Trends In Materials, Welding And Cutting

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INTRODUCTION

During the 1980s there was rapid development in the field of welding and cutting. The MIG/MAG method became firmly established and overtook welding with covered electrodes; lasers began to be used for both cutting and welding, and tubular wire made its breakthrough. The 1990s are unlikely to see such major changes in welding and cutting technology; instead, the developments and trends that can be seen today will remain with us for some time to come.

One need only look at traditional welding methods such as welding with covered electrodes (MMA). MIG/MAG, and submerged arc welding (SAW) (see Fig. 1) to realise straight away that there has been a sharp decrease in welding with covered electrodes since the mid- 1970s, and a simultaneous increase in MIG/MAG. This increase will continue. Since Fig.1 shows consumption pattern of filler material, methods that use little or no filler material, such as TIG or plasma welding, are not included in the comparison. The use of tubular wire has increased and is expected to increase further, especially gas-shielded tubular wire. The use of self- shielding tubular wire, as it is known, is still limited, and it is widely expected that it will not increase.

Welding methods

Welding with covered electrodes (MMA)

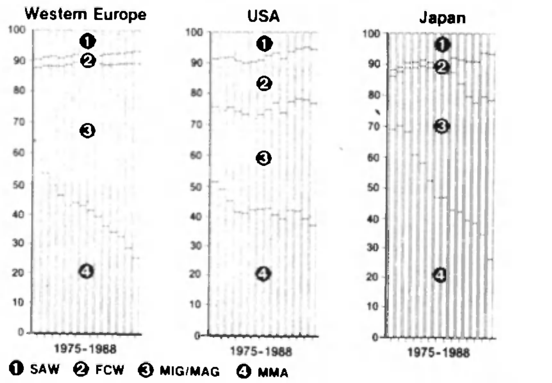

Fig. 1 : Weld metal consumption per process 1975-1988

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As Fig. 2 shows, welding with covered electrodes is decreasing, but the rate of decrease is expected to decline and eventually stabilize at a level of about 25-30% of the total consumption of filler material. The method will be able to maintain its position because of its relatively low equipment cost, versatility and ease of handling. The market also offers a large number of special electrodes for repair and maintenance welding, which accounts for quite a large proportion of all welding. In the USA it is estimated that 18% of all welding consists of repair or maintenance. In developing countries such as China and Latin America, welding with covered electrodes will continue to be the dominant method. Overall, use of the method will increase in those countries because of market growth. However, the growth will be considerably lower than for MIG/MAG welding.

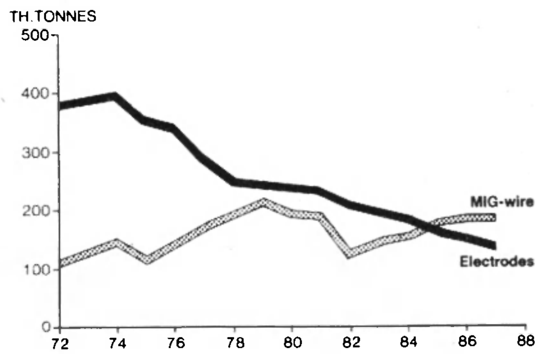


Fig. 2 : Sales of welding consumables in Europe

MIG/MAG welding

MIG/MAG is currently the most common welding method in both Western Europe and the USA. Use of the method will continue to increase, though not at the same rate as during the 1980s. In Latin America we estimate the growth during the 1990s to be 10% annually. Globally, the development of the method will be slower during the 1990s. The MIG/MAG method is known to be a highly productive method of welding, but is not always regarded as being among the quality methods. The most important task in the years ahead will probably be to try and change this view. In Japan this goal has already been achieved, since the MIG/MAG method is seen there as a quality method, suitable among other things for welding pressure vessels. Even reactor vessels are welded by the MIG/MAG method in Japan.

Areas of interest for discussion where MIG/MAG is concerned are :

* pulsing * tubular wire * narrow gap welding
* new shielding gases * mechanization.

Pulsing

During the 1980s new power sources were developed. Thyristor, inverter and transistor control made it easier to adjust the welding parameters and contributed to the development of power sources of synergic type for pulsed arc welding (see Fig. 3). Modern synergic MIG/MAG machines are very simple for welders to use. All they need do is set the wire feed rate and enter details of the filler material, shielding gas and wire diameter. On the basis of this data the power source sets the correct arc voltage and appropriate pulse parameters. Pulsed welding has advantages such as reduced spatter, higher productivity in certain applications and considerably less risk of pores. The method is mainly used for welding aluminium and stainless steel. It is widely believed that pulsed arc welding will increase greatly during the 1990s, since the method will also be used for welding mild steels since the power sources for pulsed arc welding will become ever better and cheaper. On the other hand, there is an opposing view that the methood is only justified for certain applications, and will therefore always be a nice method for aluminium and stainless steel welding.

