHEMATIC REPRESENTATION OF A MANUAL TORCH BRAZING.

Schematic representation of a manual torch brazing is shown in figures 2, 3 and 4:

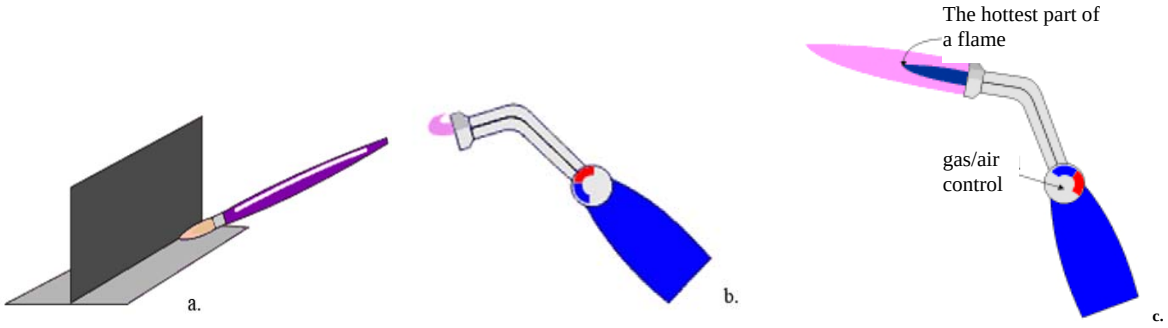

Fig. 2. Initiation of brazing operation:
a. application of flux; b. operate the burner; c. the burner parts

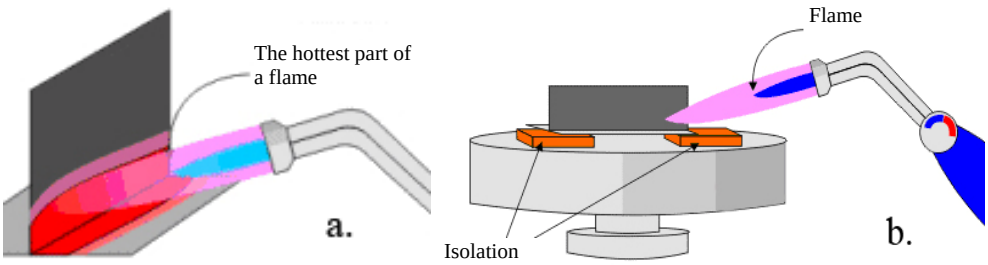

Fig. 3. Torch brazing preparation:
a. heating parts; b. parts position.

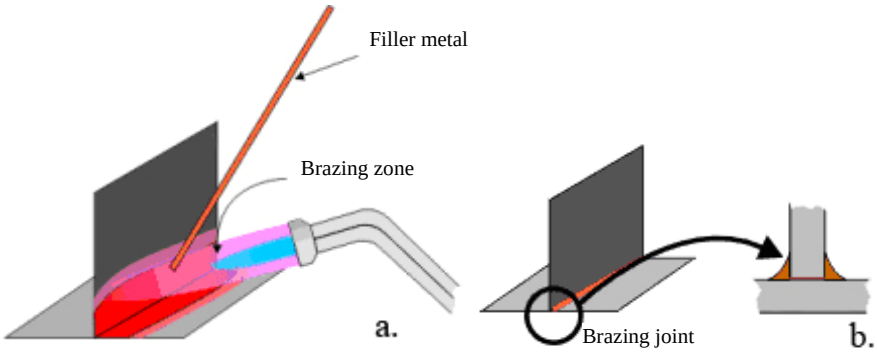

Fig. 4. Torch brazing operation:
a. filler metal application; b. torch brazing finalization.

Heat exchangers, particularly in the automotive industry, are fabricated from many different materials, such as copper, aluminum, copper-nickel alloys, steels, and titanium. Depending on the base metal selected, joint strength requirements, and assembly design, different brazing processes, such as torch, furnace, resistance brazing, and so on, can be used.

Temperature and humidity control within the atmospheres of space vehicles, space stations, and space suits can be realized with condensing heat exchangers. By use of the plate-fin design, units with high efficiency at minimum mass and volume may be tailored close to actual system requirements. Stainless steel cores, brazed together in vacuum with nickel base filler metals, are used to meet these requirements.

4. CONCLUSIONS

The use of high-performance materials in advanced engineering and manufacturing places demanding requirements on joining processes such as brazing and soldering. Appropriate design of the joints and proper selection of joining processes and filler metals can increase the application of brazed and soldered joints in sophisticated mechanical assemblies, such as aerospace equipment, chemical reactors, and high-value electronic assemblies.

The filler metal should be nobler than the base metal to minimize galvanic corrosion in the joint. Wetting and spreading are also important to prevent crevices that may generate crevice corrosion, especially when the environment has chloride ions in solution. The flux should be easily removed to avoid residues that can accelerate the corrosion rate in the joint.

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