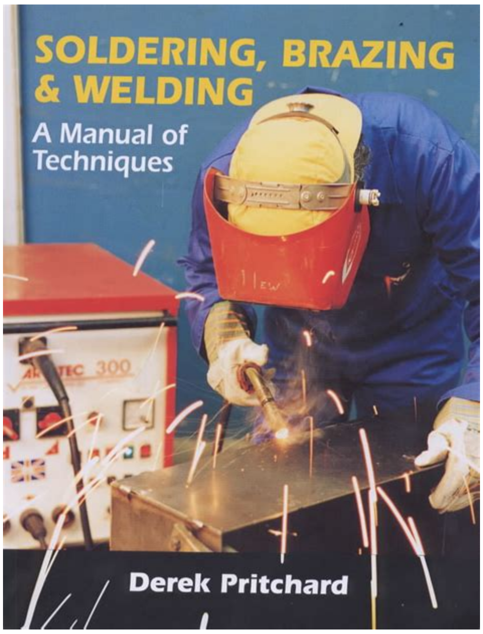

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Therefore, during the brazing process, you should take care to maintain a clearance between the base metals to allow capillary action to work most effectively. This means, in almost all cases— a close clearance. It shows how the tensile strength of the brazed joint varies with the amount of clearance between the parts being joined. Also, capillary action is reduced, so the filler metal may fail to fill the joint completely again lowering joint strength. Look at the chart again, and see that clearances ranging from.001" to.005" .025 mm to.127 mm still produce joints of 100,000 psi 689.5 MPa tensile strength. Brazed joints are made at brazing temperatures, not at room temperature. So you must take into account the "coefficient of thermal expansion" of the metals being joined. This is particularly true of tubular assemblies in which dissimilar metals are joined. Brass expands, when heated, more than steel. So if you machine the parts to have a room temperature clearance of.002".003" .051 mm.076 mm, by the time you've heated the parts to brazing temperatures the gap may have closed completely. The answer Allow a greater initial clearance, so that the gap at brazing temperature will be about.002".003" .051 mm.076 mm.. If the outer part is brass and the inner part steel, you can start with virtually a light force fit at room temperature. By the time you reach brazing temperature, the more rapid expansion of the brass creates a suitable clearance. Although there are many variables involved in pinpointing exact clearance tolerances for each situation, keep in mind the principle involved—different metals expand at different rates when heated. To help you in planning proper clearances in brazing dissimilar metals, the chart on the opposite page furnishes the coefficient of thermal expansion for a variety of metals and alloys. The rest are essentially modifications of these two. Lets look first at the butt joint, both for flat and tubular parts.http://amrithaayurvedhospital.com/userfiles/craftsman-lt1000-riding-mower-manual.xml

Preparation of this type of joint is usually simple, and the joint will have sufficient tensile strength for most applications. However, the strength of the butt joint does have limitations. It depends on the amount of bonding surface, and in a butt joint the bonding area cant be any larger than the crosssection of the thinner member. With larger bonding areas, lap joints can usually carry larger loads. Resting one flat member on the other is usually enough to maintain a uniform joint clearance. And, in tubular joints, nesting one tube inside the other holds them in proper alignment for brazing. However, suppose you want a joint that has the advantages of both types; single thickness at the joint combined with maximum tensile strength. You can get this combination by designing the joint as a buttlap joint. You wind up with a single thickness joint of maximum strength. And the joint is usually selfsupporting when assembled for brazing. It will be the crosssection of the thinner member. A good rule of thumb is to design the lap joint to be three times as long as the thickness of the thinner joint member. And a shorter lap will lower the strength of the joint.The formulas given below will help you calculate the optimum lap length for flat and for tubular joints. But in some joints, maximum mechanical strength may be your overriding concern. You can help ensure this degree of strength by designing the joint to prevent concentration of stress from weakening the joint. When youre designing a joint for maximum strength, use a lap to increase joint area rather than a butt, and design the parts to prevent stress from being concentrated at a single point. There is one other technique for increasing the strength of a brazed joint, frequently effective in brazing smallpart assemblies. Usually you dont want or need a fillet in a brazed joint, as it doesnt add materially to joint strength. It pays to create the fillet when contributing to spreading joint stresses.