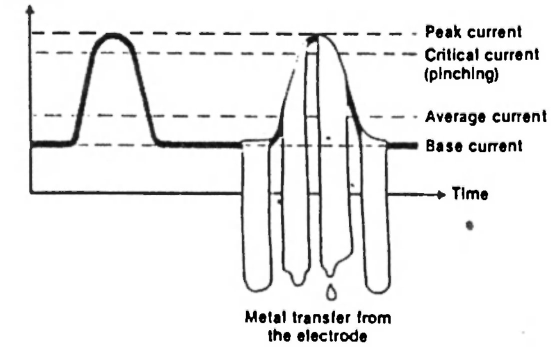


Fig. 3 : principle of short pulsing

Tubular Wire

Tubular wire is a filler material that has become firmly established during the 1980s, though the degree of use varies from country to country (see Fig. 4). Far more tubular wire is used in Japan and the USA than in Europe. In those two countries the proportion of tubular wire is about 15% of total consumption whilst the corresponding figure for Europe is only 4%. In Japan tubular wire has replaced covered electrodes in recent years, particularly in the shipbuilding industry, but in the USA the consumption has been steady over several years.

One reason for the use of tubular wire is its good welding characteristics; others are increased productivity in position welding with certain types of tubular wire. The composition of the flux can be controlled in order to optimize the arc characteristics and the flowability of the molten pool. Drawbacks include considerably higher cost and higher fume emission.

Country	MMAW %	GMAW %		Others %	Total %
		Solid	Flux cored		
JAPAN 1988	33	43	13	11	100
USA 1987	47	31	14	8	100
EC 1988	35	47	4	14	100

EC = Europe Community

Fig. 4 : Production of Welding consumables in Japan, the USA and the EC

Rutile tubular electrodes have always been user-friendly because of their good welding characteristics, but with these wires the notch toughness of the welded material has not always been sufficient. As a result of developments in this field there are now rutile tubular wires that are good enough to satisfy the strict quality requirements of, among others, the offshore industry.

Basic tubular wires gives the welded material good notch toughness and low hydrogen content. The drawback is that they are difficult to weld with and cause a fair amount of spatter. Attempts are now being made to remedy this with pulsed welding.

Narrow gap welding

The idea of introducing narrow gap welding is to increase producitivity and reduce the heat input, the cooling time between passes, the shrinkage and the consumption of filler material (see Fig. 5). The narrow gap welding technique is used in MIG, TIG and submerged arc welding. A normal joint for material 280 mm thick is shown in Fig. 6 : the cross-section area is 135 mm^2. The corresponding cross-section area for narrow gap welding, as shown on the right, is 68 mm^2.

It is important to realise that narrow gap welding calls for advanced equipment and through preparation. To avoid lack of fusion with MIG/MAG narrow gap welding an oscillating electrode or a rotating arc may be used; with TIG the helium content of the shielding gas may be increased (e.g. 70% helium and 30% argon).

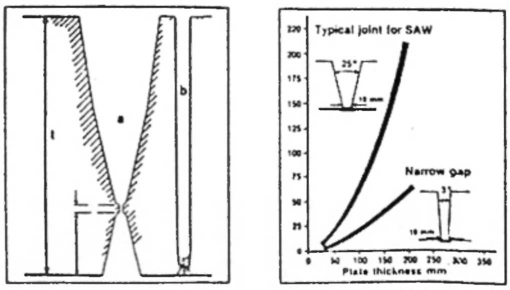
Main reasons for introduction'Higher productivity

- Lower joint energy
- Shorter cooling times to maintain allowed interpass temperature
- Less filler material

Consider

- Advanced welding equipment
- Careful joint preparation
- Shielding gas (TIG) 70% He + 30% Ar
-

Fig. 5 : Narrow gap technique



Comparison of joint cross section areas
- Thickness 280 mm (t)
- Normal joint 135 cm² (a)
- Narrow gap 68 cm² (b)

Comparison of joint cross section areas

SAW = Submerged Arc Welding

Fig. 6 . Mechanized welding

New shielding gases

New shielding gases are constantly being developed to allow optimization of the welding process and of the welding results in different applications. But now a days a good shielding gas must bring benefits not only for productivity but also for the working environment. A good example of this is a range of shielding gases, to which a small amount of nitric oxide (NO) is added to reduce the amount of ozone that is formed during gas-shielded arc welding (MIG/MAG and TIG). There are now several variants to cover different fields of application. To reduce the amount of fumes created, shielding gases with lower carbon dioxide contents may be used. Reducing the carbon dioxide content from 20% to 8% cuts the amount of fumes by 50%. Another advantage is that the filler material is used more efficiently (lower losses)

Mechanization and automation

The degree of mechanization will increase at an ever faster rate because of the desire to raise productivity, ensure higher and more uniform quality and reduce the amount of tied-up capital (see Fig. 7). Another reason for the degree of mechanization is the difficulty of obtaining sufficient number of qualified welders. MIG/MAG welding is a highly suitable method for mechanization or automation.

