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HOT AIR WELDING GUIDE FOR PLASTIC REPAIRS

Introduction



Most motor vehicles built today as well as many other modern products have components made from plastics. For example, in automobiles and truck, bumpers, grilles, spoilers, light surrounds and even complete body panels enable designers to enhance aerodynamic styling and cosmetic appeal while retaining impact resistance and eliminating corrosion.

Plastic offers the structural strength of steel by virtue of its greater elasticity. Minor impacts that could deform steel beyond repair can be absorbed by plastic. Where damage is incurred, repair by welding is possible without a loss of component strength.

Cracks, splits, warping and even the loss of material can be remedied with the aid of the **BAK RION** type hot air welding equipment. Where a steel component, with the equivalent damage, would be renewed at some cost, the repair of the plastic part can save time and expense, particularly when winter accident periods make great demands on the repairer's parts stock.

A plastic component can be quickly restored to an "as new" condition without the need for fillers or special treatments. The combination of welding and the recommended repaint procedures will show no trace of a repair that should last the life of the vehicle.

BAK hot air welders and accessories are commercially available and can be purchased online from dealer such as Best Materials: http://www.bestmaterials.com/

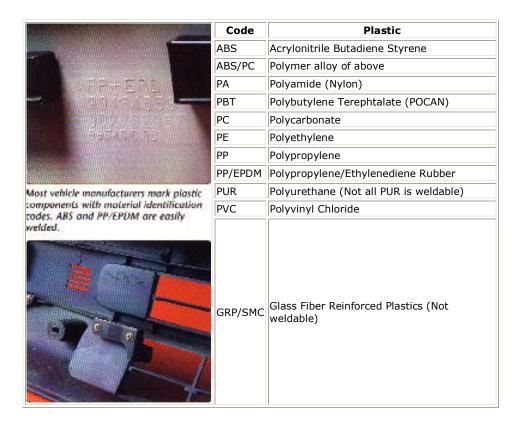






Identifying Plastics

The majority of plastics used in the motor vehicles vehicle are thermoplastics. Heated until they soften, they can be molded or welded. There are different types of thermoplastics, each having a specified temperature for welding operations.



Plastic Recognition by Test Welding

If all other information is unavailable, a test weld can be tried on the back of the component using a known plastic welding rods rod type.

Method

- 1. Fit the appropriate welding nozzle for the selected welding rod to the BAK RION hot air tool.
- 2. Set the welding temperature on the rotary control according to the welding rod material to be employed in the test (see Table in Main Welding section). Allow the tool to attain the operating temperature.
- **3.** Scrape the surface in the area of the test to remove any contamination.
- **4.** Feed the welding rod through the nozzle and into contact with the surface of the component.
- **5.** Following the technique described in <u>Main Welding</u> operations, weld 2cm of the test rod to the surface of the component.
- **6.** Remove the welding tool from the rod and then cut the rod approximately 2cm from the component surface.
- **7.** Allow the weld to cool and then try to pull the rod from the surface of the component. If it can be pulled from the component, repeat the test with a different rod. If it stays firmly in place, the component plastic has been positively identified.





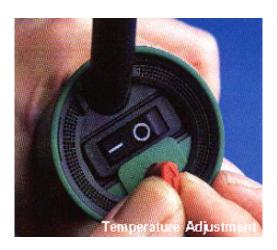


Appearance

Because plastic welding rod does not become completely molten, it may appear much the same before and after welding. One accustomed to welding metal a plastic weld may see the weld as appearing incomplete. The reason is that only the outer surface of the rod has become molten while the inner core has remained hard. The welder is able to exert pressure on the rod forcing it into the joint to create a permanent bond. When heat is taken away the rod reverts to its original form. Thus, even though a strong permanent bond has been obtained between the welding rod and base material, the appearance of the welding rod is much the same as before the weld was made, except for molten flow patterns on either side of the bead.

