Purging Solutions

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Abstract

Additional shielding of the backside/underside while root welding of certain alloys such as Stainless Steel is often referred as Purging. This prevents atmospheric oxygen from reacting with the root underside and helps in obtaining good welds. Authors are looking at some of the popular purging solutions available today in the form of consumables and accessories that are necessary for pipes/tubes, but can be considered for other common scenario of fabrication with plates/sheets to build vessels/reactors etc.

Key words: Purging; root welds; Stainless Steel; Nickel Alloys; Argon; Nitrogen.

Introduction

This write-up on Purging Solutions takes a basic approach to refresh budding shop floor engineers about the necessity of Purging, where required, various available options, how they work and to choose the right one for their application in terms of convenience, economy and assurance of end results.

Shielding of Weld Joint

Many applications in the Oil & Gas Industry, Aerospace, etc. where critical joints of Stainless Steel, Nickel Alloys, Titanium, Etc., are accessible only from one side for welding. In such cases, single V or butt joint with GTAW process is adopted. While adequate shielding from the top side is provided by the welding process, it becomes necessary to protect the other side by a suitable method separately. This kind of shielding is needed even while root welding using consumable weld inserts and also when welding Cr-Mo material above the P22 grade, even though AWS is silent on this aspect.

Some of the methods adopted are:

(i) Backside Argon Gas shielding after building a Purge dam barrier

(ii) Welding with a Self-shielding (Non-purging) Wire

(iii) Using of a Flux– paste (Solar Flux)

Back side shielding by an inert gas

During root runs of any weld with GTAW, the front side is protected by shielding gas but underside or backside remains unprotected / exposed to atmosphere and gets oxidized easily especially when it has more than 2% Cr **(Fig. 1)**. It leads to fusion defects such as lack of fusion, weld sucking, etc.

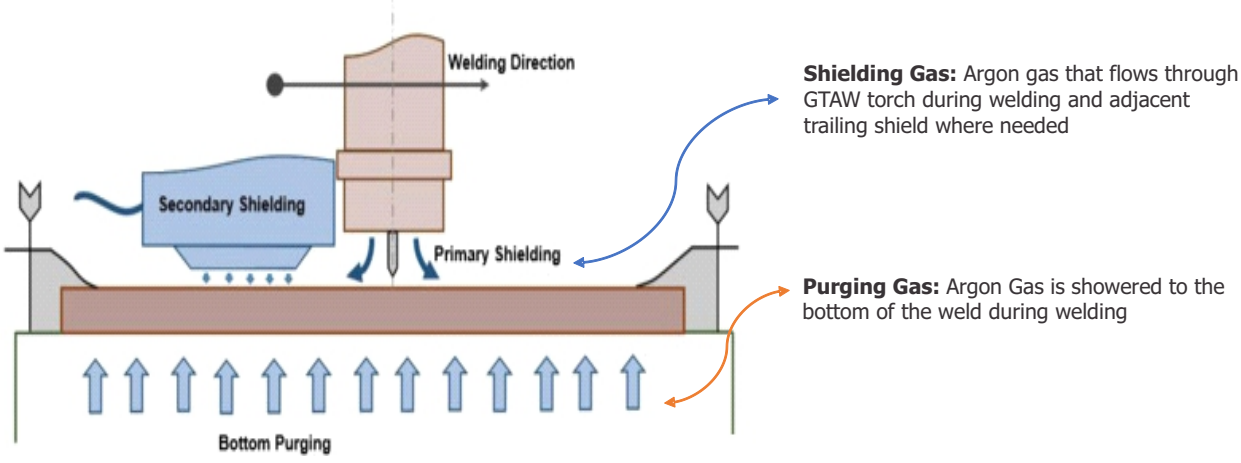

Fig. 1 : The gas shower from bottom of the root to protect it from atmospheric oxygen during welding to get good weld.

Importance of Purging

Purging is needed during root welding of Stainless steel, Nickel alloys and some Cr-Mo alloys, being sensitive to the presence of Oxygen. Argon, an inert gas is commonly used as a purging medium to envelope the root. Nitrogen can also be considered, but being lighter than Oxygen needs more flow to displace.

Welding without underside shielding or purging gas results in defective joint as can be seen in the photograph in **(Fig. 2)** and a typical in-house arrangement for purging by way of gas flow ducts, conduits affixed by adhesive tape to a SS-duplex digester vessel is shown in **(Fig. 3).**

Fig. 2 : Bad root welding because of no purging

Fig. 3 : A typical purging arrangement of gas flow, conduits affixed by adhesive tape to SS-duplex digester

Different Ways to Purge Pipes

There are four different ways to purge the pipes as follows.

