Welding Job Knowledge

Hot gas welding of plastics: Part 2 - welding techniques

See also: Hot gas welding of plastics: Part 1 - the basics

Fig.1. Plastics welding nozzles (left to right) tacking nozzle, round nozzle, high speed nozzle

Introduction

Hot gas welding is a fabrication process for thermoplastic materials. The process uses a stream of heated gas, usually air, to heat and melt both the thermoplastic substrate and the thermoplastic welding rod. The substrate and the rod fuse together to produce a weld. To ensure that welding takes place, adequate temperature and pressure must be applied to the rod, along with the correct welding speed and gun position. The overall welding operation consists of three main phases: substrate and rod preparation, welding and, finally, weld finishing. The final stage is not a necessary requirement and is dependent upon the application. There are two types of hot gas welding for thermoplastic materials, round nozzle welding and speed welding. In the first, the welding gun is used with a round nozzle attached and in the latter, a second nozzle is attached to the round nozzle and is used to heat the welding rod at the same time as the operator applies welding pressure through the tip. *Figure 1*shows a range of welding nozzles.

Material preparation

The first phase of welding is preparation of the substrate materials and the welding rod. It is important to ensure that both are clean. This is helped by ensuring good storage procedures in a clean and dry environment. Before preparing the substrate it is important to check that any protective film is removed from the surface. Once the film is taken off, a scraper can be used to remove the surface layer of the material in the vicinity of the weld. When selecting the materials for welding, the rod and substrate materials must be of the same polymer type.

If required, for example if the butt joint is used, an appropriate weld preparation should be added to the edge of the material before the scraping operation. Where the material thickness is less than 6mm, the preparation will generally be a 60° single-V chamfer. If the material thickness is greater than 6mm, then a 60° double-V preparation is used. When the joint is in a T configuration, it is not necessary to prepare the edges with a chamfer, although it is still important to scrape both the substrate materials in the vicinity of the weld to remove any surface contamination.

Once the materials are prepared, the adjacent surfaces are abutted together and tacked into position using the tacking nozzle. Tacking should be sufficient to hold all the pieces of the fabrication together prior to welding. It should be noted, however, that tacking alone should not be relied upon as the only method of holding the materials whilst welding. It is important to use additional clamps for this purpose. Once the substrates are assembled, the materials can be permanently welded together using either the round nozzle or speed welding techniques.

Round nozzle welding

In hot gas round nozzle welding, or hand welding as it is sometimes known, the rod is fed into the joint by hand. The nozzle is moved in a pendulum motion along the joint and up the welding rod, heating both the joint and rod as the weld is progressed. *Figure 2* shows round nozzle hot gas welding.

Fig.2. Hot gas round nozzle welding

When using this method it is important to maintain a constant pressure on the welding rod and a constant welding speed across the substrate. Generally, this can be helped by ensuring that you are in a comfortable position when welding. Round nozzle hot gas welding is generally only used where access to the joint is difficult, for example, around internal corners.

Speed welding

In the hot gas speed welding technique, the rod is fed into the joint via a tube in the speed-welding nozzle (see *Fig.1*) attached to the round nozzle on the hot-gas welding gun. The speed-welding nozzle also introduces hot air to the filler rod and to the joint. With this technique, the toe of the speed-welding nozzle is used to apply the pressure required for welding. *Figure 3* shows hot gas speed welding.

Fig.3. Hot gas speed welding

In order to achieve adequate welding pressure, the position of the operator's hand on the welding gun handle is important. The hand holding the gun should be placed underneath the grip and forced downwards, applying pressure to the nozzle toe as welding progresses. A light force should also be applied to the welding rod to ensure that it is fed through the tube at a constant speed. As with hand welding it is also important to feed the rod at a constant speed, maintain weld force using the nozzle toe and travel along the weld at a constant speed. Again, this is achieved by adopting a comfortable position when welding.

Producing the weld

In order to achieve a weld, the joint must be sufficiently filled with welding rod and each welding run must be adequately fused to both the next run and the parent material. Once the materials are tacked (see preparation), the first weld run can be placed into the base of the joint. The temperature of the welding gun should be set in accordance with the guidelines produced by the materials manufacturer. The manufacturers' guidelines on welding pressure,

airflow, and welding speed should also be followed. The base run should have good root penetration and, in the case of polypropylene, a small 'side wash' (see *Fig.4*)

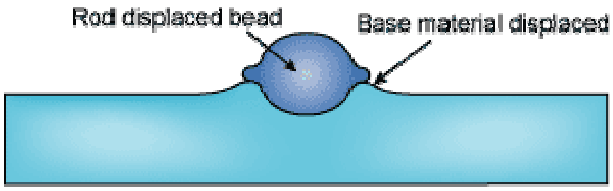

Fig.4. Section through polypropylene weld showing 'side wash'

The welding rod should not display signs of degradation (brown spots) or overheating. In the case of PVC, overheating is signified by a shiny smooth surface on the welding rod. In the case of polypropylene, 'splattering' at the edge of the weld indicates overheating of the material during welding. Between each run, as the joint is filled, a chisel or scraper is used to produce a small V preparation for the subsequent adjacent weld runs to be positioned in. This is shown in *Fig.5*.

Fig.5. Chisel between hot gas weld runs

The number of runs needed will be determined by the thickness of the substrate being welded. The weld is finished when the top series of runs is above the surface of the parent material. These runs are known as capping runs.

Finishing the weld

In some circumstances it may be necessary to remove the weld capping runs and leave a flush surface, for example where an aesthetic finish to the joint is required. These capping runs can be removed using either a hand grinder or scraper until the weld is flush with the surface of the substrate material. This can be done on both sides of the weld.