State of the Arc

Magnetism in pipes can stop welding progress

Magnetic arc blow can be a serious issue with some pipe welding jobs. John Anderson looks at its causes and how you can overcome the problem.

Arc blow can stop a job dead in its tracks – no good welds so no progress. This can be a great frustration to welders and result in very expensive project delays. This article looks at the phenomenon of magnetic arc blow, its causes and how to overcome it.

Arc deflection, or indeed extinction away from the point of welding due to magnetism, is generally referred to as (magnetic) arc blow. This may result in poor quality welding and usually occurs if the material being welded has residual magnetism. The effect occurs because of the interaction between the magnetic field of the welding arc and the field of the residual magnetism.

Causes of the magnetism

The cause of the magnetism will determine the effects that you see. For example if the material is left in the earth's magnetic field it will pick up magnetism over time (especially for a buried pipe) - the induced field will usually be even and longitudinal i.e. the same around the circumference of the pipe.

It can be induced by magnetic clamps (on pigs or on pick up), or residual magnetism left by magnetic inspection. In this case there will be zones of magnetism around the pipe, including reverses in polarity. Finally, simple actions such as plasma cutting or material stress can induce magnetism.

The effect is most pronounced in steels and although the magnetism in the material (measured in air at the end of the pipe) may only be a few tens of gauss, after fit up, the field becomes concentrated in the gap between the two pipes. In this situation the field may reach 1000 gauss. The effect of the magnetic field depends on the welding process but a good estimate is to assume that fields greater than 30 gauss will cause problems.

The make up of the steel has a significant effect on arc blow problems. This is because the element mix of the melt changes the magnetic properties and in particular the magnetic remenance (or memory). Steels with a high nickel content are particularly prone to this problem.

In practice, it is the root weld that gives the most trouble, because as the weld progresses, a degree of magnetic shunting takes place and field that would have appeared in the weld preparation is routed through the weld metal of the root pass. Nonetheless, some arc blow problems persist to the third or forth pass. For some pipes, where there is a lining of stainless steel or Inconel, the arc blow problems can occur not at the root pass but at the interface between the steels.

Solving the problem - remove the magnetism

So how can arc blow problems be solved? There are basically two ways, remove the magnetism altogether or reverse the local magnetism using externally applied fields.

To remove the magnetism completely, the material can be heated to the Curie Point, typically 1000C and allowed to cool in a zero field. For small parts this is feasible, but for pipes or plates, the energy cost and magnetic leak back make it impractical.

The magnetic field can be removed by degaussing, in a similar way to Navy ships during WW2. This technique requires that the part is placed in an ac field that is slowly reduced to zero. Although a good approach there are a number of problems. It can be slow, taking hours or even days to do the job. Worse, it may not be effective at all if the strength of the degaussing field is too low (technically below the field that magnetically saturates the material). Finally, most degaussing systems operate at line frequency (50/60 Hz), which has

Fig. 1. Zeromag in use on underground pipeline

Fig. 2. Demagnetizing a gas pipeline

a poor skin penetration into the material, so the process may be successful in degaussing the top layer, but underneath the magnetism persists. Low frequency degaussing, for example using the Diverse ZM150 which can be operated at a much lower frequency, guarantees penetration into the material.

Dynamic demagnetising

The alternative approach is to reverse the magnetizing field dynamically as the weld progresses. The Zeromag ZM100A is designed specifically for this application, and can operate in one of two ways, manual or automatic. In manual mode, the reversing field is applied and used to drive the field to zero. This works well for longitudinal magnetism. However for zoned magnetism, where the field is changing or even reversing around the weld, automatic operation is required. In this mode, Zeromag dynamically compensates for the magnetism at whatever level or direction as the weld progresses.

Arc blow occurs in any weld scenario where the base material has remanent field. In pipe welding this is particularly difficult when welding new pipe to pipe that has been in place for a number of years. There are other applications: in building with construction steels, in ship building with ship plate and in the manufacture of PNG storage. This latter application can be particularly taxing as the problem progressively builds up as the construction progresses. To overcome the magnetism with this type of job it is not possible to wind coils around the parts so it is necessary to have a deployment frame built for the demagnetizing coils.

Production considerations

The method used to deploy the demagnetizing coils depends on the job. If there are only a few welds then the demagnetizing coils can be deployed manually. For pipe lay scenarios either across land or from a lay barge, clam coils are required that allow the demagnetizing coils to be put in place in a few seconds. If pipe end degauss is being used, or pipe pass through at a fixed weld station, then special bobbins are required.

We have seen that arc blow can occur on a wide variety of welding jobs. By adopting some simple techniques the effects can be mitigated. For more difficult scenarios where the material or geometry make simple techniques ineffective then specialist equipment such as Zeromag should be used.

John Anderson is a technical magnetism specialist at Diverse Technologies, solving arc blow problems for leading welding companies around the world.
www.diverse-technologies.net

Ways to reduce arc blow

The effect of the arc blow can be reduced and completely eliminated using Zeromag. However, there are some simple things you can do without specialist equipment.

Arc blow is due to an interaction of magnetic fields and part of that is the current through the arc plasma. It is often easier to control a backward deflecting arc by welding in a direction that is towards the earth point. With pipe welds it may be that you can have multiple earth points or a circumferential strap that will overcome this aspect of arc blow.

Modify the arc drive parameters – the current flow and arc length will affect the level and incidence of the arc interference with the remenant field.

Use AC or high frequency AC rather than DC welding supply.

Some welders suggest using schemes where the power to the arc is wrapped around the work piece. Although this can help, it can make matters much worse! You can end up inducing very high magnetic fields in the pipe rather than removing them, and these in turn will be very difficult to remove without specialist equipment. A much better approach is to use Zeromag as this gives proper control of the field.