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WELDING ENCLOSURES FOR THE AEROSPACE INDUSTRY

SPECIAL RUBBER PLUGS

3D PRINTING FOR THE MARINE INDUSTRY

WELD PURGING PRODUCTS INNOVATORS, MANUFACTURERS AND INTERNATIONALLY RENOWNED SPECIALISTS

MADE IN WALES ‘MANUFACTURER OF THE YEAR’ & WELSH BUSINESS AWARDS – EXPORTER OF THE YEAR

WWW.HUNTINGDONFUSION.COM
Dear Reader,

Welcome to the third issue of Weld Purging World for 2021.

In this month’s issue we share news about our Welding Enclosures being used in the Aerospace Industry and Technical Sales Manager Luke Keane gives the latest on a recent underwater application that required our Special Rubber Plugs.

On page 10 you will find our Technical Article 3D Printing for the Marine Industry that details the concept of 3D printing, WAAM development and which of our products can help support the process.

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
michaelahess@huntingdonfusion.com
Welding Enclosures are in use by companies such as British Airways, Airbus, Pratt and Whitney, Lufthansa, Senior Engineering and Shapes Aerospace International along with many other companies in the Aerospace field.

Recently, Airframes Alaska purchased our exhibition unit to run trials before purchasing a bigger, bespoke unit.

Available for a fraction of the cost of a rigid welding chamber, Flexible Welding Enclosures® provide a technically viable option to the very expensive rigid metal chambers.

Shapes Aerospace have quoted: “We use our Argweld® Flexible Welding Enclosure® along with the PurgEye® Weld Purge Monitor® everyday for our titanium welding. They are built to last!”

The Welding Enclosures are ideal for small production quantities of items that need total gas coverage as well as single large items with critical joints.

A combination of translucent material and optically clear PVC sheet is used depending on the viewing requirements of the customer. Large access zips are fitted to each Enclosure and additional entry points can be provided for operators’ gloves. A service panel incorporates access ports for welding torches, electrical leads and water-cooling supplies and a purge gas entry port and exhaust valve is also included as standard to vent displaced gas into the atmosphere. Gas and airtight access zips can also be fitted.

Operator comfort and ease of use versus the disagreeable conditions found with a rigid plastic or metal chamber make the flexible versions a big hit with welding personnel. The manufacturers of these Flexible Enclosures are Huntingdon Fusion Techniques HFT® along with their technically trained Worldwide Exclusive Distributor Network.

Ron Sewell, Chairman for Huntingdon Fusion Techniques HFT® said: “There are many requirements within the Aerospace Industry for welding zones to be purged of oxygen down to as low as 10 ppm, which can be a problem when companies see the high costs of traditional metal chambers. Our Flexible Welding Enclosures® are an ideal solution.”

Huntingdon Fusion Techniques HFT® has spearheaded a drive to design systems specifically for the Welding Industry. The company has been at the forefront in developing these Enclosures for many years and has exploited the opportunities offered by advanced engineering polymers.
HFT® were recently called in by a specialist inshore diving contractor, who were challenged with isolating on a dam.

Technical Sales Manager Luke Keane said: “The isolation location was just 10 m underwater but up a tunnel 66 m long x 1.2 m wide. It was very probable to provide a solution but some custom machinery needed to be built for it, which required some investment from the customer.”

“HFT® designed a special Inflatable Rubber Stopper to be integrated with the contractors bespoke diving equipment that installed the stopper remotely.”

“The contractor’s skill and experience ensured the project was a success! The customers subsequent investment has saved them over a million pounds, no need to draw down the reservoir, avoided a major Civil Engineering option to install a coffer dam and the fish get to stay put.”

“A great result all round and most definitely a win-win, fantastic collaboration from the start and we love being able to save our customers money!”

The Pipestoppers® range of Rubber Plugs are manufactured from high quality materials, ensuring a long life span of each Plug. They have a temperature resistance from -40°C (-40°F) to 70°C (158°F) and are available in sizes from 2 to 78” (51 to 1,981 mm) with each Plug having a wide degree of flexibility in diameter.

