Purging Practices for Pipe Welding

By R. P. JEYAPAL*

Introduction

TIG welding process is being predominantly used in the fabrication of carbon, alloy and stainless steel pipings of various diameters in critical sections. TIG welding with consumable inserts and insert gas backing is preferred for depositing the root bead. Argon gas is preferred in such applications as in Nuclear Steam heat exchangers due to its following properties :

1. Smoother and quieter arc action.
2. Lower arc voltage at given current value and arc length.
3. Greater cleaning action in welding.
4. Lower flow rates for good shielding.
5. Easier arc starting.

Necessity of Purging

Automatic or manual TIG welding with consumable inserts and with inert gas backing is the preferred method for welding either carbon steel or stainless steel piping to obtain welds of superior quality. The method is used almost exclusively for all critical piping welds in the nuclear power field and permits realisation of TIG welding's full potential. Consumable inserts give positive control over the chemistry of materials at the root which is a critical section.

Autogenous welds in critical power pipes are undesirable for both metallurgical and mechanical reasons. The chemistry resulting from autogeneous welding results in porosity due to lack of de-oxidisers in the melt zone. There de-oxidisers are normally supplied in the weld filler metal.

Another problem common to autogeneous welds is centre line thinning which results from the welding of joints where metal to metal contact for the entire length of the weld has not been achieved. As the weld progresses the thin areas which are always located at the centre of the bead are particularly prone to centre line cracking due to the inability of the thinned section to resist the weld imposed tensile stress across the weld.

The use of consumable inserts assures that the chemistry of the root pass weld metal will be satisfactory and that the throat of the weld will be adequate to resist centre line thinning.

Better welds result if inert gas shielding is used on the root side of the weld. An examination of the root side of the welds made in an air environment indicates the root side is usually rough and irregular. Welds made with inert gas root shielding have smooth and oxide free roots. The root side of argon shielded welds also exhibits excellent wetting of the base metal while air shielded welds are characterised by poor wetting which results in numerous mechanical notches in weld root where they act as stress raisers.

Purging Devices

Environmental control zones in weld area are created by placing dams at suitable distances from

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either side of the weld joint in the pipes and purging the area with inert gas. Devices have been developed so as to serve as dams and confine the argon to a particular area on both sides of the weld. Some such devices are described below.

(*a*) *Total system purging :* Where dams cannot be used or permitted, purging entire system with inert gas is the solution. In this system, the ends of the pipe are sealed off with rubber plugs and the entire pipe is purged of air using gas. Inlet openings should be located as low as possible to take advantage of the difference in weight of air and gas. This type of entire purging will consume plenty of gas and money. Hence devices have been developed to confine the argon.

(*b*) *Inflatable Bladder Dam*

One such device consists of dam made of rubberised canvas material. Bladders can be collapsed to permit introduction into the pipe through a relatively small opening. The collapsed bladders, after being positioned accurately, are inflated to grip the inner pipe surfaces with the same gas used in the purge zone. The gas used for inflating is introduced through hoses passing through open pipe end and removed through the same end after welding. This bladder system requires atleast one open end in the final weld pipe string. Refer Figure. 1 and 1a.

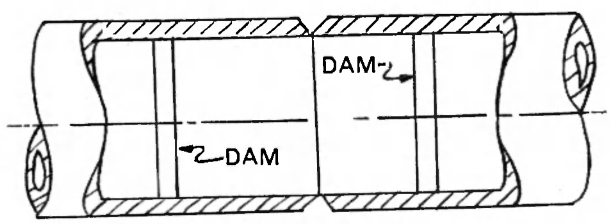

Fig. 1. Inflatable Bladder Dam

(*c*) *Collapsible Disc Dam*

This is the least expensive and simplest device. Discs are generally fabricated from one inch plywood or similar material. They are hinged in the middle and are fitted with a thick bead of foam rubber or similar material around the rim for gas tight seal against the internal wall of the pipe. A chain attached to one side of the disc is positioned so that a tug will collapse the disc and rotate it into position to permit withdrawal through the opening of the pipe. Refer Figure 2.

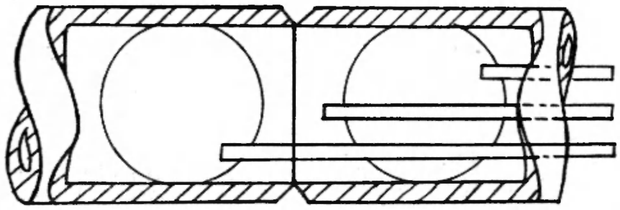

Fig. 1(a).