Temperature Control

Welding temperature can be precisely controlled in the BAK welder to accommodate most any plastic material. Adjustment is made by the Potentiometer Control Setting. Measurement can be easily checked with a thermocouple:



Thermoplastic Code	Welding Temperature °C	Tack Weld Nozzle 28	Pendulum Weld Standard Nozzle 31A	Speed Weld Nozzle 27 (3mm)	Speed Weld Nozzle 27B (5.7mm)
ABS	350	3.4	3.4	4.0	4.2
ABS/PC	350	3.4	3.4	4.0	4.2
PA	400	4.1	4.1	4.6	4.8
PBT	350	3.4	3.4	4.0	4.2
PC	350	3.4	3.4	4.0	4.2
PE hard (HDPE)	300	3.0	3.0	3.3	3.5
PE soft (LDPE)	270	2.8	2.8	2.8	3.0
PP	300	3.0	3.0	3.3	3.5
PVC hard	300	3.0	3.0	3.3	3.5
PVC soft	350	3.4	3.4	4.0	4.2







Most all thermoplastics can be welded. The quality or ability to be welded is governed by the extent of their melting range; those with the widest melting range are easiest to weld. The two most popular thermoplastics for fabrication are polyvinyl chloride (PVC) and polypropylene. Here is a list of plastic welding temperatures (in centigrade, when welded at 20C):

ABS 350°C
Acrylic 350°C
Hard PVC 220 - 300°C
Hypalon 600°C
Lucobit 600°C
Polycarbonate 350°C
Polyethylene (Hard) 250 - 280°C
Polyethylene (Soft) 270 - 300°C
Polyisobutylene 600°C
Polypropylene 300°C
Polystyrol 250°C
Polyvinylidene Fluoride 350°C

Selection of Tips

Many tip shapes and sizes are available for all types of welding conditions. A complete selection can be found here:

 $\underline{\text{http://www.bestmaterials.com/SearchResult.aspx?categoryid=1182}} \text{ and }$

http://www.bestmaterials.com/bak-welder.aspx







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Surface Preparation

Simple preparation steps will insure successful repairs.

Plastic components can be repaired from the front or rear according to ease of access. Reinforcement welds can be used across the rear of a front repair to restore strength to areas designed to withstand impact. The photographs on the following web pages demonstrate a repair on the front of a component.

If the damage passes behind a decorative or protective trim, this must be removed from the damaged component to provide complete access to the repair area.

Trims are usually fixed with an adhesive that softens with heat treatment. Attempting to remove a trim that is cold can damage it beyond repair.

The **BAK RION** hot air tool can supply 230 liters of air per minute at a precise temperature between 20°C and 700°C. For trim removal, the hot air tool is used without a welding nozzle at a temperature setting of 300°C. The temperature charts on the tool body show the rotary control setting to achieve the correct air temperature.

Whenever the hot air tool is in use, the end of the element housing becomes extremely hot. Always rest the tool on its stand when not in use.

Moving the hot air tool over the trip surface aids even heat absorption to soften the adhesive. It also prevents localized heat build-up. When the adhesive is soft, the trip should pull away neatly and allow for reuse after the repair.

Welding Groove

As in most welding, 90° V-shaped groove is used. It must be prepared along the crack to accept the welding rod and form strong repair.



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Begin by removing any paint or other coating from the repair area with a body file or sander. An area 10 to 15mm around the damage should be sufficient. If sections of the material have been impacted and become trapped, the application of heat up to 200°C will help to free them. A screwdriver blade can also be used to free trapped sections.

The 'V' groove can be formed with careful use of a square-edged file, but the best tool is a rotary burring bit with a cutting edge on its circumference and end face. This creates the 90-degree groove in one operation even following the most erratic of crack courses.

Begin the groove up to 10mm beyond the start of the crack and increase the depth progressively to maximum by the time the start of the crack is reached. The depth of the groove should be no more than 2/3 of the thickness of the material.

Best results are obtained when a high speed drill is employed. A slow drill or the use of a single cutting face burring tool may lead to it jumping from the groove.

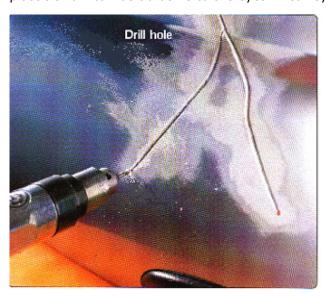
During the burring operations, always wear eye protectors and a dust mask to prevent irritation from fine particles of plastic.

