MIG/MAG welding – 'Semi-Automatic'- Not Semi-Skilled.

You may be more familiar with the term MAGS (Metal Arc Gas-Shielded) welding or even $C0^2$. In the USA it's known as GMAW (Gas Metal Arc Welding). But, to be honest this article is not about the use of terms, providing of course, we all understand I am talking about Metal Inert/Metal Active Gas welding, commonly referred to as MIG/MAG welding in the UK, even though the most common gases are a mixture of argon and CO^2, rather than just CO^2.

A more accurate term might be described as 'semi-automatic', meaning the arc is 'self-adjusting'. Any variation in the arc length produces a change in the 'burn-off' rate allowing rapid re-establishment of the original arc length.

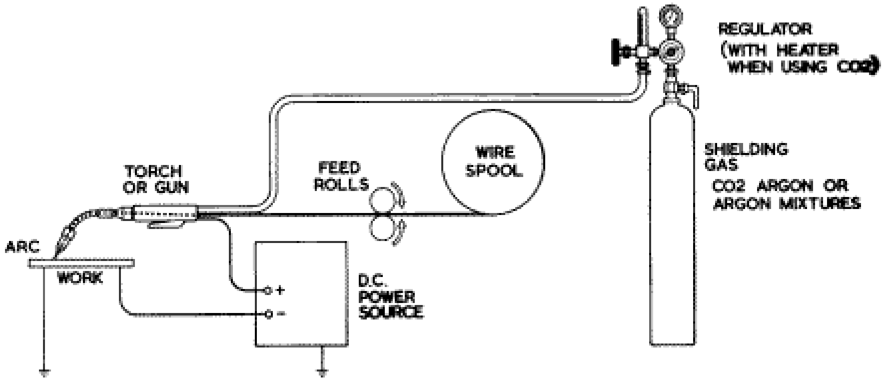
Semi-automatic welding consists of a DC arc burning between a thin metal wire electrode and the workpiece. The arc and weld zone are enveloped in a protective gas shield. The wire is fed automatically from a spool, through a torch, which is connected to the positive terminal and is moved by hand.

Now that we have got this out of the way, what I really wanted to discuss is where this process fits into today's industry and what problems, if any, we are now seeing. You certainly don't have to be a welding expert to know that in every fabrication shop up and down the country at every level, from DIY to high-tech, the MIG welding process is there, and for very good reasons. MIG has all but replaced Manual Metal Arc (MMA) welding, and in a fabrication environment has completely replaced oxyacetylene welding in all but in the smallest of vehicle body shops. It's probably fair to say, in its simplest form, it hasn't totally replaced MMA welding where pressure vessels are concerned. Although in its high-tech form 'synergic' the process provides solutions to some of its weaknesses, more about these in a minute. Synergic in simple terms may best be described as 'pulsed' current control.

So what's the problems with the process? Actually there is nothing technically wrong with the process at all, other than it may be too easy to use! It's more of a problem with the state of our industry and the demise of fully skilled/trained welders. The MIG welding process clearly offers some major advantages over MMA, not least of which is a massive increase in productivity and yes, it is easier to initially learn and to use.

Because the process is 'semi-automatic' it does mean in less experienced hands the potential for weld defects is actually increased. This is due to it being easier to operate, or at least it appears that way. But is it?

This is a large part of the problem. In real terms producing high quality welds by MIG welding should be no easier than any other welding process, but because the operating parameters and controls for the machine are easier to select/control the process can provide the illusion of creating a successful weld, when the reality may be quite different.