(*d*) *Thermally Disposable Dam*

Another simple dam material—made of corrugated card board cut to fit the ID of the pipe and sealed in place with cement or a suitable tape. Where accessibility permits, the inert gas can be introduced through a hose entering the open end of the pipe string and passing through the dams into the purge zone. The thermally disposable dam is recommended only in carbon steel piping, where post weld heat treatment is part of the welding procedure. Thermally disposable dams should never be used in stainless steel piping since the temperature required to ignite and dispose of the dam material would greatly exceed 177°C, the maximum interpass temperature, generally specified for stainless steel piping.

(*e*) *Flange Supported Rubber Dams*

To maintain an internal cushion of inert gas inside the pipe, the welding zone is isolated by inserting baffles. The gas is admitted through one of the baffles and a mixture of gas and air escapes through the other.

The argon consumption can be reduced, the preliminary purging time shortened and more convenient operating conditions established by using the attachment shown in Figure 3 in the form required for shielding the inside of a pipe flange joint.

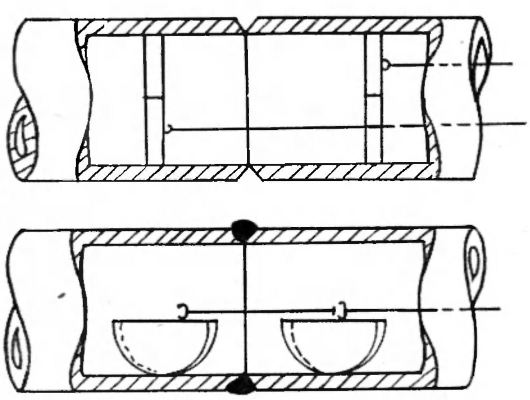

Fig. 2. Collapsible Disc Dam.

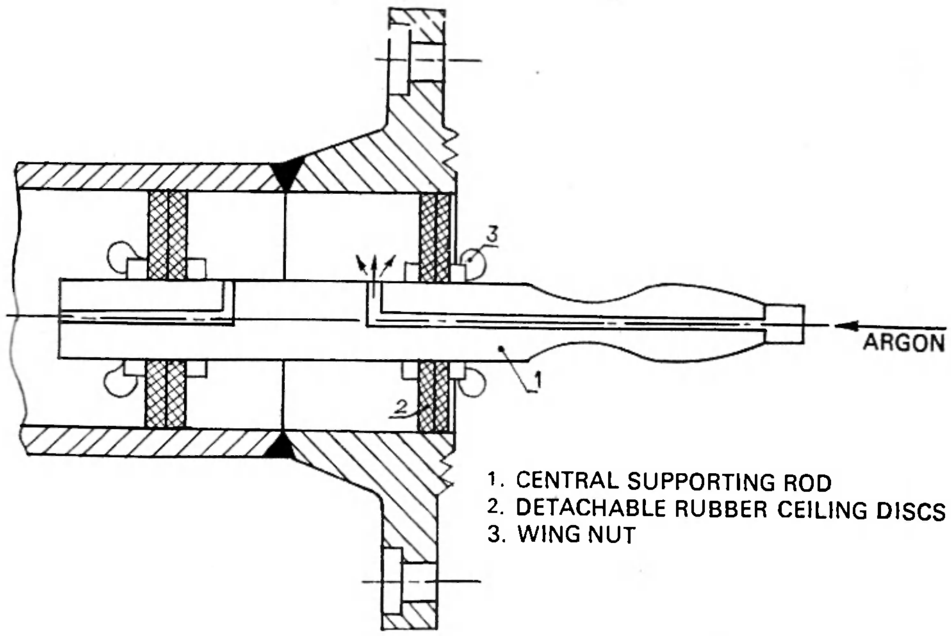

Fig. 3. Flange Supported Rubber Dams.

The attachment consists of a central supporting rod 1, the detachable rubber sealing discs 2 and the wing nuts 3. The best seal is obtained by using rubber discs of 2 to 3 mm larger diameter than the inside of the pipe. When the attachment is used, for example to weld flange to a pipe of 80 mm inner diameter and 2 metres in length, it saves as much as 50 litres of argon.