And weve discussed various ways of achieving joint strength. But there are frequently other service requirements which may influence the joint design or filler metal selection. For example, you may be designing a brazed assembly that needs to be electrically conductive. A silver brazing filler metal, by virtue of its silver content, has very little tendency to increase electrical resistance across a properlybrazed joint. But you can further insure minimum resistance by using a close joint clearance, to keep the layer of filler metal as thin as possible. In addition, if strength is not a prime consideration, you can reduce length of lap.And its broader bonding area reduces any chance of leakage. Another consideration in designing a joint to be leak proof is to vent the assembly. Providing a vent during the brazing process allows expanding air or gases to escape as the molten filler metal flows into the joint. Venting the assembly also prevents entrapment of flux in the joint. Avoiding entrapped gases or flux reduce the potential for leak paths. If possible, the assembly should be selfventing. Since flux is designed to be displaced by molten filler metal entering a joint, there should be no sharp corners or blind holes to cause flux entrapment. The joint should be designed so that the flux is pushed completely out of the joint by the filler metal. Where this is not possible, small holes may be drilled into the blind spots to allow flux escape. The joint is completed when molten filler metal appears at the outside surface of these drilled holes. Keep joint clearances close and use a minimum amount of filler metal, so that the finished joint will expose only a fine line of brazing filler metal to the atmosphere. These are but a few examples of service requirements that may be demanded of your brazed assembly. As you can see both the joint design and filler metal selection must be considered.

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If they are “contaminated”—coated with oil, grease, rust, scale or just plain dirt—those contaminants have to be removed. If they remain, they will form a barrier between the base metal surfaces and the brazing materials. An oily base metal, for example, will repel the flux, leaving bare spots that oxidize under heat and result in voids. Oil and grease will carbonize when heated, forming a film over which the filler metal will not flow. And brazing filler metal won't bond to a rusty surface. Oil and grease should be removed first, because an acid pickle solution aimed to remove rust and scale won't work on a greasy surface. If you try to remove rust or scale by abrasive cleaning before getting rid of the oil, you'll wind up scrubbing the oil, as well as fine abrasive powder, more deeply into the surface. In most cases you can do it very easily either by dipping the parts into a suitable degreasing solvent, by vapor degreasing, or by alkaline or aqueous cleaning. If the metal surfaces are coated with oxide or scale, you can remove those contaminants chemically or mechanically. For chemical removal, use an acid pickle treatment, making sure that the chemicals are compatible with the base metals being cleaned, and that no acid traces remain in crevices or blind holes. Mechanical removal calls for abrasive cleaning. Particularly in repair brazing, where parts may be very dirty or heavily rusted, you can speed the cleaning process by using a grinding wheel, or file or metallic grit blast, followed by a rinsing operation. That way, there's the least chance for recontamination of surfaces by factory dust or body oils deposited through handling. Its use, with a few exceptions, is crucial in the atmospheric brazing process. Heating a metal surface accelerates the formation of oxides, the result of chemical combination between the hot metal and oxygen in the air.

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If you dont stop these oxides from forming, theyll inhibit the brazing filler metal from wetting and bonding to the surfaces. A coating of flux on the joint area guards the surfaces from the air, preventing oxide formation. It also dissolves and absorbs any oxides that form throughout heating or that were not completely removed in the cleaning process. Understanding the functions and stages of flux will help you achieve strong, quality joints in your operation. Flux traditionally is made in a paste, so its usually most convenient to brush it on. But as production quantities increase, it may be more effective to apply the flux by dipping or dispensing a premeasured deposit of highviscosity dispensable flux from an applicator gun. Why dispensable flux. Many companies find the repeatable deposit size improves joint consistency, and because typically less flux is used, the amount of residue entering the waste stream is also reduced. Watch our new technical video for an indepth look at the four functions of flux. That way the flux has least chance to dry out and flake off, or get knocked off the parts in handling. Which flux do you use. Choose the one formulated for the specific metals, temperatures and conditions of your brazing application.Black flux is beneficial for fast induction heating, may provide better protection in a hightemperature brazing operation, and can be helpful with highliquidus filler metals. Lucas Milhaupts technical staff demonstrates the difference between white versus black flux in this video. Keep in mind that the larger and heavier the pieces brazed, the longer the heating cycle will take so use more flux. Lighter pieces, of course, heat up faster and require less flux. As a general rule, dont skimp on the flux. Its your insurance against oxidation. Think of the flux as a sort of blotter. It absorbs oxides like a sponge absorbs water. An insufficient amount of flux will quickly become saturated and lose its effectiveness.