Purging using Dams

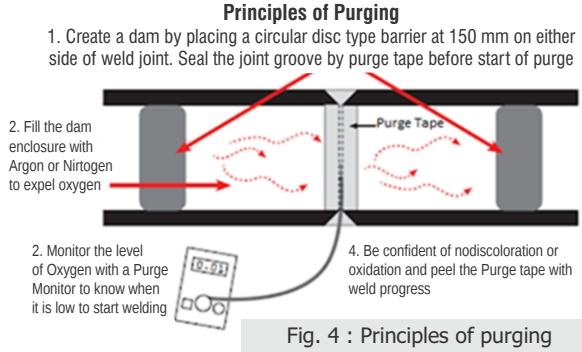

Fig. 4 : Principles of purging

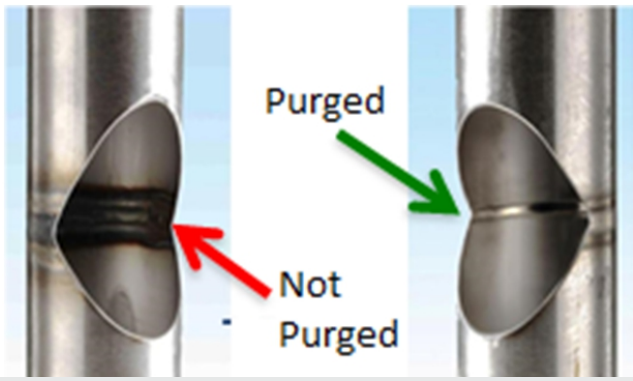

Fig. 5 : Result of purging

Fig. 4 explains the principles of purging and **Fig. 5** shows the results of welding with and without purging

Purge Dam paper/ film

Dam film or paper is used to make a barrier Dam at 150mm of either side of the root by either an adhesive liquid or tape respectively. Purge tape is used to prevent argon gas leakage by sticking the tape circumferentially over the groove to be welded. This tape is gradually peeled off, as the weld progresses along the groove **(Fig. 6)**.

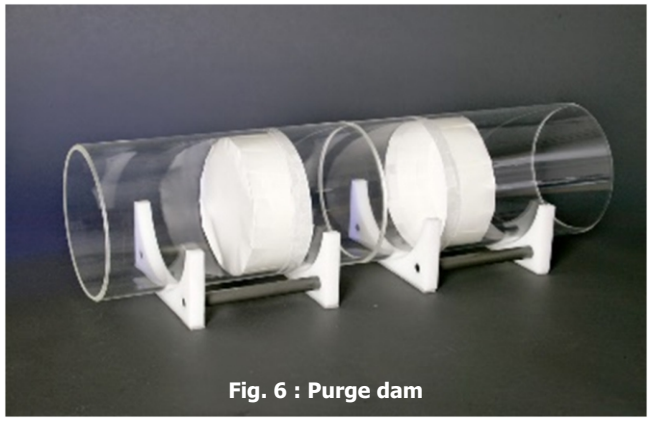

Fig. 6 : Purge dam

The purge film is made of PVA (Poly Vinyl Acetate) of 1m width x 10m or 20m long rolls that when dissolved with water, leaves no residue. Soluble quality dam paper is also available, but The Purge Film Roll has become more popular for the convenient way to stick to the pipe inside circumference.

Purge bladder

Purge bladders **(Fig. 7)** are available in various sizes as per pipe dimensions and also custom-made sizes. Besides, optional heat covers are available where these have to withstand preheating, if applicable. Please note that purge bladder comes with many other useful features and options. A special purge enclosure is also available to weld Titanium and other reactive metals / alloys.

Fig. 7 : Above is Purge bladder- regular, custom made & with Monitor during welding in progress

Ensuring Correct Purging

It is essential to confirm that the residual oxygen is below safe limits before starting the weld. This can be accurately determined by Purge Monitors showing percentage or PPM levels. Purge Monitors essentially takes the judgmental error that may occur with thumb rule approach to get 100% assured and repetitive quality of welds.

Other Add-On Options

Alloyed Tungsten electrodes having ten times life maintains the tip sharpness to improve welding efficiency with purging, Tungsten sharpeners and Pipe purge plugs are available for enhanced productivity.

