2021 ISSUE 10: OCTOBER

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A WELCOME FROM THE EDITOR

Dear Reader,

Welcome to the October issue of Weld Purging World 2021.

This month, Technical Sales Manager, Luke has been delivering various Weld Purging Presentations focusing on topics such as ‘how to purge’ and ‘why purging with the correct equipment is important.” We also set another record with a huge 136” Pipestopper being manufactured at our UK HQ for a European customer. Read more on this on page 3.

On page 6 you will find our Technical Article, which discusses the welding issues faced during space rocket manufacture and how the latest Weld Purging Equipment can overcome these challenges.

If you have any information that you would like to be featured in future issues of this publication, please contact me.

As always, we hope you enjoy the issue.

Best wishes,

Michaela
Marketing and Social Media Manager
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Technical Sales Manager, Luke was invited to do a presentation at the TWI – London branch. Luke delivered a presentation on the significance of purging during welding, which included details on why we purge, how to purge and the benefits of carrying out purging correctly.

A 136” diameter Pipestopper was manufactured for one of our European customers, another record for HFT as this is the largest we have ever produced in this design.

Luke was also invited to do a presentation (via Zoom) for the HPC welding forum on applications for different purging products in welding operations, focusing specifically on how to improve quality of welds on stainless steels in the nuclear sector.
The use of home made sponge foam purge dams for pipe weld purging is still very familiar throughout the welding industry. However, operators are unaware as to how the use of sponge foam can adversely influence the metallurgical strength of a joint.

When sponge foam starts to warm up from the heat of the weld, the foam starts to outgas the harmful elements that exist throughout the foam (oxygen, nitrogen and water vapour). If the operator is unable to use a high quality Weld Purge Dam and wishes to use a low cost alternative, Huntingdon Fusion Techniques HFT® manufacture water-soluble Weld Purge Film®, ensuring all welders can achieve a great purge every time, at a reduced cost and without the introduction of harmful gases to the weld.

Ron Sewell, Chairman for HFT® said: “Making a dam with Argweld® Weld Purge Film® is much easier than all of the complex cutting and shaving that goes into the self fabrication of a sponge dam. Simply cut off a length of film from the roll, greater than the diameter of the pipe and stick the surplus film to the water-soluble adhesive that is applied to the pipe beforehand.”

“Cut costs, but don’t use inferior products such as paper or sponge, use superior ones like Argweld® Water Soluble Weld Purge Film®. Homemade dams made from material such as foam, sponge or paper can often lead to loss of welds when they leak or slip from position, oxidising the weld and causing unnecessary rework.”

“Welders have even been known to burn their hands when removing a foam dam, which has caught fire. With the use of our low cost Weld Purge Film®, welders can ensure that their dams do not come loose during welding.”

Weld Purge Film® Kits can be used on pipe diameters up to 900 mm (36”) and for temperatures up to 300ºC (572ºF) without the material burning, coming loose and losing the weld purge.

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EASY STAINLESS STEEL WELDING

Weld Purge Monitors® are in use throughout the Welding Industry. Used during the welding of reactive alloys, they ensure the oxygen present is at a low enough level to avoid oxidation, which can lead to a loss of the alloys’ corrosion resistance properties.

For stainless steel, the oxygen level needs to be as low as 100 ppm. Recognising the requirement for a low cost, portable 100 ppm monitor, Weld Purging Experts Huntingdon Fusion Techniques HFT® designed and developed the PurgEye® 100 Weld Purge Monitor, which is now the World’s leading monitor for welding stainless steel.

Georgia Gascoyne, CEO Managing Director for HFT® said: “Our award winning PurgEye® 100 is really a game changer for the welding industry. Stainless steel is often the metal of choice in many different industries for its corrosion resistance properties, strength, weight and cost, so developing a monitor that can read accurately down to 100 ppm was a huge requirement.”

The PurgEye® 100 features an auto calibration at the touch of a button, which ensures the monitor is always reading correctly. It is IP65 rated for water and dust and also features a low sensor and low battery indicator. With a large, easy to read digital screen, the operator will immediately know when it is safe to start welding ensuring a perfect welding environment every time.
Stainless steels and titanium alloys are widely used in space rocket manufacture. They offer resistance to corrosion and mechanical properties are good at elevated temperatures. Extensive published information is available on both materials but some of the problems associated with fusion welding have only been recognised relatively recently.