Increase due to

- increased productivity
- more even and higher quality
- improved working environment
- reduces material in progress (capital)

Fig. 7 : Mechanized and automated arc welding

The first robot stations for arc welding appeared at the end of the 1970s. Since then they have been developed in terms of repeatability, intelligence and ability to communicate. Figure 8 shows the number of installed robot 1989. A further development of the welding robot station is the Flexible Manufacturing System. FMS for short. Currently there are about 400 such installations in Europe. Figure 9 shows a Swedish design, which has been installed at several companies. It is a handling and storage system in which workpieces are called up in any chosen sequence. For full utilization of the installation it must be possible for programming to be done off-line; in other words, teaching of the robot must be done outside the system (see Fig. 10).

TIG welding

TIG welding is a qualify method used primarily for stainless steel and non-ferrous metals. However, the field of application is being extended, since it is now possible to increase productivity by introducing hot-wire filler material and/or narrow gap welding.

With hot-wire filler material (see Fig. 11) the wire is heated resistively and fed continuously to the melt. The wire is heated with the aid of a separate power source. The Hot-wire filler material technique can raise the deposition rate by 40-50%, as well as bringing other advantages such as reduced risk of cold flow and better transfer of alloying elements.

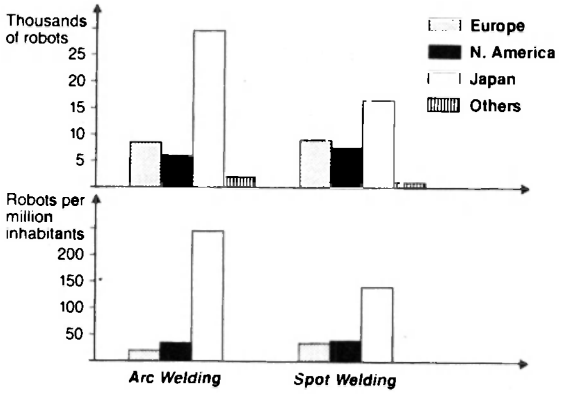
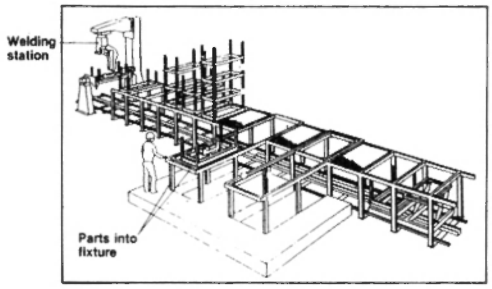


Fig. 8 : Number of welding robots, 1989



In the system pallets can be called randomly independent of entering order. We are on the way towards CIM = Computer Integrated Manufacturing (control of unmanned production based on Computer produced drawings).

Fig. 9 : Materials handing and storage system

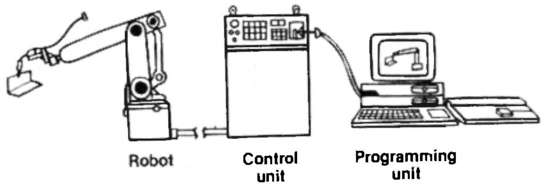
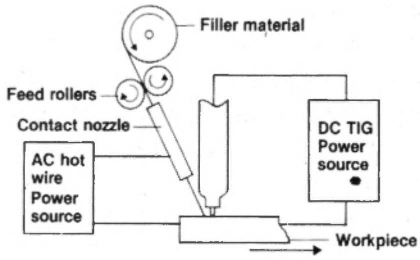


Fig. 10 : OffOline programming of a welding robot



Advantages with the hot wire-system are:

- Less risk of pore formation
- Less risk of cold flow
- Improved transfer of alloying elements from wire to weld pool when the wire doesn't pass through the area with the risk of bum off.

Fig. 11 : TIG hot wire

We have referred before to narrow gap welding. Figure 12 shows how may fewer passes are needed with narrow gap welding compared to normal weld beads, for different material thicknesses. An important point to bear in mind with narrow gap welding with TIG is that a more helium-rich shielding gas is needed to reduce the risk of incomplete penetration.

Another trend in the field of TIG is an increase in the use of micro TIG. The method has been improved by better starting characteristics and modern transistor-controlled power sources, which give greater precision. One consequence of these advantages has been that micro-TIG has replaced microplasma in many situations, Micro-TIG can be used on sheet guages from 0.5 mm down to 50 mm.