### CALENDAR: EVENTS IN THE INDUSTRY

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<tr>
<th>Event</th>
<th>Dates</th>
<th>Location</th>
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<tr>
<td>FabTech</td>
<td>13 - 16 September 2021</td>
<td>Chicago, USA</td>
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<td>WIN Eurasia</td>
<td>10 - 13 November 2021</td>
<td>Istanbul, Turkey</td>
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<td>Adipec</td>
<td>8 - 11 November 2021</td>
<td>Abu Dhabi, UAE</td>
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<td>TechniShow</td>
<td>March 2022</td>
<td>Netherlands</td>
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</table>
Qwik-Freezer™ Pipe Freezing Equipment uses liquid carbon dioxide (CO2) to freeze stationary water in any chosen sections of pipe or tubing.

Here are our Frequently Asked Questions....

What condition does the pipe and water inside have to be in?
Ensure there is no flow of water through the pipe. The outside surface of the pipe must be clean of foreign matter. Water should be at 20ºC (68ºF) or colder. Always freeze on a horizontal line whenever possible. If attempting a vertical freeze, the water must be below 20ºC (68ºF). Additional injections and waiting time may also be necessary. A vertical pipe may take up to twice as long as a horizontal line and the CO2 consumption will be double. Do not attempt to freeze close to a main line that has flowing water as the turbulence can prevent formation of the ice plug.

Can I freeze on a weld?
Welds can be affected by the thermal cycle during freezing. Our advice is to inspect for defects before and after the freeze operation.

What kind of pipes can Qwik-Freezer™ be used on?
Qwik-Freezer™ can be used on any metal pipes. It is applicable to plastic pipes, but freezing will take longer.

How much water pressure will an ice plug hold?
Ice plugs have passed pressure tests up to 34.47 MPa (5000 psi). HFT® conservatively rates them to 10.34 MPa (1500 psi).

Will I need ventilation whilst freezing?
CO2 is heavier than air and will collect in confined and low-lying work areas. To prevent the danger of asphyxiation, make sure there is always good ventilation. Ventilation fans must be used in confined and low-lying spaces.

Do I need to wear safety clothing?
Gloves and safety glasses should be worn at all times when operating Qwik-Freezer™ equipment. Do not handle dry ice as frostbite could result.

What about bursting or fracturing pipes?
Pipe fractures are not caused by the ice plug or the freezing process. They are caused by a failure to allow enough space between the ice plug and closed connections. This is due to the increase in pressure that is caused by water that is displaced by the ice plug as it grows that can create a ‘hydraulic ram’ if enough space is not allowed.
DIAMOND WHEEL TUNGSTEN GRINDER

Diamond Wheel Tungsten Electrode Grinders are recommended for all tungsten electrode grinding. Tungsten is a very hard material and with the diamond wheel being a harder material it makes for a smooth grind.

The Tungsten Electrode is one of the most important variables involved in TIG welding. Preparing your Tungsten Electrode correctly will help to improve arc starting, arc stability and consequently weld quality.

Huntingdon Fusion Techniques HFT® now manufacture the TEG-1000 Tungsten Electrode Grinder with a diamond wheel, producing smooth, perfect surface finishes that eliminate arc jumping leading to consistent welds.

Ron Sewell, Chairman for HFT® said: “Using a Grinder that has been designed and manufactured specifically for tungsten metal is not only a much safer option, they provide more accurate results leading to as many as ten times greater number of arc strikes and giving very directional arcs without flicker or wander.”

“Even if you have some of the best welding equipment available, without a properly prepared Tungsten Electrode, your weld could always be compromised!”

The use of the TEG-1000 Grinder will give repeatable Tungsten Electrode points every time, enabling consistent arc performance and welding results. Sizes 1.0 to 3.2 mm can be ground as standard, with other sizes catered for on request.

PIPE PURGING AT A LOW COST WITH WELD PURGE FILM®

Titanium, stainless steel and other corrosion resistant materials are widely used for pipework. It is therefore necessary to ensure that a reduction in corrosion resistance does not occur during welding when elements are lost due to oxidation. The joint can be protected against oxidation using a technique called Weld Purging.