When the groove is finished, the welding rod for the material should rest neatly in it, the upper curve face of the rod protruding 1 to 2 mm above the surface of the repair. This allows for weld dressing operations, eliminating the need for fillers and ensuring enough depth of penetration for the rod.

This test relates to larger components, such as bumpers, where a 5mm profile welding rod should be used. If a 3mm welding rod is used, more than one run may be necessary. For small or thin-walled components, one run of 3mm rod may be sufficient.

Crack Prevention

After removing decorative trims and adhesive, the end of each crack or split should be drilled with a maximum 3mm diameter drill to prevent further lengthening of the crack. Remember, plastic swarf can be abrasive to the eyes. Wear eye protectors.



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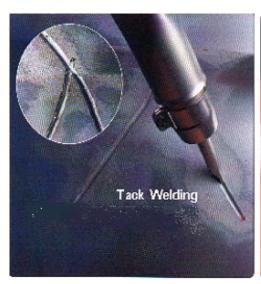


Missing Material

Where small sections of plastic are lost, a piece can be used from a spare, unsalvageable part of the same material. This can be shaped and inserted, though success will depend on the availability of spare plastic, the intricacy of the design, and the experience of the operator.

Tack Welding

Welding operations are completed in two stages. First, tack weld the base of the crack. The heat knits the sides of the crack together and holds both sections of the component in alignment.





A Tack welding nozzle 28 (push fitted onto the standard nozzle of the **BAK RION**) is used at the temperature specified for the material (see table). The weld is best completed in one continuous run from end to end, drawing the welding nozzle tip along the base of each 'V' groove.

The sole of the nozzle should be inclined at an angle not exceeding 20° to the groove base. As the nozzle is drawn along, hot air softens the plastic below the heel of the nozzle and the toe draws the softened material together.

Avoid applying pressure to the weld via the tool, as the material at the base of the groove is thin and not strong. While tack welding, minor misalignment of the panel sides or newly inserted material can be corrected by holding the sections in position until the weld has knitted and cooled.

After each welding run, brush the nozzle clean with a brass suede brush. Remove any difficult residue by increasing the heat level to maximum to soften it.

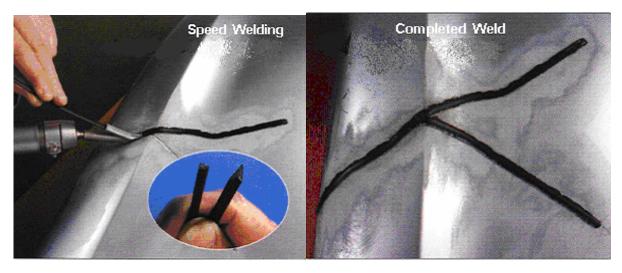






Main Welding

The most important rule in plastic welding is that it is only possible to weld like with like. Hence the need to identify the plastic material and select a matching welding rod.



The main welding operation begins with preparation of the welding rod. Cut the end to a pencil point using a trimming knife or side cutters; this provides a progressive fill in the 'V' groove, particularly where it starts in the center of a panel, preventing the formation of bulbous protrusions of plastic.

Fit speed welding nozzle 27B to the **BAK RION** hot air tool, set the correct temperature for the material and allow the tool to warm up for two minutes before starting.

Insert the trimmed welding rod through the nozzle feeder until approximately 5mm protrudes on the underside. Hold the tool so that the speed welding nozzle sole runs along the crack parallel to the component surface.

The protruding rod must be held beyond the start of the 'V' groove so that heat is directed onto the start point for welding.

When the surface plastic shows signs of slight "wetting", move the welding nozzle along the groove. The nozzle toe should rest on the rod in the groove while under the heel and there should be an air gap of 3mm. Feed the rod steadily into the nozzle with a downward hand pressure of about 2.5Kg, sufficient to push the softened rod into the groove. To judge what a pressure of 2.5Kg feels like, take a short piece of weld rod and use it to press down on a set of scales until 2.5Kg registers. (Do not apply downward force to the weld via the hot air tool itself). Wherever possible, the weld should be completed in one continuous run along the contour of the crack.

