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MODULE 5

Special methods of fusion welding

Plasma welding



plasma welding

- The emergence of plasma (plasma, plasma) is necessary for the ionization of gas (mechanical or thermal), at which the ejection or release electrons of the outer valence (orbital) carbon spheres.
- Relaxed electrons have a negative charge and lead the plasma current. Ionized nucleus - the remaining ion has a positive charge electrons. Outwardly, however, the plasma acts as an electrically neutral.
- To ionize the gas is often used as a heat source an electric arc which is contracted by a small diameter passage of the outlet nozzle and increasing the temperature to a higher degree of ionization.



plasma welding

- In diatomic gases (nitrogen, hydrogen and oxygen) must be done first dissociation gas, at which the distribution of the gas molecules into atoms.
- Part gas which is ionized and it is colder, generally stabilizes the plasma jet axis of the burner so that it does not touch the walls of the plasma nozzle.

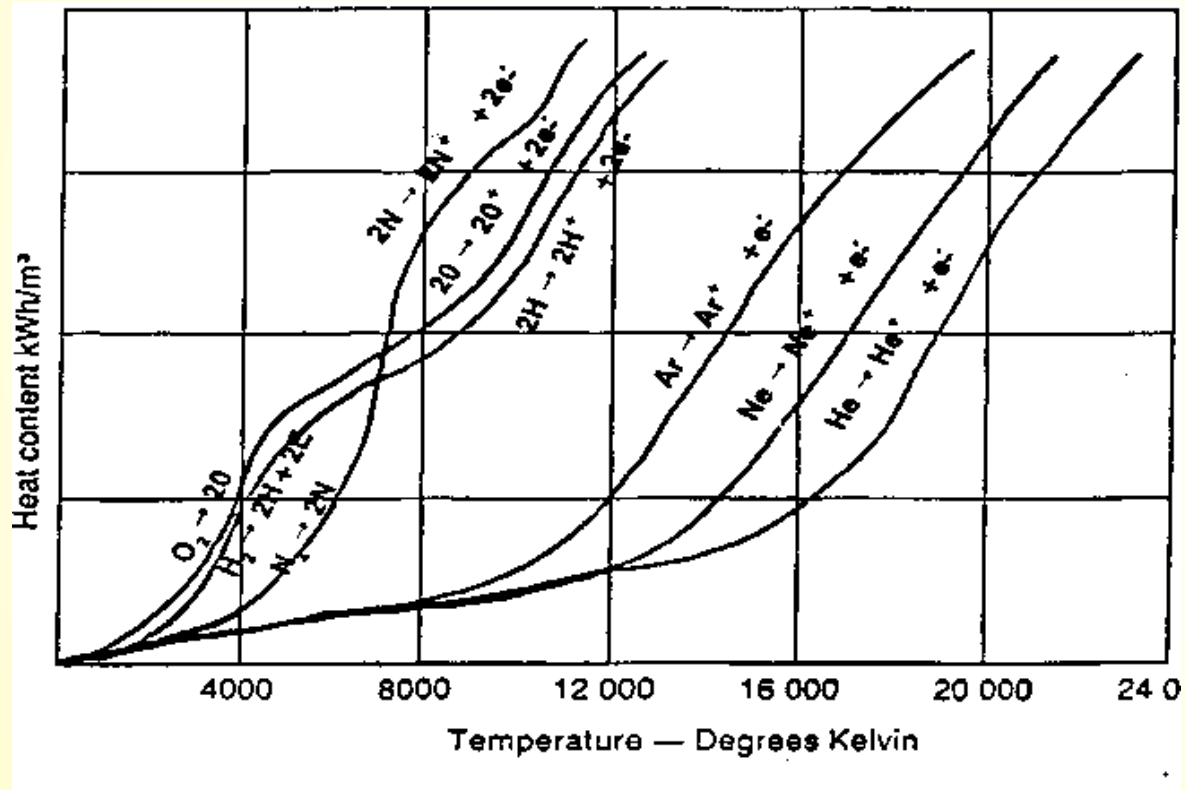


For the use environment, the following approximate average plasma temperature

- Nitrogen plasma to 9000 ° K
- Hydrogen plasma 10 000 ° K
- Argon plasma 16 000 ° K
- Helium plasma 20 000 ° K
- Water stabilized plasma when 35 000 ° K



Dependence on temperature gas enthalpy



KUBÍČEK, J. DANĚK, L. KANDUS, B. *Technologie svařování a zařízení. Učební texty pro kurzy svařovacích inženýrů a technologů.* Plzeň: ŠKODA WELDING, s. r. o., 2011. s. 138.