Huntingdon Fusion Techniques HFT® have designed and developed Weld Purge Film®, a water-soluble purging barrier for a variety of pipe sizes, which keeps Weld Purging costs low.

Ron Sewell, Chairman for HFT® said: “Argweld® Weld Purge Film® will save operators large costs by minimising gas usage and cutting down dramatically on time taken to make a purge. It is also ideal for closing welds where a tandem Weld Purging System may not be suitable. After welding, the water-soluble film is simply washed away during the standard hydrotest cycle or by water rinsing of the pipe interior.

Previously, pipe welders might have used water-soluble paper, but as paper contains a high percentage of water which is undesirable to have near a weld, the Argweld® Weld Purge Film® is a tremendous new benefit for Weld Purging.
When welding reactive metals such as titanium, zirconium and nickel alloys, it is important to monitor the oxygen level before, during and after welding especially in industries where tubes and pipes must be free from oxidation with no metallurgical defects.

Weld Purging Experts Huntingdon Fusion Techniques HFT® have designed and manufactured the PurgEye® 600, an all in one Weld Purge Monitor®, which reads from atmospheric level of oxygen (20.94%) down to one part per million (0.0001%).

Georgia Gascoyne, CEO for Huntingdon Fusion Techniques HFT® said: “Possibly the greatest feature of the PurgEye® 600, apart from its total measuring range, is our revolutionary PurgeNet™, which can connect together smart accessories such as a visual warning alarm in case of rising oxygen levels.”

The stylish desktop PurgEye® 600 has a colour touch screen with graphics model, which allows the user to pre-set oxygen of their choice to trigger alarms. Using ground breaking technology, the PurgEye® 600 has a long life sensor and has been designed with a large, full colour touch screen (3.2”/ 81 mm) and on-screen graph displaying the oxygen levels during the welding process.

The PurgEye® 600 also comes with PurgeLog™ data logging capability for easy transfer of data logging and weld certification for quality control purposes. The PurgEye® 600 Weld Purge Monitor® is ideal for all industries where oxide free, zero colour welds have to be achieved and where traceability is a major advantage for the requirements of high-end Quality Control systems.
The marine industry in general has been slow to embrace the 3D printing concept. The use of continuous liquid metal deposition under computer numerical control has created opportunities to produce complex shapes such as forgings and castings whilst avoiding the need for expensive tooling and the time delays in fabricating moulds.

Notwithstanding this slow start, development work at Delft Technical University in 2017 has led to the production of the world’s first metal deposited marine propeller.

The majority of published documents on 3-D printing have been restricted to high precision applications, particularly in the medical sector.

Whilst these examples illustrate the potential for producing small complex shapes the process is slow and expensive. Less well promoted are applications in which large engineering products using metals have been produced faster and less costly than using traditional methods such as casting and forging.

The concept of 3-D printing

Several methods for 3-D printing using metals are now in regular use by specialist organisations. Essentially they involve using a targeted heat source to melt or sinter metal alloys and progressively build up a complex three-dimensional shape. A computer numerical control system, usually a multi-axis robot, guides the heat source. Solid metal in the form of wire or powder is fed into and is fused by the heat source.

One version uses a laser or an electron beam as the heat source in conjunction with metal powder, Direct Metal Laser (DMLS) or Electron Beam (DMEBS) sintering. This powder technique is most effectively applied where smaller, delicate objects are required. An example is the production of body implants [1 – 3].

The welding version of 3D printing, Wire and Arc Additive Manufacture (WAAM), is performed by laying down progressive beads of metal, [Figure 1]. This technique is more suited to the production of larger and heavier engineering components as evidenced by the manufacture of marine components and airframe structures [4 – 6].