The temperature cycles experienced during welding affect the weld and heat affected zone properties of these materials in different ways.

**Stainless steels**

The most widely used are the austenitic materials of which the 300 series constitute the largest subgroup. Of these, EN 1.4301 (AISI 304), is favoured for rocket body manufacture. It is readily available, can be formed easily and offers good general corrosion resistance coupled with stability at higher temperatures.

Welding does, however, present problems associated with loss of chromium in the fusion zone due to oxidation and formation of chromium carbide. The balanced composition includes 18% chromium, added for corrosion resistance, so any reduction in chromium content will affect the corrosion properties.

**Titanium Alloys**

A range of titanium alloys is now available and currently in widespread use are the grades 5 and 9. Grade 9 titanium alloy contains 3% aluminium and 2.5% vanadium, less alloying material than the more common Grade 5 (6% aluminium and 4% vanadium). Grade 9, referred to as Ti-3-2.5, offers improved resistance to corrosion and better mechanical strength and is now routinely used in applications such as hydraulic tubes.

Weldability of Ti-3-2.5 is good provided that the necessary precautions are taken. Due to the reactive nature of titanium and its alloys, inert gas shielding should be in place on both the OD and ID of tubes and protection assured when welding plate and sheet.

During welding those parts of the weldment exposed to temperatures above 520°C will absorb oxygen, nitrogen and hydrogen and must therefore be protected until they have cooled below this critical temperature. The alloys are subject to embrittlement.

Production of defect free welds in stainless steels and titanium alloys thus depends upon ensuring that an effective inert atmosphere is provided to protect all joint areas that may exceed as little as 500°C.

Commercial equipment has been developed over the last 25 years by specialist operations across the globe. This might range from tube and pipe protection, surface shielding and complete coverage.

**Tube and Pipe Welding**

Inert gas purging is now the global preference for avoiding contamination during welding of tubes and pipes.
Over the past decade major advances in purge equipment design have been incorporated into systems that are rapidly becoming commonplace internationally. Development has been driven largely by the need to improve reliability, decrease purging times and dispense with operator skill. Designers have been able to exploit technological advances in materials and component parts.

Essentially a purge system includes a method of sealing the inside of a pipe on either side of the weld zone then displacing air with an inert gas. The seals must be reliable and leak tight, effective and easy to insert and remove. The inert gas must be of a quality commensurate with the need to protect the molten metal. Gas flow should be laminar to maintain a high level of protection and pressure controlled to offer adequate coverage but without expelling molten metal from the joint.

Early, and with hindsight, primitive systems involved the use of paper, card, wood and polystyrene discs. Often these provided at best poor sealing and on occasions burst into flames. It comes as a surprise that these practices are still used, even by prominent fabrication companies across the world.

An example of the development programme is the Argweld® series of purge systems that can now accommodate all diameters from 25 mm to over 2000 mm.

![Fig 1. The concept of pipe purging and fully integrated purge equipment. The PurgElite® system employs a design which allows for easy and positive insertion into position and limits the purge volume thus allowing savings in inert gas. These are multi-use devices.](image)

The principle of tube and pipe purging can be extended to accommodate diameters as small as 12 mm by using expandable plugs. These are located either side of the joint to seal the local volume and include international pipe connections to allow for admission and release of protective inert gas.
Principle features of contemporary inert gas purge systems:

- Rapid deployment and removal.
- Small purge zone so considerable reductions in inert gas use.
- Re-usable systems.

Surface Shielding

Primary shielding of the molten weld can be provided by careful design of the welding torch. Standard torches may be suitable, but a large ceramic cup is essential to provide even nominal primary shielding for the entire molten weld. Significantly better shielding can be provided by an Argweld Weld Trailing Shield®, the function of which is to protect the solidified weld metal and associated heat-affected zones until the temperature falls below 400°C. Significant development has taken place during the last year in Argweld Weld Trailing Shield® design. These devices provide inert gas cover not only around the torch cup but also behind the torch, thus offering effective protection of the weld during the critical cooling phase.