Gases for plasma welding

- Plasma: Ar, Ar + H₂, Ar + He with a flow rate of 0.5 l.min⁻¹ 20 l.min⁻¹
- Focusing (rarely) to narrow the plasma jet and the flow rate of 3 l.min⁻¹ to 18 l.min⁻¹
- Protective to protect the weld pool from oxidation by ambient air with a flow of 2 l.min⁻¹ 20 l.min⁻¹
- For those active materials, Zr, The flow rate was increased to 20 l.min⁻¹ 30 l.min⁻¹.



Technical characteristics of plasma

- Simultaneously with the elastic collisions of molecules (atoms) are present in substantially inflexible, leading to dissociation and ionization of gas
- A chemically homogeneous gas is converted into a mixture of atoms, ions, electrons, photons etc.
- The mixture of particles in plasma is quasi-neutral. The number of positive and negative particles is approximately the same
- The electrical conductivity of the plasma is dependent on the mobility of electrons (100 times higher than the ions), and about 20 000 achieves conductivity of metallic materials
- On the plasma has strong electric and magnetic fields



Technical characteristics of plasma

- The work of welding based on plasma TIG welding.
- Place ceramic nozzle is used a nozzle made of metal which is cooled by water or gas.
- In principle, there are two wiring burner.
- Involvement dependent (transferred arc) in which a negative pole connected to the tungsten electrode and the positive pole to the material.
- For starting and ignition of the auxiliary arc is used VF ionizer connected to the metal nozzle.
- Auxiliary (Pilot) arc made sufficiently conductive environment for ignition of the main arc and a relatively long distance.
- dependent involvement is mainly used for welding, cutting and welding.

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Technical characteristics of plasma

- Connecting the power poles only on the metal electrode and the nozzle is called the independent circuit (non-transferred arc) and is used mainly by thermal spraying or surface hardening.
- Plasma burner has a tapered outlet nozzle, which contributes to the contraction of the plasma beam.
- It is supported by the focusing gas which is a mixture of argon with hydrogen or nitrogen.



Weldability plasma welding

- Weldability and welding parameters for plasma welding are similar to TIG.
- Plasma however, welding achieves high welding speed, more preferred width to depth ratio (1: 1.5 to 1: 2.5) and reliable root fusion.
- Welded all types of steel, copper, aluminum, titanium, nickel, molybdenum, and alloys thereof.
- Parameters welding of high-alloy steel to a thickness of 2 mm to 10 mm range in the following ranges: voltage between 28 V and 40 V and the welding current is between 50 A and 300 A.
- Alike parameters are used for welding of nickel and its alloys and for welding of titanium is about 15% to 20% lower.
- Welding speeds are compared with the TIG considerably higher and said parameter varying between 20 cm.min⁻¹-85 cm.min⁻¹.

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Weldability plasma welding

- ▶ Aluminum welding with alternating current and such. tl. 6 mm can be welded with this process:
 - ▶ Straight polarity at the electrode - welding cycle of 140 A at 20 m / s (or 125 A, 20 m / s)
 - ▶ Inverted polarity at the electrode - cleaning cycle of 180 A at 3 m / s (or 200 A 2 m / s).
- ▶ Materials susceptible to overheating are welded using a pulsed current.

