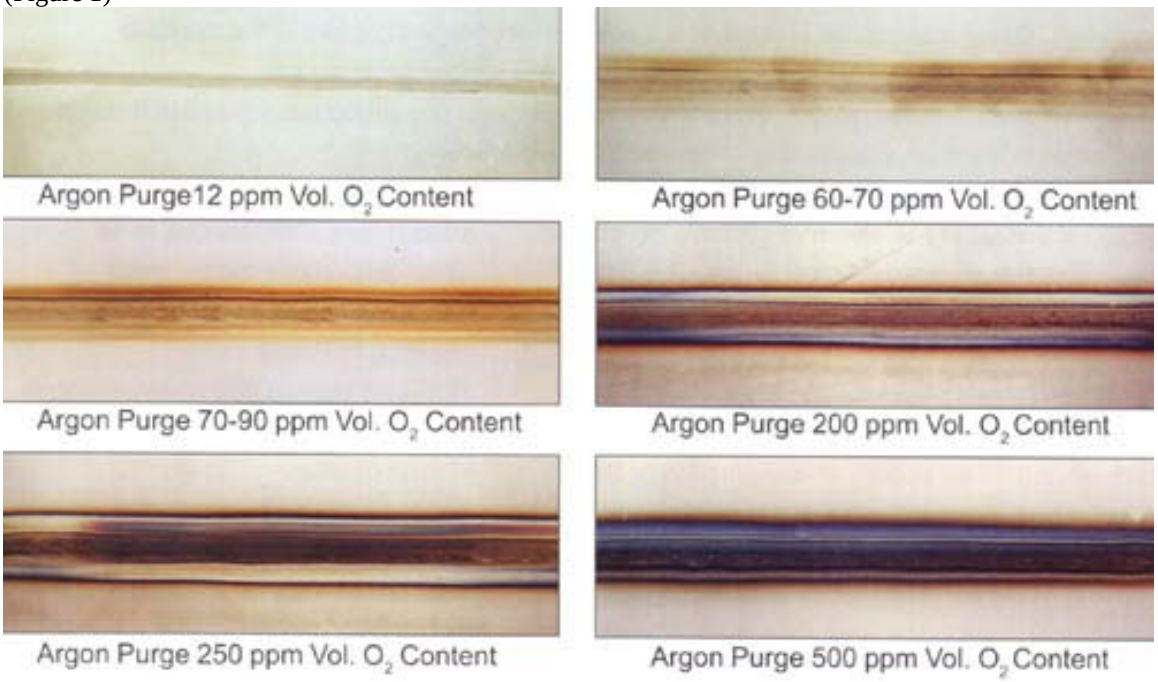
WHY PURGE ? (Excerpt from Practical Welding Today March/April 2000 issue.)

Purging for Pipe Welds - On Corrosion-Resistant Metals.

When welding stainless steel, titanium and other corrosion-resistant materials, creating a perfect weld environment is of the utmost importance, because the desired corrosion resistance depends on it. During welding, the heated weld seam is exposed to air and oxidizes if it is not protected. This oxidation must either be prevented or treated later. Successful welding depends in part on a combination of proper purging equipment and techniques, and these are the focus of this article.

(Figure 1)



Note: Some Oxygen Indicators/Purge Monitors read down to 1% - This is still 2094.6 ppm of oxygen!

Preventing Oxidation:

During the welding of steels, oxidation occurs in the weld seam if oxygen reaches this area unhindered. This situation is even more acute with titanium, zirconium, molybdenum and other gas-reactive metals and alloys. The resulting oxidized surfaces are no longer corrosion-resistant, and further treatment is necessary.

Removing oxidation by grinding also removes the metal's passive protection against corrosion. Other mechanical procedures, such as brushing, blasting and pickling remove the oxidation, which restores corrosion resistance. However, in some cases such as pipe welding, removing oxidation after welding is difficult or impossible to do.

During pipe welding, oxides are usually located in areas that are almost impossible to access, such as in two 4-inch-diameter pipes that are each 10 feet long. Pickling will restore the corrosion resistance, but it is time-consuming and nearly impossible on a remote job site. Instead of removing oxidation, another solution is to prevent it from occurring in the first place. In essence, this is what purging tries to achieve.

With purging, a gas is used to protect the weld seam until it has cooled to the point that oxidation no longer can occur. Usually, an inert gas, such as argon which is heavier than air, is used (see Figure 1). Other purging gases such as nitrogen and nitrogen/hydrogen blends can also be used.

Purging Equipment:

Taping up the ends and purging the whole length of pipe is a common approach, but this time-consuming and uneconomical process usually results in wasted purging gas, unproductive labor time and a less-than-desirable outcome. Proper equipment and accessories should include:

1. A purging unit.
2. Aluminum tape.
3. An oxygen indicator.
4. A tungsten electrode grinder.

A purging unit should reduce the purge volume, provide a well-sealed chamber and introduce no contaminants. The purging gas must be distributed at a slow enough speed within the purge chamber so that argon and oxygen mixing is reduced and excess turbulence is minimized-a key to high-quality purging. At the same time, the purging chamber should be sealed against further oxygen penetration. To speed up the purge time, the loss of argon should be reduced and fresh oxygen prevented from entering the weld area.