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A flux that absorbs less oxides not only insures a better joint than a totally saturated flux, but it is a lot easier to wash off after the brazed joint is completed. Bright metal surface is visible underneath. Test the temperature by touching brazing filler metal to base metal. If brazing filler metal melts, assembly is at proper temperature for brazing. The atmosphere such as hydrogen, nitrogen or dissociated ammonia completely envelops the assemblies and, by excluding oxygen, prevents oxidation. Even in controlled atmosphere brazing you may find that a small amount of flux improves the wetting action of the brazing filler metal. Now you have to hold them in position for brazing. Be sure they remain in correct alignment during the heating and cooling cycles, so that capillary action can do its job. If the shape and weight of the parts permit, the simplest way to hold them together is by gravity. Or give gravity a helping hand by adding additional weight. Design it for the least possible mass, and the least contact with the parts of the assembly. A cumbersome fixture that contacts the assembly broadly will conduct heat away from the joint area. Since these are poor conductors, they draw the least heat away from the joint. At the initial planning stage, design mechanical devices that will accomplish this purpose, and that can be incorporated in the fabricating operation. Typical devices include crimping, interlocking seams, swaging, peening, riveting, pinning, dimpling or knurling. A simple mechanical holding device is the best, since its only function is to hold the parts together while the permanent joint is made by brazing. Proper fixtures should meet these criteria Brazing experts at Lucas Milhaupt offer these tips for improving your joint design Unfortunately, molten flux reaches the bottom of the blind hole and is trapped there, as alloy melts and tries to enter the joint.

The alloy cannot displace the flux, so heavy flux inclusions and poor joint quality result. The alloy is induced by heat to flow to the top of the joint, pushing the flux out. This leaves the hole open and results in a sound joint. Take into account the expansion and contraction characteristics of the metals being joined. If possible, design the joint so the higherexpansion material is the outer member of the joint. It will expand more than the inner member, providing clearance where the filler metal will flow. Many products manufactured today could be redesigned for brazing to reduce manufacturing costs. Even though silver is expensive, it represents a small percentage of total assembly costs. If they are required, keep them out of the heat zone, so they will not be affected by flux residue or oxidation. In addition, proper joint design is the path to efficient fixturing. It involves heating the assembly to brazing temperature, and flowing the filler metal through the joint. The heating method most commonly used in brazing a single assembly is the hand held torch, therefore most of this guide will focus on manual brazing practices and principles. However, if you need assistance with furnace brazing, please see our furnace atmosphere blog. If you’re brazing a small assembly, you may heat the entire assembly to the flow point of the brazing filler metal. If you’re brazing a large assembly, you heat a broad area around the joint. When joining a heavy section to a thin section, the “splashoff” of the flame may be sufficient to heat the thin part. Keep the torch moving at all times.When it comes to safely brazing with oxyacetylene torches, lets look at two important aspects safety equipment, plus procedures for safe operation. This is serious business arc rays and sparks can result in loss of sight, fume inhalation can lead to lung damage, and other accidents can cause burns, fires, or explosions.