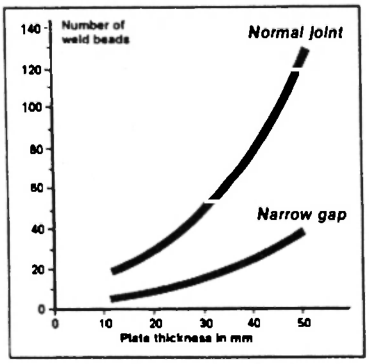
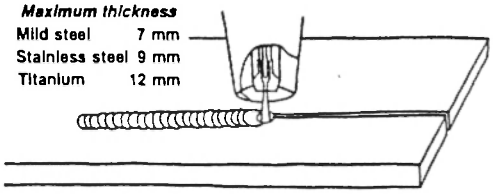


Fig. 12 : Number of TIG welded beads as a function of thickness

Plasma welding

Plasma welding (See Fig. 13), is currently used mainly for stainless steel in the 3-9 mm gauge range. The method is not likely to be used to any great extent for welding mild steel. The method has many advantages, for example low heat transfer to the workpiece and high weld quality, but it does require careful preparation of the joint.

Aluminium can how be plasma welded (see Fig.14). Hobart have developed a method with varying polarity. This facilitates oxide break-up and gives high-grade welds.



Advantages:
- Relatively insensitive to arc length variation
- Limited distortion of workpiece
- Good arc stability
- High weld bead quality
- No tungsten inclusions

To consider
- Joint preparation
- Setting of parameters

Fig. 13 : Plasma welding

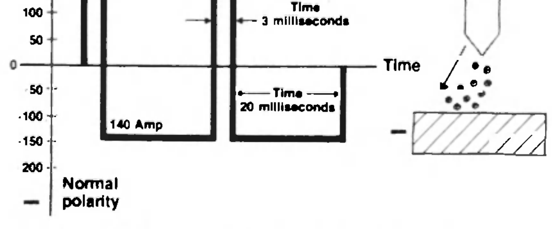
Welding method	Deposition rate kg/h	Duty factor %	
		Manual welding	Mechanized welding
SMAW[1]	1—3	10—20	—
GMAW[1]	1—7	15—25	25—75
FCAW[1]	2—8	15—25	25—75
GTAW[1]	0—(1)	15—25	25—90
GPAW[2]	0—(1)	5—25	25—90

1) all positions *2) all positions except under up*

Fig. 14 : Productivity of arc welding methods

Productivity

Figure 15 shows deposition rates for the arc welding methods which we have discussed above. Note the possibilities created by mechanization to improve productivity and often also the quality.



Break up of oxides occurs during the positive period of the electrode. The heavy ions hit the workpiece and the oxide layer breaks up

Fig. 15 : Plasma welding of aluminium : changing polarity

Electron beam welding

Electron beam welding is a method that goes back 30 years and which was initially used in the nuclear and aircraft industries. It has undergone continuous development and now has many other fields of application. Electron beam welding has the following advantages :

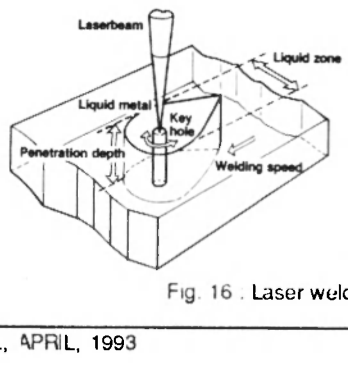
- - low heat transfer per unit length
- - the width of the welded joint can be limited
- - great depth of penetration (up to 400 mm)
- - normally needs no filler material
- - high weld quality
- - no finishing needed
- - material or material combinations which are difficult to weld with other methods can be welded.

The drawbacks include high capital cost and the fact that the methods needs a vacuum. In mass production the problem of long pumping times can be solved by using several small chambers directly suited to the workpiece to be welded. One or more chambers are pre-pumped while welding takes place in another chamber. It is also possible to use electron beam welding on ordinary construction materials without them having to be in a vacuum. There are a number of such installations in service, but the use of the technique has been limited since penetration is markedly less than in a vacuum. In addition, X-Radiation is a problem if vaccum chambers are not used.

In the area of thinner steel sheet, laser welding will probably take over from electron beam welding to some extent due to the need for a vacuum, but the method will maintain its position in heavier industry as well as in the aircraft and nuclear power industries.

Laser Welding

The use of laser welding (see Fig. 16), will probably increase during the 1990s, especially in thinner material gauges where great accuracy is called for. The automotive industry, where the method is already used for spot welding, is expected to become a major user. Combined situations with laser cutting followed with laser welding will become more common.



