WELDING EQUIPMENT

IN THE ZONE - A new approach to solve welding arc blow

Magnetism stops welding. New methodology complements techniques using cables wrapped around the object. John Anderson reviews demagnetising deployment methods and introduces the new product concept - ZeroZone

Typically, magnetic arc blow turns up in pipelines or constructions where the steel components have been aligned north-south for long periods of time. This causes the components to become magnetised and, typically when repairing or tying-in a new part, magnetic arc blow occurs. There are other causes of remanent magnetism, most notably, NDT, storage and handling.

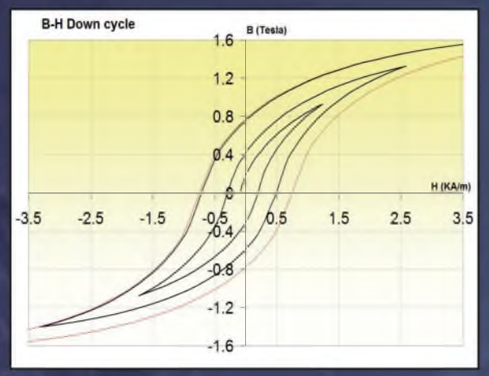
At the sharp end, magnetic arc blow causes welding job delays, poor weld quality, welder frustration and unexpected costs; this is particularly frustrating when everything is in place yet the project is completely stalled. When working from a lay barge or sub-sea the costs incurred in setting up the job and the day cost of the support means that even short delays are very expensive. For those who have not planned for this problem all sorts of schemes are tried: heat it up, hit it with a hammer, trail the weld set cables over it or put in sacrificial bridges of weld metal.

Each of this has an element of truth in the thinking but in practice are poor (or impossible subsea), briefly:

1. Heating the material beyond the Curie point will remove the magnetism but heating the whole pipe to ~600C, is energy inefficient, dangerous and could cause metallurgical changes.
2. Striking or vibrating parts can in time remove magnetic fields - not practical with even modest sized components.
3. Magnetism will be affected by current from conductors - bad news is it can make it worse.
4. Weld metal bridges across the joint will divert magnetic flux - but many such bridges are required for a good magnetism reduction which is the same as putting in bad weld and grinding them out!

Methods that work

Fortunately, there are a number of methods for overcoming magnetic arc blow that work well if you have the right equipment - Zeromag, essentially a smart bi-directional high current power source. The techniques that can be used are:



Above: down cycle of magnetism in steel

1. Field nulling or balancing: this sets up a magnetic field in the opposite direction to the remanent field reducing the new field to zero. This works almost instantly minimising job delays.
2. Degaussing: this down cycles the magnetic material in ever reducing bipolar current loops until the magnetism is gone (see graph). This is only really practical for pipe ends or a pipe weld joint. Although a good approach it has several practical problems. It can be slow taking minutes or even tens of minutes to do the job. Worse it may not be effective at all if the strength of the degaussing field is too low (below the saturation magnetisation of the material). The high field necessary requires high currents and for the time to degauss this is very energy intensive.
3. Single cycle degauss: this method, unique to Zeromag, is to 'learn' the pipe material and then execute a specific single cycle degauss profile. The time taken is much reduced, although the levels of remanent field are slightly higher than down cycling.
4. AC degaussing: Penetration depth into the steel when running at line frequency of 50/60Hz is insufficient to degauss thick walled plate or pipes completely but can work well on thinner material.

For all the above methods, demagnetising cable must be deployed, preferably around the steel object that has the magnetism. This can be facilitated for pipes up to about 2 metres diameter using clam coils that effect the cable wrapping of 25 turns in a single action.

The magnetic effect

The magnetic arc blow effect is due to the combination of current in the weld plasma and the magnetic field resulting in a force on the plasma that is perpendicular to the current flow in the arc and the magnetic field direction. For a pipe weld, the magnetic field direction is axial with the pipe, the current will be radial to the pipe and the resulting arc deflection will be circumferential.

With low magnetic field levels welding can proceed unaffected, however, as magnetic field levels increase, the arc becomes progressively more unstable and difficult to control. The result is often poor quality welds that have to be ground out. At even higher fields the arc blows out such that the arc is immediately extinguished and no welding can take place.