Shelf Shielding, Non-Purging Filler wire

Non-Purging filler wire **(Fig. 8)** is a method where no Argon gas is used and the root is protected by the flux cored or coated wire itself. The flux melts during welding and wraps the weld to protect it from atmospheric Oxygen.

Flux-cored: These are available for root welding of Stainless Steel of AWS Grades : R308LT1-5, R316LT1-5, R309LT1-5, R347T1-5 and R2209T1-5 having 2.2mm diameter and of 1000mm length.

Fig. 8 : Non-purging filler

Flux coated: The above-mentioned grades are available in diameters of 2.0mm, 2.6mm and of 1000mm length.

Note: This type of wire is yet to be included in AWS specification.

Mechanical properties: The Non-purging filler wires deliver very good tensile strength combined with elongation because of low impurities. This also results in excellent Impact properties @ minus 196°C and meeting IGC practice-E **(Fig. 9)** test requirements.

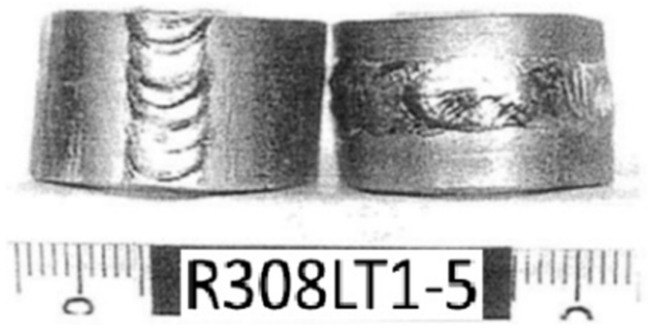

Fig. 9 : Bend specimen

Solar flux

Solar flux is a proprietary product not covered by AWS specification, but used for a long time by some as an alternative to gas purging. There are two variants, Type-B for SS and Type–I for Ni-alloys welding.

Solar flux is in powder form, when mixed with alcohol (ethanol) form a slurry to be applied to the pipe edges of the joint by a brush. Thereafter leave the alcohol from the coating to evaporate **(Fig. 10)**.

During welding, the flux releases inert gas that protects by enveloping the weld-root from atmosphere and leaves no residue.

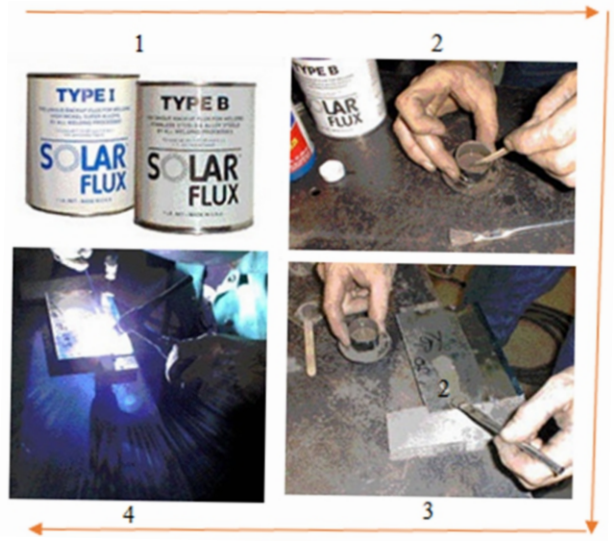

Fig. 10 : Solar Flux usage

Guidelines for Welding with Self-shielding (Non-purging) filler wire

This guideline is for welding of pipes with non-purging filler. The illustration **(Fig. 11)** shows how pipe is divided into 8 segments and sequentially welded in uphill position with a short arc. In addition, root preparation and current setting to be as shown for the keyhole technique. It is recommended to stop the weld at the groove face and restart to be made after a back step of 10mm.

Once GTAW arc is started, it will form a vortex hole in front. The welding filler wire should be fed at a higher pace of 10% compared to the solid filler wire to compensate for the lower efficiency of deposition because of flux. It is recommended to move forward with a swing/weave motion from left to right, while at the same time add the filler to the left side of vortex/keyhole to allow the flux to flow to the underside. The flux will also flow to the top side and thereby cover the bead from both sides. A fresher may require around 4 days of training before getting the technique right.