Advantages:
- Low distortion
- Narrow welded joints
- High welding speed
- Suitable for automation

To be considered:
- Requires careful positioning of workpieces
- Low tolerance for gaps in the joints
- High investment costs

Fig. 16 : Laser welding

Brazing

Brazing is an old technique that has come back. One example is furnace brazing, in which many, often complex joints can be brazed at the same time. The method is simple and easy to mechanize.

Developments are continuing in the area and are specially aimed at producing new brazing materials to bond metals to ceramics and brazing materials for metals that are difficult to weld.

Resistance welding

The automative industry is trying to reduce the use of arc welding methods in production. Instead one makes extensive use of resistance welding methods, particularly spot welding.

CUTTING METHODS

The three thermal cutting methods flame cutting, plasma cutting and laser cutting are widespread and well known to most people (see Fig. 17). Flame cutting is the traditional and clearly predominant method, but its use is slightly declining because of the increase in laser cutting and plasma cutting. Flame cutting remains a very cutting method, partly owing to its versatility. It covers the entire gauge range from 3 to 300 mm for unalloyed steels. By using special torches the field of application can be extended to gauges of up to 1000 mm or even more. the quality of cut is excellent when the cutting parameters are correctly set. In economic terms, flame cutting is clearly an alternative where numerically controlled machines are used in conjuction with several torches in order to increase the productivity per employee (see Fig . 18).

Laser cutting gives a high-quality cut, narrow kerve and low heat transfer to the workpiece. The economic gauge for unalloyed steel is 2-3 mm. The uae of laser cutting will increase, mainly due to increased laser power output, which will enable heavier-gauge material to be cut. This may mean that the market for plasma cutting will be restricted in the future.

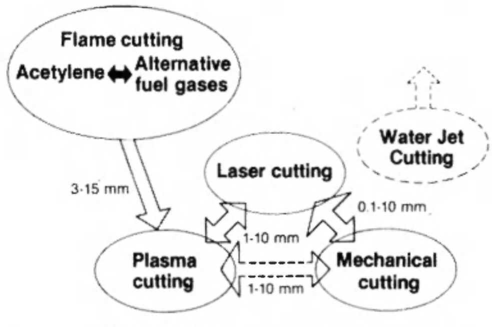


Fig. 17 : Structural changes in cutting

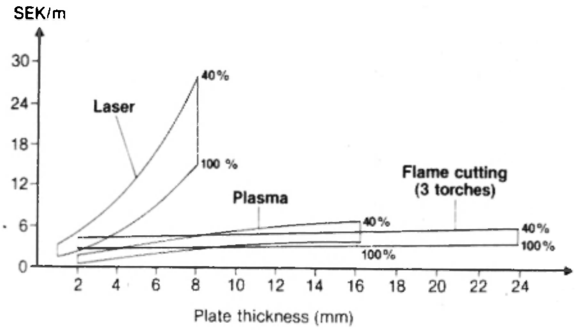


Fig. 18 : Comparison of cutting costs (40% and 100% duty factor)

The economic cutting range for plasma cutting is 3-15 mm. In this range plasma is faster than laser, but the quality of cut is not comparable. The introduction of oxygen plasma, nitrogen plasma and above all air plasma has resulted in a marked increase in plasma cutting, an increase which will continue (Fig. 19). Smaller sets intended for manual cutting are usually air plasma, whilst larger mechanized installations use oxygen, nitrogen or argon mixtures as the plasma gas. Plasma power sources above 300 A never use air.

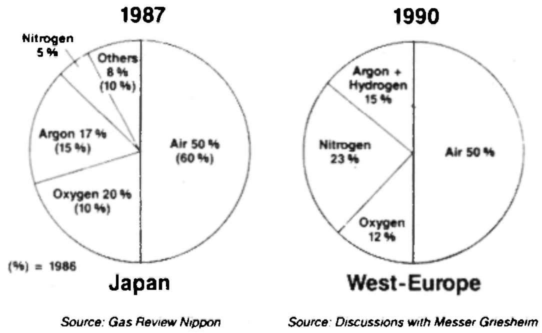


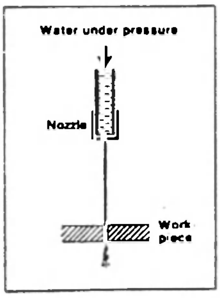
Fig. 19 : Distribution of gas consumption for plasma

In connection with subsequent welding of air-plasma cut edges, weldability problems like pore formation and lack of fusion have been noticed. Investigations have shown that high concentrations of nitrogen in the cut edges are responsible for the problems. There are different ways to avoid the problems. One is to grind off the thin layer of the cut surface that has a high nitrogen concentration. This is an expensive method and it will reduce the productivity. Another way is to cut with oxygen plasma.