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Oxygen cylinders, typically painted green, contain oxygen compressed up to 2,200 psi pounds per square inch. Oxygen is a stable compound by nature, but any oil or grease which comes in contact with the oxygen will burst into flames. Therefore, keep hands and gloves free of these materials before handling cylinders. Acetylene gas cylinders are compressed at only about 250 psi, which is much lower than oxygen tanks. However, unlike oxygen, acetylene is rather unstable and, therefore, should not be introduced into the torch above 15 psi. As an extra precaution, cylinder valves should be open no more than 1.5 turns, in the event an operator must close a valve quickly. Turn keys or knobs on the regulators allow adjustment of the outlet pressure. Again, the setting should be no more than 15 psi for acetylene. Consult the torch manufacturer for proper pressure settings for acetylene and oxygen. Alternatively, check valves can be placed between the gas hoses and the torch. Please note that check valves can stop reverse gas flow, but they cannot stop flame in the event of a flashback. Flashback arrestors contain cutoff valves with low melting points. When triggered by flame, they readily shut off the gas supply and thus extinguish the flame. Both check valves and flashback arrestors should be tested or changed regularly to ensure they are working properly. Keep acetylene and oxygen separate until the torch is ignited. When starting a torch, the acetylene valve should be opened first. Next, the torch should be ignited, and then oxygen can be introduced. Please note that opening both gas valves prior to ignition can cause gas backflow into either gas hose, leaving the system vulnerable to flashback. If using dual torches to heat both sides of a part, do not aim the torches at each other, but rather, angle each torch toward the part.

If one torch should cause flashback in the other, operators will hear a loud hissing sound and should immediately turn off the gas by closing first the acetylene valve and then the oxygen valve. Others are poor conductors and tend to retain heat and overheat readily. The good conductors will need more heat than the poor conductors, simply because they dissipate the heat more rapidly. If the flux changes in appearance uniformly, the parts are being heated evenly, regardless of the difference in their mass or conductivity. Now you are ready to deposit the filler metal. The heated assembly will melt off a portion of the filler metal, which will instantly be drawn by capillary action throughout the entire joint area. This can be accomplished by either brushing on or dipping the rod in flux. On larger parts requiring longer heating time, or where the flux has become saturated with much oxide, the addition of fresh flux on the filler metal will improve the flow and penetration of the filler metal into the joint area. Molten brazing filler metal tends to flow toward areas of higher temperature. In the heated assembly, the outer base metal surfaces may be slightly hotter than the interior joint surfaces. So take care to deposit the filler metal immediately adjacent to the joint. If you deposit it away from the joint, it tends to plate over the hot surfaces rather than flow into the joint. In addition, it's best to heat the side of the assembly opposite the point where you're going to feed the filler metal. In the example above, you heat the underside of the larger plate, so that the heat draws the filler metal down fully into the joint. Always remember—the filler metal tends to flow toward the source of heat. The following welltested precautions should be followed to guard against any hazard from these fumes. Full flux coverage reduces fuming. Also, consult your SDS regarding specific hazards associated with brazing flux.

Intense localized heating uses up flux, increases danger of fuming. Apply heat only to base metals, not to filler metal. Direct flame on filler metal causes overheating and fuming. Zinc coatings galvanized will also fume when heated. Learn to recognize these coatings. It is recommended that they be removed before parts are heated for brazing. Consult Pages 3437 or the Safety Data Sheet SDS for maximum recommended brazing temperatures of a specific filler metal. The filler metal carries a warning label. Be sure to look for it and follow the instructions carefully. And cleaning is usually a twostep operation. First— removal of the flux residues. Second— pickling to remove any oxide scale formed during the brazing process. Best bet is to immerse them while they're still hot, just making sure that the filler metal has solidified completely before quenching. The glasslike flux residues will usually crack and flake off. If they're a little stubborn, brush them lightly with a wire brush while the assembly is still in the hot water. This step can be crucial since most fluxes are corrosive, such as the pictured refrigeration line corrosion. This joint would fail during service. The joint would leak soon after being placed into service. This leads to corrosion. What is the best cleaning method. You can remove excess flux by various means; the most costeffective approaches involve water. Therefore, brazing fluxes are typically designed to dissolve in water. When soaking is not possible, use a wire brush along with a spray bottle or wet towel. When using a soak bath of any kind, change the solution periodically to avoid saturating the cleaning solution. When quenching a brazed part in hot water, take care to avoid compromising the braze joint. Quench only after the braze filler metal has solidified to avoid cracks or rough braze joints. Note that quenching can affect base material mechanical properties.