The pipe's joints should be sealed from the outside with a halogen-free, temperature-resistant aluminum tape . Regular tape should not be used for sealing pipe gaps because these adhesives generally contain halogens, specifically chlorine. Chlorine, like hydrogen and oxygen, is absorbed by reactive metals at high temperatures, causing embrittlement in the weld surface.

All components used in the manufacture of purging units should therefore be halogen-free, heat-resistant and void of dissimilar metals. An excess pressure vent also should be included to aid in the venting of oxygen and excess purging gas from the purged environment. When welding corrosion-resistant materials and purging, it is important to note that the rest oxygen (the percent volume of oxygen left after purging with an inert gas) is made up of the following:

1. The content in the supplied welding and purging gas.
2. Oxygen penetration and diffusion through internal gas supply lines, gas hoses, seals, connections (including connections within the welding machine), regulators, purging units, and welding gaps.

Rest oxygen is composed of many (sometimes small) additions because the final reading at the welding joint can include trace oxygen content in the gas from a small leak at the hose/regulator connection or can enter through the welding gap. Because of this, it is wise to monitor the complete procedure with an oxygen indicator. This sensor should be able to measure accurately to 1 part per million (PPM) oxygen.

Oxygen indicators with read-out capabilities of only 0.1 percent (1,000 PPM) or 0.01 percent (100 PPM) may not be accurate enough, as most precision welding is done well below 70 PPM. Higher accuracy makes it possible to find the source of each extra oxygen value and prevents weld failures and/or rework.

To ensure optimal weld quality, gas tungsten arc welding (GTAW) electrodes must be ground centrically and longitudinally. The ground tip geometry must be of a high-quality finish to help guarantee proper arc stability. Electrodes that are ground correctly on a tungsten electrode grinder fitted with a diamond wheel last longer and produce better welds because of greater arc penetration. Regrinds should also be done on a tungsten electrode grinder at the same prescribed angle as the welding procedure dictates to maintain consistent parameters and results.

Purging Techniques:

A common question about purging is the flow rate at which the welder should purge. Actually, the flow depends largely on the volume to be purged.

In practice, the welder should strive for enough flow to force the oxygen gently out and maintain a slightly higher pressure inside than outside the purge chamber. This action prevents fresh oxygen from

re-entering the purged area through the weld seam when welding and, at the same time, minimizes excess turbulence, which can cause instability in the welding arc.

The length of purge time is another common question. Besides using practical experience to determine purge time, welders can use many formulas that have been calculated to find the exact moment to weld. However, weld quality depends on many factors, including humidity, volume & material, to name a few.

The correct length of time to typically purge is until the oxygen sensor indicates a value below 70 PPM for stainless steel or below 50 PPM for titanium. This can take between two and four minutes when using a purging unit. Some industries such as semi-conductor, require a level below 10 PPM, and this range may take much longer to reach.

The welding parameters should be set by the welding engineer and enforced by quality control. Also, purging should continue until the weld seam has cooled sufficiently so that oxidation can no longer occur. When making multiple root-pass welds, purge gas flow should be maintained until the weld seam is 3/8 to 1/2 inch thick, depending on the specific welding procedure and the material's elasticity. Preheating pipe with high temperatures, as is sometimes recommended, can encourage the formation of chrome oxides, and a rest oxygen content below 100 PPM is highly recommended.

The permeability of oxygen gas hoses and supply lines should be monitored closely. Moisture accompanied by oxygen can penetrate gas supply lines and prevent an otherwise clean operation from meeting codes and specifications. This is especially true when the purge gas line has not been used for a while or is being used in a humid environment. In these instances, ensuring adequate gas flow before welding will remove these residual amounts.

Weld Quality:
The effective welding of stainless steel, titanium, nickel, zirconium, molybdenum, tantalum and their alloys for the nuclear, petrochemical, pharmaceutical, semi-conductor, aerospace and food industries requires the proper tools to create a perfect weld environment. Purging equipment and its use can have a major impact on preventing oxidation and improving final weld quality.

For more information, refer to Recommended Practices for Root Pass Welding of Pipe Without Backing, DIO.11 (Miami: AWS, 1992).

A. J. Schenk is Vice President of Sales with Intercon Enterprises Inc., 1125 Fir Avenue, Blaine, Washington 98230, phone 800-665- 6655, fax 604-946-5340, e-mail sales@intercononline.com, Web site [www.intercononline.com].

In the Article "Effects of Welding Electropolished Stainless Steel as Used in Ultra-Pure Fluid Delivery Systems for the Semiconductor and Pharmaceutical Industries" (Published in the Journal of the Arkansas Academy of Science, Vol. 56, 2002), the authors, Dr. Guna Selvaduray and Steve Trigwell, show (in Table 2.), that an ***O2 level as low as 31.6 PPM*** *lead to a* ***FAIL*** *under Fluorescent and Maglite scans – relating to their Abstract quote "…leads to discoloration in the Heat Affected Zone which can lead to corrosion." And they state in their Conclusion: "The discoloration in the Heat Affected Zone commonly observed in welded electropolished stainless steel is caused by contamination by O2 of the argon purge gas used during welding and is a function of the concentration of O2 in the purge gas."*