Correct mating between the welding rod and the material occurs when the rod is seen to soften and the new rod moves down the nozzle feed. As the rod melts into the groove, two smooth, continuous ridges will appear at the edges, accompanied by a slight wash at the sides of the weld. Do not move too quickly, failing to create a wash, nor too slowly, thereby overheating and even scorching or distorting the plastic.







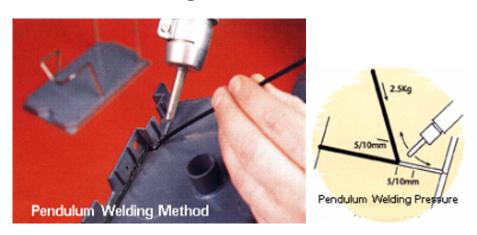
When the weld has been completed, remove the hot air tool, sliding the nozzle off the remaining welding rod. Once cool, the unwelded rod end is cut off as close to the weld as possible.

The completed weld appears as a smooth, continuous line with the wash still visible alongside it, confirming that the rod has welded successfully with the component.

During the welding, previously unseen cracks may open up. These are not new but are impact cracks that have been present since the initial damage. These must be treated and welded as any other crack damage.

If the weld is successful, reinforcement welds can be added to the reverse of the material across the axis of the repair. The same preparation and weld operations apply.

Pendulum Welding



Where cracks or splits pass through tight corners, it may be difficult to use the normal speed welding nozzle. In such cases the technique of pendulum welding is effective.

Prepare the crack in the normal way, then feed the welding rod manually into the 'V' groove at an angle of between 80 and 90 degrees to the groove. Exert about 2.5 Kg downward force on the rod while playing the hot air tool, fitted with standard nozzle 31A, onto the base of the rod and into the 'V' groove in a constant pendulum action. The bias of the action is determined by the comparative thicknesses of the component material and the welding rod.

Both must be in the same molten state at the point of fusion. Dressing and finishing is the same for speed welded material.







Welding Defects

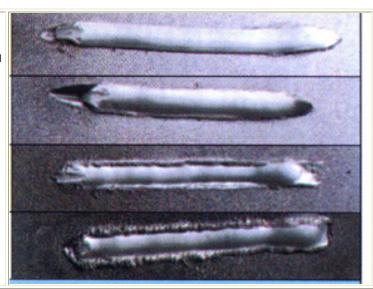
The table and pictures below detail common causes of weld defects.

The weld was started correctly but completed too quickly. No wash indicates haste or too low a temperature.

The hot air tool was not allowed to attain the correct operating temperature and the weld was finished too soon, leaving a hole.

Too much pressure has been applied to the rod, leaving a low and deformed bead. Filling may be necessary.

The welding temperature was too high, blistering the sides of the weld. The repair area may be brittle.



Welding Defects and Causes

Poor weld penetration or poor bonding	Incorrect weld site preparationWeld speed too fast/temperature too lowWeld attempted with dissimilar materialsPoor technique	Uneven weld bead width Charred weld	Welding rod stretched Uneven pressure applied to welding rod Welding speed too slow Temperature too high	Warping	Repair area overheated Parts fixed under tension Poor site preparation
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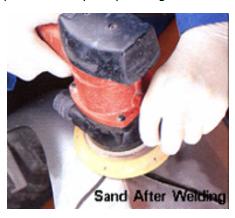




Weld Dressing

A successful weld forms a slightly raised, smooth, even bead across the component surface. Welds must be flatted only when they are cold; warm welds clog the sanding disc.

Remember that plastic is a soft material that yields easily to abrasives. For this reason, use a 120 grit disc first, then progress to 180 and finally 320 to produce a smooth finish. Always use new, clean, sharp papers. Allow a 7 to 10cm margin around the weld area for dressing to provide a key for painting.









Painting Plastics

There are many paint schemes that are suitable for use on plastic components. Check with the vehicle manufacturer for approved schemes.

Surface preparation prior to painting can be completed with fine grade abrasive paper, followed by a thorough cleaning which is essential for good paint adhesion. Cleaning agents should be compatible with the recommended paint scheme.

A repaired plastic component should be completely repainted to ensure invisibility of the repair.

The finished component should be as strong as the original and provide an unblemished cosmetic finish.