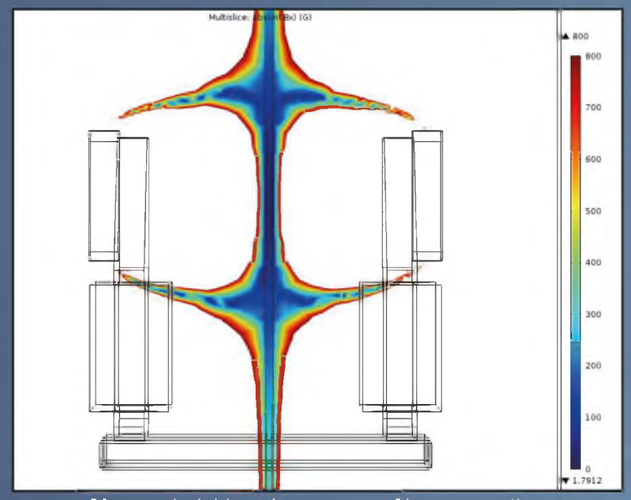
Subsea wet welding is difficult so removing magnetism problems is an essential prerequisite for quality welds.

Enter the zone

When working with large plate or pipes, the demagnetisation process requires that the magnetic field is controlled via the demagnetising cables. When the object is large it cannot be coiled around with the cables so normally lay on coils are used where coils are simply laid on the component either side of the weld prep. This works well for modest fields, but for high fields the most efficient way to null the magnetic field is to use ZeroZone. This pre-wound assembly provides a magnetic bridge across the weld prep to allow control of the magnetism.

ZeroZone is a new concept marrying together all the demagnetising methods that work, with the metal bridge idea that discussed earlier. The product is an optional add-on to the Zeromag system and when deployed on a pipe or plate produces a zone that can be completely controlled magnetically without the need for demagnetising coils. The resulting system is highly efficient and will nullify fields approaching 1000 gauss.

In operation, ZeroZone is placed across the weld prep. The arms and pole pieces are adjusted so that the active area of the pole pieces are in close contact with both sides of the work piece. Mechanical adjustments allow for 2 orthogonal angular adjustments to allow for misalignment of the abutted planes of the 2 plates. Pole pieces are supplied to cater for both plate and a variety of pipe diameters.



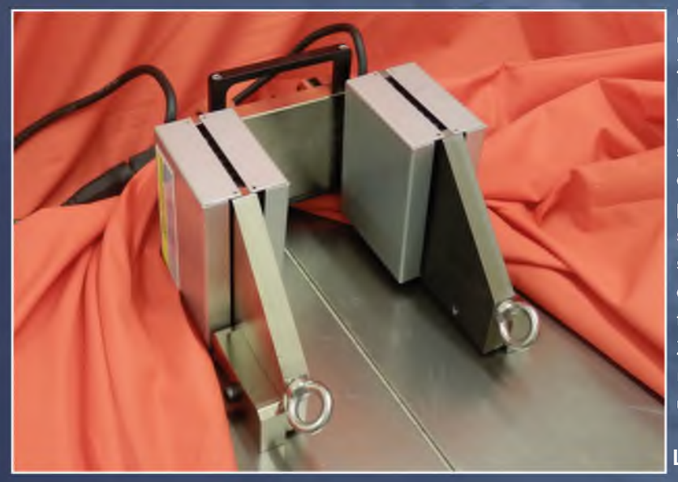
Above: dark blue shows zone of low magnetism

In deployment, ZeroZone is connected back to Zeromag and the system operates with all the normal modes of Zeromag are available - manual nulling, automatic nulling, downcycle degauss and single cycle degauss.

Using Zeromag nulling, welding can commence immediately within the jaws of ZeroZone, and as the weld advances, ZeroZone can be moved to track the torch or welding halted to allow ZeroZone to be moved. The technique used depends on the application. See sub-sea article for under water application.

Subsea zone

ZeroZone can be used subsea - with wet welding. In this case the Zeromag is sited topside and ZeroZone and the Zeromag probe used by the diver in the water. Its operation in this mode requires some small changes to the standard setup: the connectors to the cables to Zeromag need to be sealed from the water and a special version of the Zeromag probe is required sealed for subsea operation. With this arrangement ZeroZone can be used at depths of up to 40 metres (130 feet), so it can be used for repairs on rigs and offshore steel frameworks for wind power generators.



Left: ZeroZone on two weld plates

The key advantages are efficient nulling of the magnetism and complete electrical safety. Working subsea with ZeroZone the largest possible differential potential is 15 volts, although in practice the normal working potential is about 1 volt at 30 amps. All the electrical power systems remain topside.

Summary

The ZeroZone product is a new approach to solving arc blow problems. It is most applicable for large components, plate, pipeline and complex infrastructure such as heat exchangers or LPG tanks. Its advantage is that, working with Zeromag, the user can enjoy all the magnetic field control measures in a targeted zone where the welder is working.

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