Water jet cutting

An alternative to the thermal cutting methods is water jet cutting (see Fig 20). The method emerged during the 1970s, when it was used to cut composites. Since then it has been developed to cut metals. This was made possible by adding abrasives to the jet, a technique known as abrasive water jet cutting (see Fig. 21). Using water jet cutting without abrasives it is possible to cut, in addition to composites, materials such as leather, rubber, textiles, wood, mineral wool and frozen foodstuffs. Abrasive water jet cutting can be used to cut sheet metal in gauges up to 50 mm, concrete up to 200 mm, stone and ceramics.

In water jet cutting without abrasives, the material is broken down by the very high water pressure, which may reach 400 bar. In abrasive water jet cutting, on the other hand, the materisl is broken down by the abrasion. The water pressure is lower than in water jet cutting without abrasives.

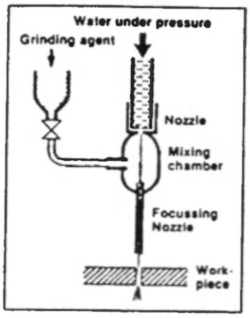


Water pressure	4000 bar
Nozzle diameter	0.08-0.3 mm
Kerf width	approx 0.1-0.3 mm
Water velocity	approx 1000 m/s
Water consumption	3 l/min

Example of polymer additive which produces a longer, more compact jet of water:

0.2-0.5% polyacrylamide or polystyrene sulphate.

Fig. 20 : Pure water jrt cutting



- ***Water pressure is used for grinding, not disintegrating material***
- **At high speed, the jet of water acts like a water suction device**
- **Water pressure: 2000-3000 bar**
- **Focussing nozzle**
  - **high-strength alloy**
  - **will last 10-20 hours**
  - **diameter 0.8-2.0 mm**
- **Grinding agent**
  - **Granite (iron-rich aluminium silicate)**
  - **Olivine**
    grain size 0.2-0.5 mm
    consumption 0.2-1.5 kg/min
- **Water consumption 2-6 l/min**

Fig. 21 : Abrasive water jet cutting . adding a grinding agent to the water.

Abrasive water jet cutting competes to' some extent with the thermal methods but, as Fig. 22 shows , the cutting rate is very low, so the method is only competitive where some particular technical advantage can be exploited. Examples of such advantages are that the quality of cut is very good and that no heat is transferred into the workpiece. The latter feature means that there are no metallurgical changes at the cut edge, no microcracks form and there is no deformation of the workpiece. Abrasive water jet cutting is also a suitable method for cutting surface treated materials like zinc or polymer coated sheet metal, since this cutting method will minimize destruction of surface treatment.

The table in Fig. 23 shows the most suited cutting method for different materials.

		Cutting speed (mm/min)			
Materials	Plate thickness (mm)	Flame cutting	Plasma cutting	Laser cutting	Abrasive Water jet cutting
Steel	5	850	4500 A	2200 C	200
Steel	20	660	2000 A	-	50
Stainless Steel	3	-	5000 B	6500	200
Stainless Steel	40	-	500 B	-	10-20
Aluminium	2	-	>600 B	1000 C	800
Aluminium	40	-	1200 B	-	80

A Nitrogen plasma with water injected, 500 A

B Gas plasma (Ar/H_2),240 A

C Carbon dioxide laser 1000 W, with oxygen as cutting gas

Fig. 22 : Representative cutting speeds for abrasive water jet cutting and thermal cutting.

CUTTING METHOD	MATERIAL						
	Mild Steels	Stainless Steels	Aluminium	Titanium	Plastics not reinforced	Plastics fibre reinforced	Ceramics
Flame	+ + +			+ +			
Plasma	+++	+++	+++	++	+	+	
Laser	+++	+++	++	+++	++	+	++
Mechanical	+++	+++	+++	+++	+++	++	+
Water jet	+	+	++	+	+++	+++	++

+ + + well suited + + suited + possible

Fig. 23 : Cutting methods for different materials.

Construction materials

Structural steel

Many of the major steel producers in Japan are attempting to diversify their production, in other words to make a wider variety of products. Among the ways in which they try to do this is developing new materials such as polymers and composites, and moving into other sectors. Even so, the production of steel and traditional steel products is at a very high level, and is therefore quite natural that large sums are still invested in steel research and development. High strength and extra-high- strength steels (HS and EHS steels) are rhe result of this investment. They count as unalloyed structural steels, but their yield point is significantly higher , EHS steel have yield points of 490-960 MPa. Increased strength means that the weight of the construction can be reduced. The high strength of this steel is not associated with lower weldability.