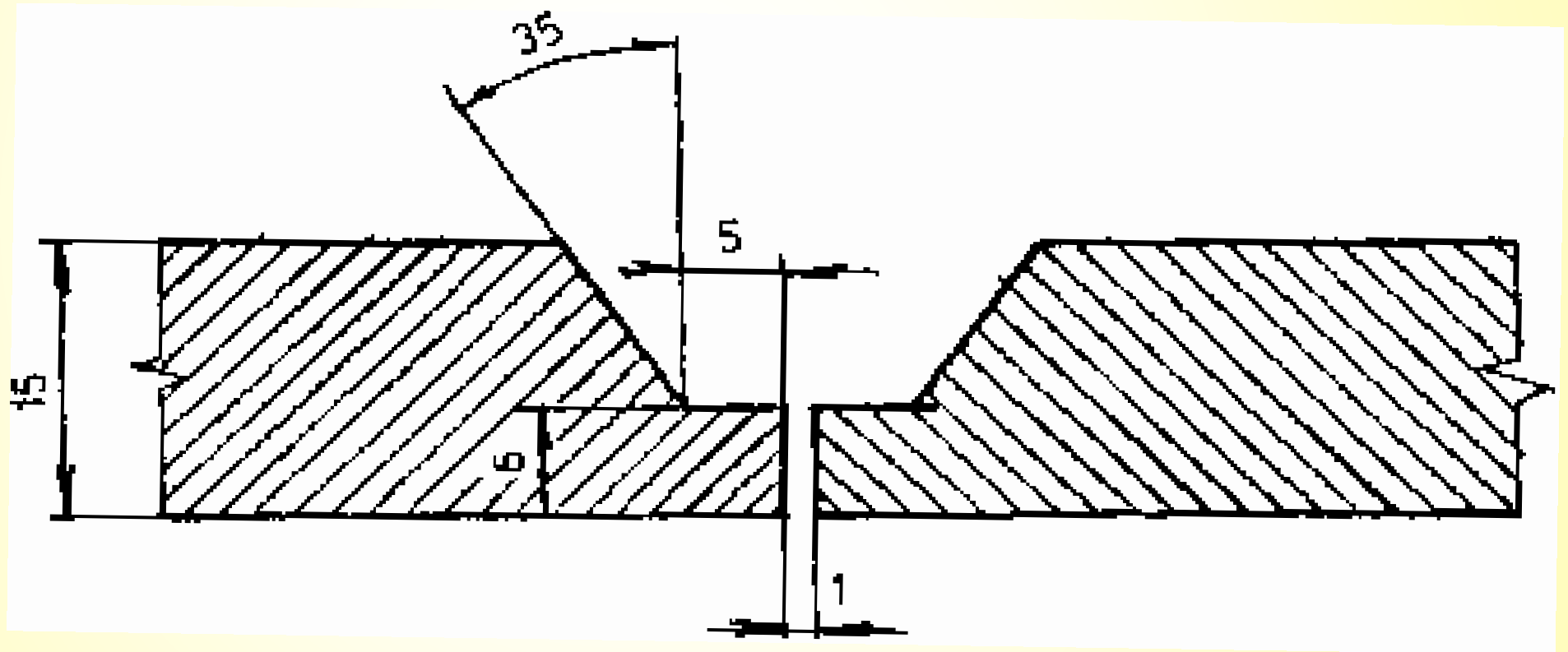


Adjusting the welded areas for plasma welding

- It does not have weld surface, no adjustment because the plasma beam has a high dynamic effect and boiled root and larger thicknesses.
- Stainless austenitic steel is welded without modification taper to a thickness of 10 mm to 12 mm with a gap of 0.5 mm - 1 mm as root protection gas forming gas.
- For unalloyed and medium alloyed steel edges are not adjusted to a thickness of about 6 mm to 8 mm.