In terms of applications for WAAM and DMLS/DMEBS the welding version is most suitable for heavier and larger products whilst the powder alternative is best applied where smaller, delicate objects are required. In other words, welding is essentially a bulk deposition technique and powder is a precise and highly controlled process.
Examples of WAAM manufacture

Several applications of 3-D production have been made and are appropriate to illustrate the potential in the marine industry. These are illustrated in Figs 2-4.

Driving forces behind WAAM development

The primary driving force behind the development is the potential to make huge savings in materials and therefore costs. One specific area of application is in airframe manufacture. Many components are made currently by machining from a solid billet or forging, but over 50% of the original stock is lost as swarf. Another area under consideration is landing gear production where a cost saving of 70% is expected by using additive manufacturing.

Current Activity

Additive layer manufacturing offers several advantages for certain structural components such as a vast reduction in material wastage, especially when producing many heterogeneous parts, and the ability to produce a great variety of part designs for prototype work quickly. There is also the key benefit that it allows the consideration of unconventional designs that otherwise would not be practical because of manufacturing or cost constraints due to, for example, complex or unusual geometries, bringing with it many different opportunities and challenges.

Early work at Cranfield University for Rolls-Royce targeted aero engine applications. Researchers here developed the wire + arc deposition process to examine the use of Inconel, titanium, aluminium and various nickel alloys. Since then the focus has shifted to airframes. Although laser and powder methods are useful for certain applications such as rapid prototyping or for small highly complex parts, this technology is limited by its speed and the size of component it can accurately manufacture. In contrast, the processes being developed at Cranfield are designed for high deposition rates.

To put this difference into context, the Cranfield centre is currently targeting a deposition rate of 10 kg/hr, compared with a typical 0.1kg/hr using laser + powder methods, which can also potentially carry the risk of the material not being fully consolidated if fusion has not occurred between grains. Additive arc + wire systems are also capable of producing parts several metres in size and simplify the process of producing single piece linear intersections.

The Damen Shipyards Group entered a cooperative consortium with RAMLAB, Promarin, Autodesk and Bureau Veritas to develop first class approved marine propellers.

The early work terminated in the production of the world’s first WAAM manufactured propeller in 2017 [8]. It is based on a Promarin design typically found on a Damen Stan Tug type 1606 [Figure 5].
Cost of Consumables

Only a limited number of metallic alloy systems are currently available for additive manufacturing using powders principally Ti-6Al-4V, some stainless steels, Inconel 625/718, and Al-Si-10Mg. The cost for many stainless steels is in the region of $400/kg. Few problems remain when it comes to fusion welding and consequently an extensive variety of wire electrodes is available, most of which can be used for arc deposition. Because of the quantity of wire manufactured the cost is not high. Typically, stainless steel filler wire is readily available for $30/kg.

Deposition Rate

Powder deposition rates are very low and average 0.1 kg/hr. With advancing technology this may well increase but at the present time this severely restricts applications. The wire arc process is capable of laying down 10 kg/hr of a wide range of metal alloys. [Table 1.]

<table>
<thead>
<tr>
<th></th>
<th>WAAM</th>
<th>MLS/DMEBS</th>
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<tbody>
<tr>
<td>Available Range of Filler Metal</td>
<td>Wide, all standard filler wire compositions are readily available</td>
<td>Limited powders generally need to be specially manufactured</td>
</tr>
<tr>
<td>Cost of Filler Metals</td>
<td>Low</td>
<td>High</td>
</tr>
<tr>
<td>Cost of Equipment</td>
<td>Low, standard GTAW plant coupled with low cost purging equipment</td>
<td>High, specialist precision instrumentation necessary</td>
</tr>
<tr>
<td>Deposition Rate</td>
<td>High, 10 kg/hr</td>
<td>Low, 3.1 kg/hr</td>
</tr>
<tr>
<td>Applications</td>
<td>Larger and heavier parts over 5 kg and above 40 mm</td>
<td>Small precision objects typified by prostheses and auto/aerospace components</td>
</tr>
<tr>
<td>Strength</td>
<td>Generally equal to parent material strength</td>
<td>Limited information available but generally good</td>
</tr>
<tr>
<td>Advantages / Disadvantages</td>
<td>Low cost, but post-deposition machining often necessary</td>
<td>High cost, but precision deposition produces near-finished parts</td>
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Table 1. Comparison of Wire and Arc Additive Manufacture (WAAM) and Direct Metal Laser/electron Beam Sintering (DMLS/DMEBS)