Do not quench materials with large differences in coefficients of thermal expansion to avoid cracks in the base materials and tears within the braze alloy. Additional cleaning methods include For chemical soaks, monitor the pH level to determine when to change the solution. Be advised that soft metalsincluding aluminumrequire extra care, as they are vulnerable to the embedding of particles. Some metal groups achieve a desired effect from a special treatment after cleaning. Stainlesssteel and aluminum parts, for example, may benefit from chemical immersion to improve surface corrosion resistance. Then the flux becomes totally saturated with oxides, usually turning green or black. In this case, the flux has to be removed by a mild acid solution. Simply agitate the brazed assembly in this solution for 30 seconds to 2 minutes. No need to brush. A word of caution, however—acid solutions are potent, so when quenching hot brazed assemblies in an acid bath, be sure to wear a face shield and gloves. The best pickle to use is generally the one recommended by the manufacturer of the brazing materials you're using. Highly oxidizing pickling solutions, such as bright dips containing nitric acid, should be avoided if possible, as they attack the silver filler metal. If you do find it necessary to use them, keep the pickling time very short. Will work on carbon steels, but if pickle is contaminated with copper, the copper will plate out on the steel and will have to be removed mechanically, This sulphuric pickle will remove copper or cuprous oxide stains from copper alloys. It is an oxidizing pickle, and will discolor the silver filler metal, leaving it a dull gray. This HCl pickle is not like bright dips on nonferrous metals. The phoscopper and silverbearing phoscopper filler metals are different, and then only when used on copper without flux. In this case, a hard copper phosphate slag forms in small globules on the metal surface.

Prolonged pickling in sulphuric acid will remove this slag, but a short pickle in 50% hydrochloric acid for a few minutes is more effective. When the brazed joint is to be plated or tinned, the removal of the slag is absolutely essential. A final mechanical cleaning, therefore, is advisable for work which is to be plated. This step is crucial for several reasons; including the corrosive nature of most fluxes and the possibility that excess flux could contribute to joint failure.Your methodology will depend on the application, service and enduser requirements plus regulatory codes and standards. Be sure to state acceptance limits in terms of minimum requirements. Pressure or bubble leak testing involves the application of air at greaterthanservice pressures. Vacuum testing is useful for refrigeration equipment and detection of minute leaks, employing a mass spectrometer and a helium atmosphere. If you are unable to develop an accurate and dependable method of inspecting a critical brazed joint, consider revisiting your joint design to allow adequate inspection. Both nondestructive and destructive methods may be employed, depending on the application, service and enduser requirements plus regulatory codes and standards. The assembly is ready for use, or for the application of an electroplated finish. In the few instances where you need an ultraclean finish, you can get it by polishing the assembly with a fine emery cloth. If the assemblies are going to be stored for use at a later time, give them a light rustresistant protective coating by adding a water soluble oil to the final rinse water. And we've gone into a fair amount of detail in order to be as informative as possible. To get a more balanced picture of the overall brazing process, it's important to note that in most daytoday brazing work, these steps are accomplished very rapidly. Newlyfabricated metal parts may need no cleaning at all.

When they do, a quick dip, dozens at a time, in a degreasing solution does the job. Fluxing is usually no more than a fast dab of a brush or dipping ends of the parts in flux. Heating can often be accomplished in seconds with an oxyacetylene torch. And flowing the filler metal is virtually instantaneous, thanks to capillary action. Finally, flux removal is generally no more than a hot water rinse, and oxide removal needs only a dip into an acid bath. And, as we'll see later on, these economies in time and labor are multiplied many times over in high production automated brazing. The pure speed of brazing represents one of its most significant advantages as a metal joining process. These cookies are also used to ensure we show you advertising that is relevant to you. If you continue without changing your settings, you are agreeing to our use of cookies to improve your user experience. You can click the cookie settings link on our website to change your cookie settings at any time. Cookie Policy This information is collected in the form of cookies. The information collected does not identify you directly, but it can give you a more personalized website experience. The following describes the different types of cookies we are using and gives you the option to not allow some types of cookies. Click on the category headings to learn more and change your default cookie settings. Please note that blocking some types of cookies may impact your website experience. Without these cookies, website services, such as remembering your shopping cart items, cannot be provided. We are unable to turn these cookies off in the system. While you may be able to set your browser to block or alert you about these cookies, some parts of the website will not function without them. They help us understand what pages are the most popular. All of the information collected is aggregated and therefore anonymous. If you do not allow these cookies, we will not know when you have visited our website.

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