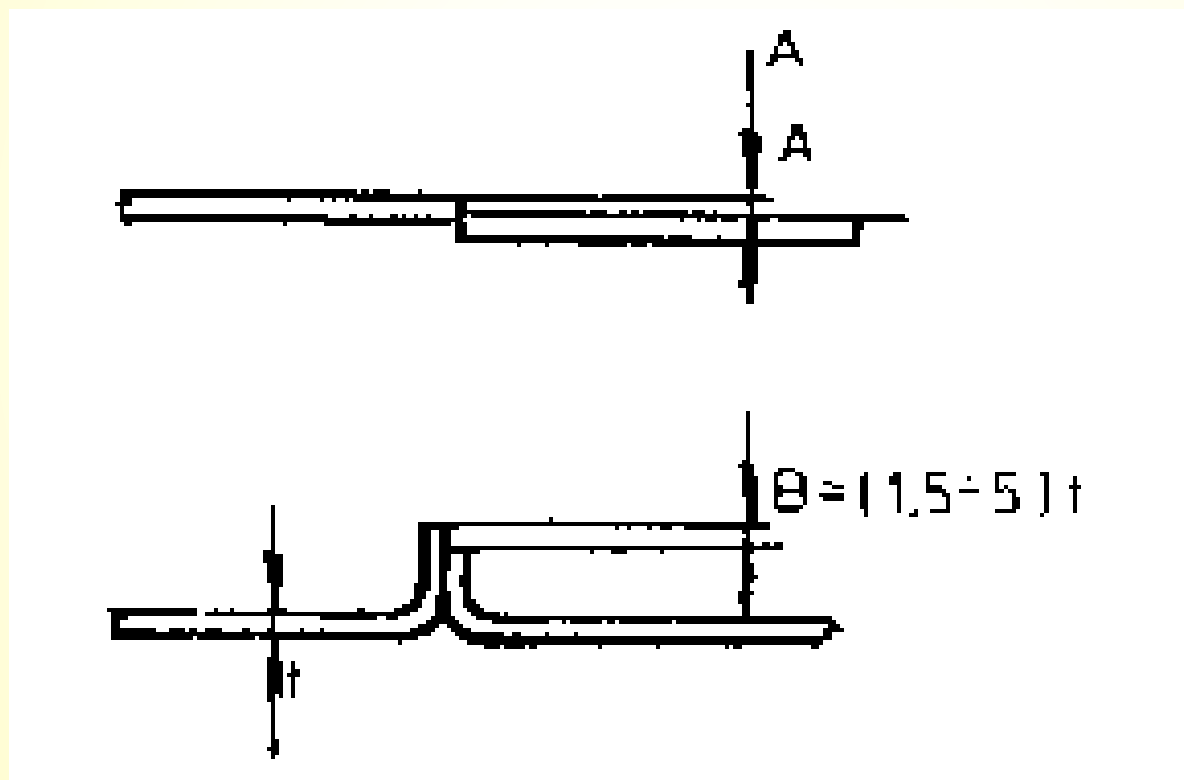
Treatment areas for plasma welding



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Microplasmic welding

- High stability of the plasma arc burning even at low currents is utilized in microplasmic welding. The current intensity is here in the range of 0.05 A to 20 A.
- Microplasmic welding can weld metal foil 0.01 mm sheet and 2 mm.
- A significant problem when joining thin sheets, the preparation of the weld gap, which should be between 10% and 20% of the film thickness.
- Necessity It is to use a fixture for heat dissipation and positioning during welding.
- Microplasmic welding is used in the aerospace industry, microelectronics, instrumentation, chemical and food industry.



Examples of parameters microplasmic welding

- Stainless steel, thickness 0.25 mm, flow of 5.6 A, the welding speed 38 cm.min⁻¹.
- Nickel alloy inconel 0.3 mm, the current 6, welding speed 40 cm.min⁻¹.
- Copper, thickness 0.075 mm, a current of 10 A, the welding speed 15 cm.min⁻¹.
- Titanium, thickness 0.2 mm, a current of 5 A, the welding speed 12.5 cm.min⁻¹.



Safety plasma welding

- Principles for plasma welding are similar to the welding arc.
- Here it should be taken into account the high temperature in the arc and the ultraviolet radiation that arises when the welding.
- At this welding method, it is necessary to protect the welder and noise, which in some cases may reach 120 dB.
- If to cut material plasma, it must ensure proper extraction.



Plasma cutting

- In this method, the thermal cutting is the hallmark of a high temperature and a large plasma jet exit velocity (1000 m / s - 2000 m / s).
- Plasma can cut any metal materials, which are made of metal.
- Parameters deriving from the cutting performance of the machine, the thickness of the cut material, the type of material and its properties.
- If we cut thin sheet, it is possible to operate at high speed up to 12 m / min.



Plasma cutting

- To metal cutting plasma gas is used, air, oxygen, combined nitrogen, steam stabilized.
- Plasma dividing the material is easy to automate and mechanize.
- Advantage it is also a fact that the plasma cutting has very little effect on the surface of the cut material.
- To disadvantages can arrange high noise while working up to 100 dB, rounder upper edge worse burn holes thicker sheets (above 15 mm), relatively strong UV rays and also the formation of smoke, ozone and nitrogen oxides.