Process Limitations

Many alloys may be used during the WAAM process simply by using the welding torch inert gas shroud as protection. However, some materials are much more prone to reaction with residual oxygen and this can lead to fusion zone and surface oxidation. Titanium alloys are particularly sensitive but stainless steels, and many low alloy steels also demand additional inert protection. With the electron beam process, protection is assured since operations are carried out in a vacuum. Nevertheless, this is an expensive alternative to arc welding.

Overcoming the Problem of Oxygen Contamination

The issue of adequate protection has been resolved by developing flexible enclosures that can be purged with inert gas, usually argon. These can accommodate the entire welding equipment and robot and provide inert gas protection throughout the deposition process.
Flexible Enclosure Technology

There have been considerable advances in enclosure development since the concept was introduced over two decades ago. Huntingdon Fusion Techniques Ltd [10] for example has spearheaded a drive to design systems specifically for the welding industry. These innovative products offer significant attractions over both vacuum and glove box alternatives not least a significant reduction in cost.

The largest facility to date has a volume of 27 cubic metres, adequate to accommodate all workpieces, welding equipment and even a programmable robotic system. By purging the enclosure with inert gas an operating oxygen content is low enough to prevent oxidation during welding and cooling.

Monitoring the Oxygen Content

Control and real-time monitoring of the oxygen content of the purge gas is crucial if discolouration and loss of corrosion are to be avoided. Techniques for measuring oxygen content have been available for decades but only recently have instruments been developed specifically for welding applications. Users increasingly demand complete absence from discolouration and no loss of corrosion resistance and this implies purge gas oxygen content to be as low as 20 ppm (0.002%). Very few oxygen purge monitors are capable of meeting this sensitivity but the PurgEye Monitors cover all requirements.

Conclusion

A crucial benefit of 3-D printing is that it opens up possibilities for the production of complex designs that otherwise might not be practical or economic. In terms of applications for WAAM and DMLS/DMBS the welding version is most suitable for heavier and larger products whilst the powder alternative is best applied where smaller, delicate objects are required. In other words, welding is essentially a bulk deposition technique and powder is a precise and highly controlled process. Many alloys need to be protected from contamination during the welding operation. The formation of metallic oxides can reduce corrosion resistance and affect mechanical properties. The use of an effective oxygen-free inert gas environment is essential.

References

Damen shipyards release further details about world’s first 3D printed propeller. 3D Printing Industry. September 2017.
Wire+arc additive manufacturing vs. traditional machining from solid: a cost comparison. Martina F.
Huntingdon Fusion Techniques Ltd, UK

Acknowledgements

Fig 1: www.researchgate.net.  Figs 2, 3: FIT Prototyping GmbH Germany  Fig 4: Cranfield and WAAM3D ltd waaam3d.com  Fig 5: Damen Shipyards, Netherlands  Figs 6, 7: Huntingdon Fusion Techniques Ltd, UK
SAFER WELDING by Switching to Blue-Tipped MULTISTRIKE® TUNGSTEN ELECTRODES

Huntingdon Fusion Techniques HFT® design and manufacture blue-tipped MultiStrike® Tungsten Electrodes.

- MultiStrike® Tungsten Electrodes are non-radio-toxic, non-thoriated, non-carcinogenic.
- They will strike 10 times more arcs than a red tipped thoriated tungsten, when tested under identical conditions.
- Suitable for a wide variety of welding operations, particularly effective in the welding of titanium, stainless steel and aluminium AC and DC.
- Providing savings through longer life, more strikes per electrode before grinding, less re-work, less wastage and lower power requirements.

Eliminate the thoriated dust in the atmosphere by changing to MULTISTRIKE® TUNGSTENS so that when there is tungsten grinding dust, it is not radio-toxic.

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