BASIC REQUIREMENTS FOR SEMI-AUTOMATIC MIG WELDING

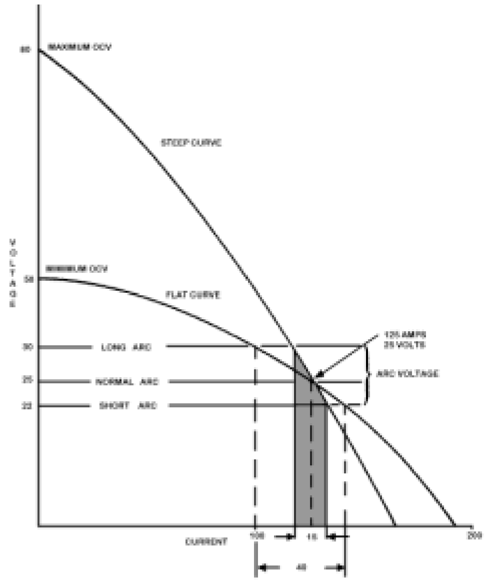
Even in the hands of an inexperienced welder it would be possible to produce acceptable looking welds in a very short period of time. Unfortunately, this is the whole point. As we don't have the bank of skilled welders we once had, manufactures have to source welders wherever they can. Personnel employed in one discipline are often asked to master several, usually without the benefit of formal training. Because of MIG weldings undoubted benefits, the process is the only sensible solution when it comes to mass-production as well as maintenance and fabrication environments. However, it is these very benefits that are now affecting industry, through an increase in weld defects, which tend to go unnoticed until a failure occurs.

On our travels up and down the country we see more and more problems with MIG welding than any other process. Out of all the welds or welders we test, MIG welding has the highest failure rate and when it comes to a typical 'T' joint fillet weld test, I would go as far to say only 20% of the welders we test are able to ensure adequate root fusion is produced on a first attempt. We believe in part, this is due to it being considered as a semi-skilled method. Also, in part, by an increased tendency for MIG welding to be susceptible to certain types of weld defects, i.e. lack of fusion and cold lap are common.

With a small diameter wire you can weld thin gauge metal, or thick steel plates/pipes in any position and do nothing but flick a couple of switches and adjust the wire feed speed! If the same person were asked to make a weld using MMA, in the same training period, it would be most unlikely they would succeed. This is because the only variable a MMA power source provides, is current. Get that wrong and the results will be poor. Whereas MIG welding, being semi-automatic, controls voltage and wire feed speed automatically thereby, controlling arc length/burn off.

For all fabricators where MIG welding is used it's fair to say 8-10 of the welders employed will be self-taught or at best semi-skilled on that process. The real knowledge and ability of many MIG welders is frighteningly poor, daft as it sounds, this is probably due to the ease and popularity of use. If you speak to any skilled welder, he will always tell you he avoids MIG welding, if possible! This 'semi-automatic' principle of operation doesn't mean the process is semi-skilled; it refers to the control of welding parameters that would otherwise have to be controlled by the operator. The result being, the machine will accommodate an inappropriate, or less than ideal setting, thereby, permitting a weld to be made. Whereas, the other welding processes mentioned provide nothing to the operator other than a value of current (amps). It's the skill of the operator who then produces the weld.

Let me explain a little further. The graphs below show two completely different welding power source characteristics. A 'drooping' characteristic, or constant-current output, typical of MMA/TIG welding and a 'flat' characteristic or constant-voltage output typical of semi-automatic welding.



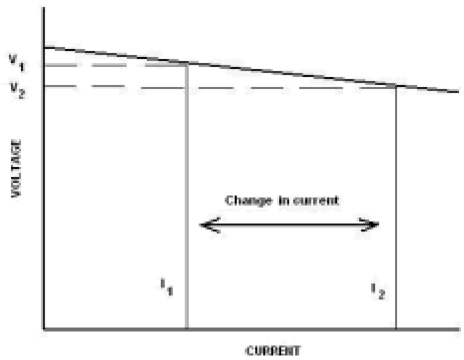
A typical 'drooping' characteristic curve for MMA welding.

As you can see there is no similarity.

With the drooping characteristic you can see a small change in arc voltage produces a much smaller change in arc current, depending upon the open circuit voltage (OCV). This means the burn-off rate is much slower for MMA welding, or put another way, for any given change in arc length the current change is small. This allows manual welding to take place, as even in the hands of a skilled welder, arc length will vary as welding is progressed, but under these circumstances the current changes will only be small. As current is the only controllable variable the welder can set, it's essential this remains as close as possible to the value selected.

With the flat characteristic you can see a large change in current for a small change in voltage. Because of this, the power source controls arc-length. If this were left to the welder, as in MMA, the change in current would be so large it would not be possible to produce acceptable welds. Therefore, in all semi-automatic welding the arc-length and the 'burn-off' rate are controlled by the machine.

The burn-off rate increases as the arc-length decreases so as to rapidly compensate for the increase in current from I_1 to I_2. This response rate needs to be extremely rapid. Of course the welder needs to try and maintain a consistent 'stick-out' length. Stick-out length may best be described as the distance from the contact tip to the work piece.