This is crucial for alloys such as stainless steels and titanium alloys where exposure to gases such as oxygen, nitrogen and hydrogen at temperatures as low as 500°C can materially reduce corrosion resistance and mechanical strength.

Fig 2. Nylon/rubber expandable plugs are available for tubes and pipes between 12 and 150 mm diameter.

Fig 3. Argweld Weld Trailing Shield® concept.
The technical skills of manufacturers of Argweld Weld Trailing Shields® such as Huntingdon Fusion Techniques in the UK have been used to advance the design of these products and they are now in use globally.

Principle features of contemporary Argweld Weld Trailing Shields®:

- The welding torch is mounted on the leading end of the shield and inert gas fed through quick-connect ports behind the fusion zone.
- A seal between the shield and the work is assured through the use of flexible, pre-formed and easily replaceable silicone skirts.
- Accommodation of curved surfaces down to 25mm diameter in addition to linear weld joints

Complete Coverage

There is increasing demand for fabrication of complex three dimensional components using alloys that are sensitive to oxidation and contamination. These are best fabricated in sealed enclosures where the entire welding operation is carried out in an inert atmosphere where contamination can be eliminated and oxygen levels reduced to well below 10 ppm.

Where quality and freedom from oxidation and contamination is crucial, total protection is afforded by using weld enclosures. Metal chambers and glove boxes have been in use for decades, and these are effective in providing a totally inert atmosphere during fusion welding.

Fig 5. The accident involving Formula 1 racing driver Romain Grosjean at the Bahrain circuit in 2020 could have been fatal were it not for the head protection provided by the ‘Halo’ structure. This typifies an application where structural integrity is vital. Complete protection of the titanium alloy fusion zone during welding is essential and is provided by using an inert gas enclosure.
The development and introduction of flexible enclosures over the past decade is leading to widespread use, especially in the aerospace industry, where complex three-dimensional assemblies in stainless steel and titanium alloys need to be welded.

These enclosures can be manufactured quickly and current models are available up to 9 cubic metres in volume. They are made using engineering polymers and employ leak-tight access zones.

Typically, metal enclosures cost at least ten times more than flexible alternatives, size for size. Excellent access and all-round visibility. Multi-access enclosures allow several smaller fabrications to be welded in the same gas cycle. Alternatively, they can be used for a single large item requiring access to several joints. Long gas-tight and air-tight zips for large parts. Access for operators’ gloves, welding torches, electrical connectors and purge gas entry and exhaust tubing.

**Fig 6. Single and multiple operator enclosures are available either off the shelf standard or bespoke units.**

**Monitoring The Purge Gas Oxygen Content**

To ensure that residual oxygen levels are measured accurately and maintained throughout the welding cycle the use of an oxygen purge monitor is vital. These specially designed instruments can be used to continuously monitor oxygen levels accurately. They are also useful as quality control tools and records can be stored using a data logging software interface.

Two essential characteristics of a suitable instrument are that it must have an adequate measuring range and it must sample the gas for oxygen content inside the purge volume.

Although many commercial monitoring systems are available these are generally not sensitive enough to meet the requirements for quality welding of alloys such as some stainless steels and most titanium alloys where the presence of oxygen levels as low as 20 ppm are essential if loss of corrosion resistance and reduction in mechanical properties are to be avoided.

Typical of advanced monitoring systems is the PurgEye® family of instruments from Huntingdon Fusion Techniques HFT® in the UK.
Principle Features of Purge Gas Oxygen Monitors:

- Software for computer interfacing, data acquisition, storage and printing of results and graphs for quality control purposes.
- Measurements taken close to the joint.
- Audio and visual alarms when the oxygen level is reading a greater value than the threshold set by the user.

References

1. Welding can reduce resistance to corrosion, Fletcher M J, Stainless steel World India and Middle East. June 2021
2. Job Knowledge 109, Mathers E, The Welding Institute

Further sources of information

Huntingdon Fusion Techniques HFT® is a technology-led company with an extensive library available to its customers on request. The library includes a wide range of technical documents, many of which have been peer reviewed and published internationally.
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