High-strength and extra-high-strength steels are fine-grain- treated by the addition of aluminium, niobium, vanadium or titanium. These elements increase the strength of a steel without loss of ductility. For extra-high-strength steels the fine-grain treatment is not enough. Such steels are therefore quenched-and- tempered after hot-rolling; this involves heating to 900oC, rapid colling in water and annealing at 600oC. Another method that is becoming increasingly common is controlled rolling, a process in which the steel is finish-rolled at a lower temperature then that in normal hot-rolling, and is then colled rapidly.

High-strength and extra-high-strength steels are welded in the same way as ordinary structural steels. Some require preheating where the material is thick, to reduce the risk of cracking.

The use of high-strength steels is increasing. Common fields of application are the manufacture of cranes, forestry machines, garbage trucks, vehicles girders pressure vessels and so on.

Stainless steels

The consumption of stainless steels is increasing and will continue to do so (see Fig. 24). Over the last 10 years the annual growth rate has been about 4%. The reason for this rate of growth is the increasingly demanding environment in the petrochemical industry and the process industry. Demand for these materials is also growing in industrial sectors such as foodstuffs, electronics, biochemistry and nuclear power. Stainless steels have also replaced other structural materials in many applications where it has been realized that stainless steel is cheaper in the longer term, if both capital outlay and maintenance costs are taken into account.

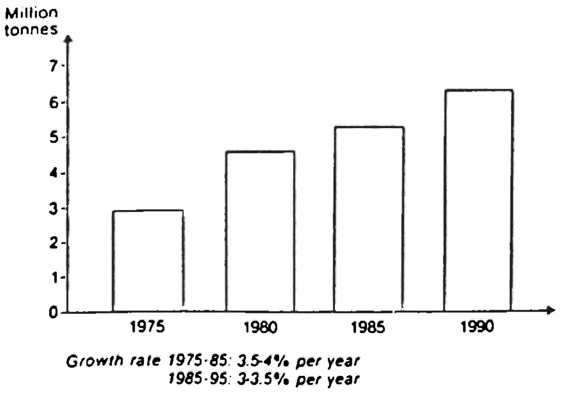


Fig. 24 : Growth of stainless steel consymption in the Western world

Two types of stainless steel have been and will continue to be very important : ferrite-austenitic steels and fully-austenitic steels.

Ferrite-austenitic steels, also known as duplex steels, have existed for a long time, but have not been used much because of their poor weldability. This has now been improved by reducing the carbon content and adding controlled amounts of nitrogen to reduce the risk of carbide precipitation during welding. These are the advantages of duplex steels :

- - good weldability
- - great strength
- - good resistance to stress corrosion, above all, but also to general corrosion and pitting.

The latest generation of these steels are known as super duplex steels. Their resistance to pitting has been improved still further by an increased alloy content.

Unlike ordinary austenitic steels such as SS 2333 (AISI 304), which shows a few percent of ferrite after welding, fully austenitic steels remain austenitic after welding. Fully austenitic steels are highly alloyed to enable them to stand up to corrosion attack in particularly harsh environments. These steels may be prone to crack formation on welding, so it is essential that they are made with extremely low levels of impurities. The filler materials must also be low in impurities. Special materials resistant to hot cracking have also been produced. To reduce still further the risk of hot cracking , welding should be done with a low, controlled heat input. Plused welding offers considerable advantages here.

Aluminium

Aluminium and aluminium alloys are structural materials with many good properties: they do not corrose, they conduct electricity and they combine strength with lightness. Growth in the use of aluminium during the twentieth century has been remarkable (see Fig. 25).

This rapid development continued up to the mid-1970s, when the oil crisis heppened. It dealt a heavy blow to the production of aluminium, which uses large amounts of energy. Aluminium became more expensive compared with other metals (see Fig. 26). Although the manufacture of aluminium has been moved to countries where energy is cheaper, and although there has been an overall drop in the price of oil aluminium production is currently at only a modest level (see Fig. 27). This is because the explosive growth of earlier years saturated many markets, and because there has been technical progress in other metals as well as non-metals.

Metal	1900	1925	1950	1975	1987
Aluminium	6	181	1500	12840	16330
Copper	450	1400	3200	8180	10190
Zinc	480	1140	2060	5470	7020
Lead	870	1510	1850	4840	5630
Nickel	8	37	150	700	780
Silver	5	8	6	10	14

Fig. 25 : World production of non-ferrous metals (kton)

	Price ratio
• 1900-1910	2.17
• 1920-1939	1.27
• 1950-1975	0.65
• 1976-1988	0.84

Fig. 26 : Price development of aluminium/copper in the USA

	1900- -1925	1925- -1950	1950- -1975	1975- -1988
Aluminium	14.5	8.2	9.0	2.2
Copper	4.7	3.4	3.8	2.0
Oil -	—	5.1	6.8	0.6
Steel	1.0	2.0	6.0	-1.0
Staineless Steel	—	—	4.0	3.0

Fig. 27 : Annual development of world production (%)

Recycling of metals

Steel and aluminium will continue to be important materials in the future. One reason for this is the possiblity of recycling. These materials are already being extensively recycled. At least 40% of the world's production is based on scrap, and aluminium recycling in Western Europe rose from 25% in 1980 to over 30% in 1989.