Comparison between gas purging and Non-gas purging methods

The purging gas requirement is around six times the volume of space to be purged. Therefore, larger volumes need longer time to displace the atmospheric Oxygen to be brought down below 1 percent that is necessary to start welding. Building a Purge dam barrier, bring down the volume of space to be purged to bring down the requirement of Argon gas volume and purging time. As a thumb rule, a 25LPM purge gas flow takes 100 seconds per meter of pipe that are below 80mm diameter and 200 minutes per meter for a 1200mm diameter pipe.

On the other hand, Non-gas Purging method, roughly reduces cost of man-hours by 25% and Argon gas usage by 60% in comparison. Therefore, Non-gas purging method can bring down total welding cost.

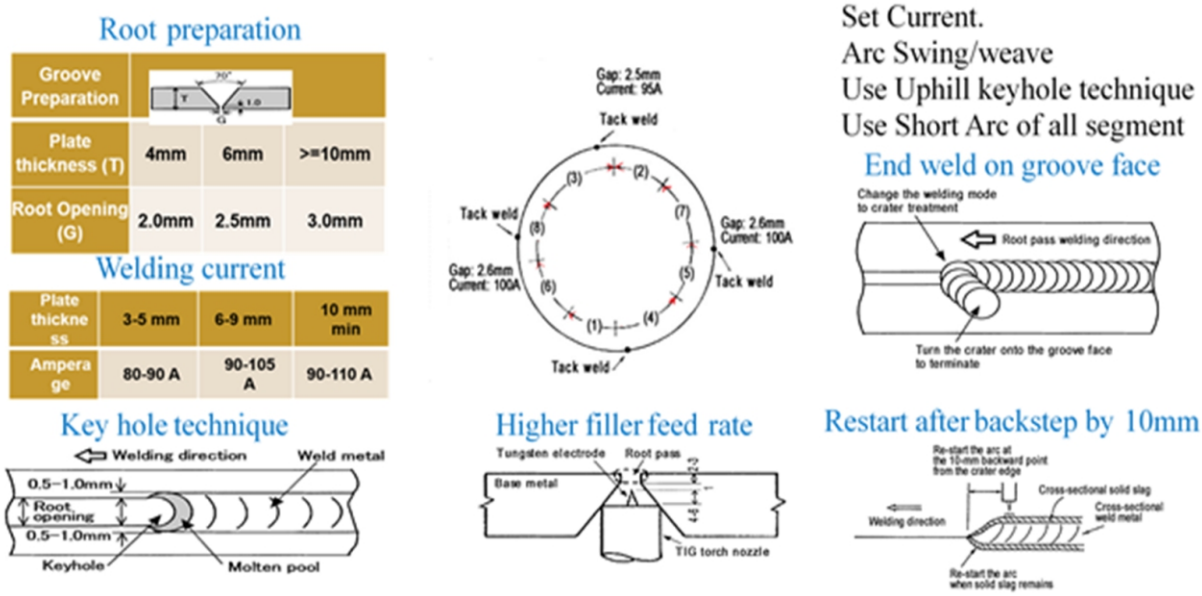

Fig. 11 : Guidelines on Shelf shielding Non-purging filler

Fig. 12 is a discoloration reference chart that relates the intensity of discoloration to the levels of residual oxygen present during welding. This could be because of a premature start of weld before all the atmospheric oxygen is purged.

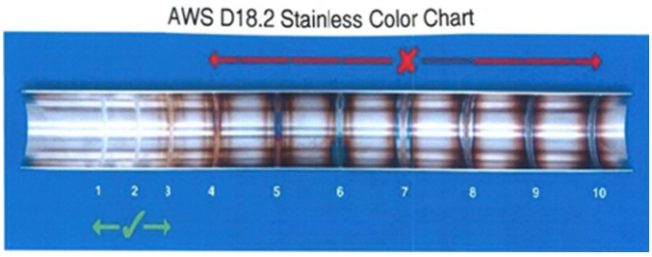

Fig. 12 : Discoloration chart

Conclusion

Purging during welding of root becomes a necessity especially for SS, duplex, Cr-Mo, Nickel alloys, etc., to get defect free welds. Authors have considered two options under each category to provide Weld root protection. First category is by Argon gas purging the space within the constructed barrier under the root called 'Dam' and second one of not using Argon gas, but by using flux to get root protection by a slag cover or by inert gas release during welding. Authors hope that this would help the prospective user in selecting the method and related accessories for the intended application. Non-gas purging method is apt for applications where root gas purging is not possible. Also, it is worth experimenting with the Non-gas purging methods to determine the convenience and economy for the application on hand.

Acknowledgement

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