(f) Water Soluble Purge Dam

Where the end of the pipe or tube is accessible, one can use a removable dam (as described earlier) to contain the inert gas and prevent air currents. Where the dam cannot be removed physically after completion of welding, some other means has to be devised to eliminate it. Until recently, paper or card board was used and ignited by means of an external flame after it was no longer needed. Twin problems arose from the use of this procedure; the paper sometimes moved away from the original location, especially in vertical lines, and combustion was not always complete even when it stayed in place, which often left undesirable residues in the line.

To overcome these problems, the use of paper which is completely soluble in water has begun. The paper called 'DISSOLVO' purge paper dam, is made of a cellulose polymer. Since all the welded joints in the critical nuclear applications are subjected to hydraulic or steam testing after the completion of the welding, the 'DISSOLVO' paper gets dissolved and is flushed away during the test. The residue is bio-degradable and free from harmful contaminants. These paper dams can be used in all joints with ease and they have been found to be sufficiently strong to dam argon and other gases needed for reliable fusion.

The following table gives the typical purge time and flow rates for various pipe sizes without the devices discussed above.

Table No. 1.

Pipe size (in) I.D.	*Pre-weld*		*Flow rates during welding cfh*	*Vent sizes inches*
	Argon flow rate —cfh	*Purge time minutes*		
3.0	20	3	*	1/16
4.0	20	3	*	1/16
5.0	20	5	*	1/8
6.0	20	6	*	1/8
8.0	25	8	*	1/8
10.0	25	13	*	1/8
12.0	30	13	*	1/8
14.0	30	16	*	3/16
20.0	35	25	*	3/16

* Upon completion of the purging cycle, flow rate should be reduced as required to maintain a slight positive pressure during welding.

NOTE : 1. The purge time and flow rates were those required to reduce the oxygen content 1% or less and were derived from experimental data obtained from direct measurement of the oxygen content of outflow from typical purge enclosures in various pipe sizes.

NOTE : 2. The purge time and flow rates are based on enclosures twelve inches in length. Where enclosures exceed twelve inches in length, the flow time should be increased proportionally.

NOTE : 3. The chart is not applicable to total system purging where the use of an oxygen analyser is recommended. Purging should be continued until the oxygen content has been reduced to 1% or less.

Purging without the Device :

From the table No. 1

Purge time	... :	780 Seconds
Flow rate used	... :	25 CFH
Volume of argon used	... :	$25 \times \frac{780}{3600}$
	:	5.40 cu.ft.

Therefore percentage volume of argon saved by purging with the device $= \frac{(5.40 - 0.97) \times 100}{5.40} = 82\%$

Thus it is seen that the volume of argon required to purge is very much reduced by the introduction of the device in the pipe.

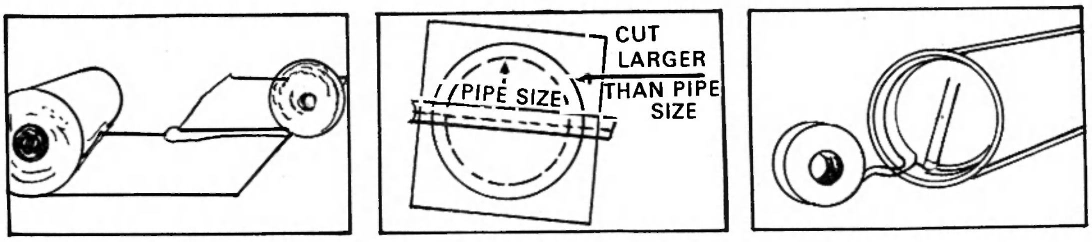

Fig. 4. Water Soluble Purge Dissolved Dam.

In an experiment at BHEL, Tiruchirapally, saving of argon resulted from the use of flange supported rubber dam purging device on a 260 mm I.D pipe.

Purging with the Device :

Purge time for 260 mm pipe	... :	140 seconds
Flow rate used	... ... :	25 CFH
Volume of argon used	... :	$25 \times \frac{140}{3600}$
	:	0.97 cu.ft.

Conclusion

As seen from the points discussed, the rare and costly commodity argon can be considerably saved by incorporating devices, appropriate to the joint design, in the pipes to be purged. With the device in position, an optimum flow rate of 25 CFH is ideal, for minimum consumption of argon. To reduce the purge time, the pipe may be prepurged at a higher flow rate and maintained at a lower flow rate during the welding of the joint.

Acknowledgement

The author thanks the Principal, Mr. P. S. Mani Sundaram and Professors A. Krishnan and Dr. C. R. Kandaswamy for permission to publish the paper.