So far it has mainly been scrap from various stages of incustrial production that has been recycled. The proportion of "old scrap", i.e. material from scrapped cars, buildings, household maçhinary and packaging, will rise. This increase will place greater demands on collection and sorting of garbage. New methods are being developed, one example being the separation of aluminium from other materials with the help of the eddy current principle.

Strong arguments in favour of recycling are :

- - saving in raw materials
- - savings in energy
- - reduction of harmful matter released in water and air.

Titanium

Like aluminium, titanium and its alloys combine strength and lightness, as well as having excellent corrosion properties. These properties mean that titanium is used widely in the aircraft, cellulose and chemical industries. Like aluminium, titanium is being used increasingly. The highest growth rate is in the aerospace industry.

Other materials

Metals and metal alloys have dominated the field of structural materials so far in the twentieth century (see Fig. 28). In the closing years of the century, other construction materials will gain in importance. The use of plastics and plastic composites will increase greatly during the 1990s, at a rate of about 6% per year in the industrial countries. The highest growth rate will be in plastics used for technical purposes and not in traditional areas such as the packing industry.

The Japanese are developing many new materials, such as fibre- reinforced materials and composites. At the same time they are developing new joining and parting methods, since conventional thermal welding and cutting techniques can seldom be used on these materials. The broadening of the field is illustrated by the renaming of many of Japan's "welding labs" as "joining labs".

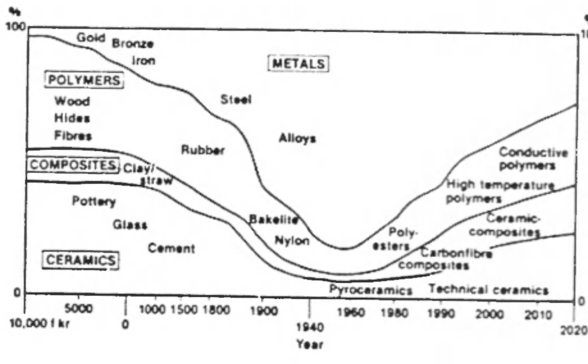


Fig. 28 : Relative importance of construction materials

Welding environment

Just as during the 1980s, there will be great interest in the working environment. This is partly due to increased environmental awareness and partly because of the difficulty of recruiting people to become welders. Many young people see welding as dirty, heavy and noisy work, and there is some justification for this view. It is true that welding is often associated with problems such as fume and gas emissions, thermal radiation, heavy lifting and uncomfortable working postures, as well as the noise associated with handling sheet metal. However, many of these problems can be overcome with good general vantilation and by using the special accessories available today, such as local fume extractors, lifting gear, positioners, liquid- crystal welding glass, etc. It is important for management to make sure that these accessories are easily available to the welders and that they are used . In addition, straight forward, simple information must be provided to motivate the welders to use the accessories provided.

Considerable research and development is taking place in the field. Among other things, attempts are being made to reduce the formation of fumes during welding with self-shielding tubular wires. Other examples are the production of more convenient and more easily handled local extraction devices and new shielding gases which reduce the amount of ozone in gas arc welding (MIG/MAG and TIG welding).

Mechanization and automation of the welding and cutting processes is extremely important for the environment. Welders escape direct exposure to fume, gases and thermal radiation, as well as avoiding heavy lifting and monotony. Their status is enhanced by working with the supervising computerized equipment. Further measures that will improve the working environment are investment in training and giving welders more responsibility at the workplace.

It is often said that "people are a company's main resource". Investing in a better working environment for welders in the shape of the measures described above, also increases productivity, since absence due to illness is reduced, and it becomes easier to recruit qualified people for industrial work in the future.

CONCLUSIONS

There will be no dramatic changes to today's welding and cutting technology during the 1990s. The decade's watchwords will be productivity, quality and working environment (see Fig 29). Productivity, will improve in step with increasing mechanization and automation in the industry. The switch from manual metal-arc welding to MIG/MAG welding is another example of a change that leads to higher productivity. Quality demands will become stricter and high quality will be a means of competition for producers. This will be accompanied by an increased demand of international standards and for well-trained welders and welding engineers with standardized qualifications.

Fig. 29.

Attention will be focused on the working environment during 1990s as well. Increased awareness of environmental issues and the difficulty of recruiting people to train as welders mean that efforts must continue to improve the working environment of welders.

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