A typical ‘flat’ characteristic for MIG welding.

At the end of the day, because MIG welding is easier to control, it is easy to master in a shorter period of time. This means training courses don’t need to be lengthy affairs, but massive improvements can be seen in under a day for anybody currently engaged in MIG welding who may have never had the opportunity to be trained.

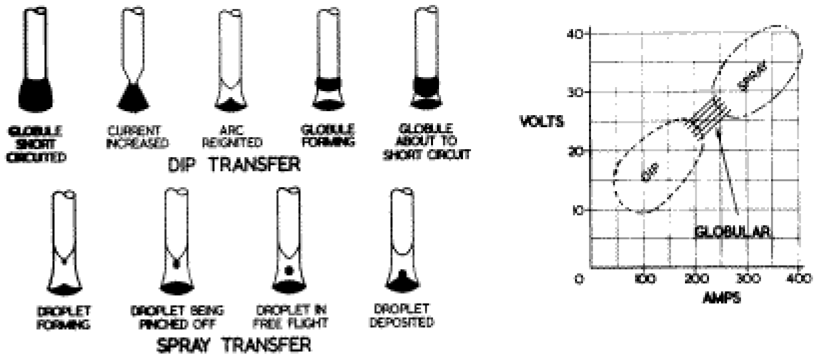
Do you know how many methods of transfer MIG welding provides? Do the terms “dip”, “globular”, “spray” or “pulsed” mean anything to you? Are you familiar with the term ‘inductance’ or ‘choke’? How is amperage selected for MIG welding? What are the settings on the front panel on a MIG machine controlling? Do you always get high levels of spatter when welding? What gas flow rate should be selected? What is the importance of the contact tip and weld quality? How do you need to set the feed roller pressure?

These are just a few basic questions. If you cannot answer these or are not familiar with the terms the chances are you are not operating the process to its best potential and weld defects, or at least poor productivity, will be inevitable.

Dip transfer, also known as short-circuiting, is carried out using currents below 200 amps and below 24 volts. Under these conditions the arc is so short that the molten globules at the electrode tip ‘short-circuit’ to the workpiece at rapid, regular intervals. The current during short-circuiting melts off the electrode tip and allows re-establishment of the arc. This is ideal for welding on thin gauge materials and out of position working and/or root runs for butt welds.

Inductance controls the rate of rise up to peak current during dip transfer. Without the correct setting it will cause globules to explode out of the arc resulting in excessive spatter. Too slow a current rise will result in stubbing or starting problems. The higher the inductance the lower the speed at which the short-circuiting current builds up. A low inductance setting will give higher short circuiting frequency and a relatively cold weld. High inductance will give lower short circuiting frequency and a relatively hot weld due to longer arcing periods between short circuits.

The actual amperage in MIG welding is controlled by the wire feed speed. The faster the speed the higher the amperage draw.



Shows dip and spray transfer mechanism and the current/volts necessary.

In setting up the machine, you are actually setting the voltage, which needs to be in keeping with wire speed feed. Once the wire feed speed and voltage are set the circuit may be "choked" to produce the correct arc condition.

Spray transfer operates at over 250 amps and over 25 volts. The metal is transferred across the arc in free flight droplets in the form of a fine spray. This transfer is limited to flat/H-V positional welding for steel, due to the large liquid weld pool but will provide a high deposition weld-metal deposit. This means it's limited to thicker materials.

Gas flow rates will depend on the worksite conditions and to some extent the work to be welded. If we assume you are using a mixture of argon and $C0^2$ you should set a flow rate of between 12-18 ltrs/min. The shroud will also need to be kept clean as this also affects gas flow. Tool high or low a pressure and porosity will occur. The contact tip is another important consideration. This does get damaged easily and is essential to good electrical contact, as it transfers current to the wire. Therefore, a worn tip will present all sorts of electrical contact problems. The feed roll pressure is another factor often overlooked as not being particularly important, as is the drum break. If pressure is too high it will deform the wire and cause poor current pick-up, too little pressure and the wire will misfeed.

If we consider all the possible shortcomings discussed so far, it's not that surprising that weld defects and failures occur. The good news is, to train welders so they better understand the process and can select the correct welding parameters is a quick and simply affair.

If you would like to improve your skills, productivity, quality and costs. Please contact Speciality Welds Ltd, or visit our website at www.specialwelds.com

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