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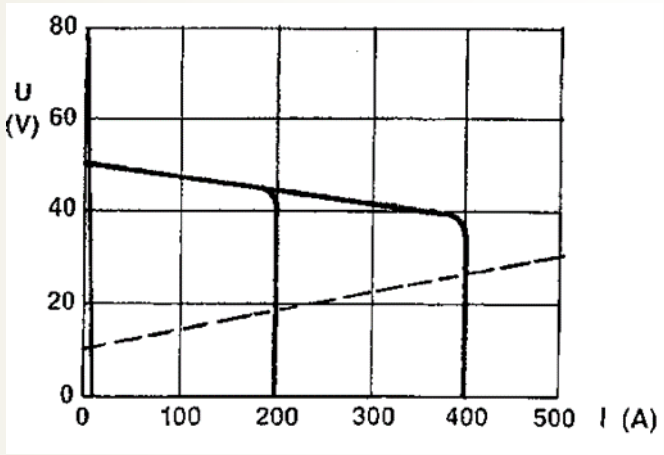
MODULE L
Shielded welding

TIG

Welding equipment for TIG welding

- For TIG welding is used as welding power source inverter, a typical feature is steep static characteristic, which means that a constant current.

Source voltage characteristic for TIG welding



The standard line of work for TIG method

AMBROŽ, O. A KOL. *Technologie svařování a zařízení: učební texty pro kurzy svářečských inženýrů a technologů*. Ostrava: ZEROSS, 2001. s. 117.

Accessories welding sources TIG welding

- The control unit comprises means for controlling the welding process - beginning and ending of welding, ramp descent at the beginning and end current process control of different levels of current for welding complex weldments with different thickness of material, the pulse unit, closing and interruption of current.
- Arc ignition is implemented by a high voltage high frequency ionizer, which at a distance of a few millimeters excites an electric spark ionizes the gaseous medium discharge.
- That to create conditions for conducting electrical current, are developing dissociation and ionization of the surrounding protective gas and ignite their own arc.

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Accessories welding sources TIG welding

- Touch called ignition. ignition current is enabled by the control unit of the welding parameters.
- Starting a current whose intensity is low and reaches a maximum of 10 A, only heats the tip of the tungsten electrode.
- This condition may take longer time, and in delaying the electrode is increased at a controlled welding current rise value.
- Advantage the process is in the exact location of the beginning of the weld to weld bevel.

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Accessories welding sources TIG welding

- Programmer in direct relation to the control unit provides settings counterblow and Final blow gas, closing and regulating the cooling water circuit, triggers the ionizer and mechanized welding process controls all movement of the torch, or the entire welding head.
- In event robotized welding is connected directly to the robot controller.
- The coupling and connecting elements between the individual parts of the conductors and hoses of various diameters and lengths.
- All components form one unit of welding equipment.

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Accessories welding sources TIG welding

- The AC power source is most adapted to the welding transformer using TIG welding power electronic components that increase the slope of the static characteristic.
- For new inverter AC voltage sources is collected for the RF transformer.
- The stabilizer is at AC welding a very important element. It is a source of high voltage pulses with a high frequency, which acts only when the welding current has a zero value, and performs the function of the auxiliary ignition unit - ionizer.

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Accessories welding sources TIG welding

- Conventional stabilizers into the welding circuit induces current voltage of 2500 V to 6000 V, a frequency of 2 MHz to 5 MHz.
- At today's design resources but often uses pulse generator with low frequencies that have lower interference telecommunications.
- The control system has an important role during welding, particularly when welding aluminum and aluminum alloys, which compensates for distorted sinusoidal waveform which is caused by a different ionization potential of tungsten and aluminum.
- Improves the effect of the cleaning arc.

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Types of welding currents

- DC welding shock
- AC welding shock
- Welding impulse current

DC welding

- DC welding is a basic way of connection TIG welding.
- At this connection electrode is connected to the negative pole of the source material and welded to the positive (direct involvement).
- Distribution the heat of the arc is erratic and approximately 1/3 of the heat attributable to the electrode, and 2/3 of the total heat is transferred to the base material.
- Thanks This electrode is not thermally overloaded and conversely weld pool has a large penetration depth.
- On great depth of penetration is affected by the impact of electrons that its kinetic energy is converted into heat.

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DC welding

- DC welding with direct polarity is used for joining all types of steel, copper, nickel, titanium and their alloys.
- This method of connection can also be used for welding of aluminum in a protective atmosphere of Argon and at least 75% helium.
- At DC welding aluminum due to the high conductivity of the helium passes into the weld pool by a large amount of heat, which allows melting and surface oxides.
- Oxides the influence of surface forces pulling on the edge and the center of the melt of the molten bath is clean.
- This welding process is mainly used for renovation and repair of large and thick-walled aluminum castings or weldments.
- Allows associate and thick-walled and thin-walled components especially fillet weld.

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DC welding

- Inverse polarity connection is not because of the high heat load and can be used exceptionally used for welding thin-walled welded aluminum low current.

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AC welding

- AC welding is used for welding of aluminum, magnesium and their alloys.
- Significant problem when welding aluminum, aluminum oxide layer, which protects the aluminum under normal conditions against further oxidation.
- Layer of Al_2O_3 has a high melting temperature - 2050 ° C using a direct current in an argon prevents the metallurgical connection, because covering the surface of the molten aluminum whose melting point is about 658 ° C.

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AC welding

- The cleaning effect occurs when connecting the electrode to the positive pole of the source, when the argon ions of relatively high mass are accelerated towards the molten bath and acts on a mechanical effect oxides (reminds blasting).
- On the base material is also formed in the cathode spot, which is not stable and moves to the place covered with oxides (have lower emission energy) and after striking of the cathode spot, the oxide more easily evaporated.

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AC welding

- When the positive electrode connection arises only a small penetration, and therefore, alternating current is applied when the negative electrode connection when there is a deep penetration.
- Modern welding devices have a square waveform alternating current, and are equipped with "Balance", which allows extension or narrowing of the positive or negative cycles of current i.
- This function can either reinforce the cleaning effect when the positive period if the oxidized surface, or enhance penetration depth p s negative period.

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Welding impulse current

- It is a modern way of TIG welding, the principle is based on the regular change of current strength (basic and pulse).
- The course of a rectangular impulse current
- Current modulation
- In practice, there are two types of modulation current:

a) Long pulse, from 1 sec to 10 sec, for a material thickness of 4 mm to 6 mm,

b) Secondary pulses with a frequency of 1 Hz to 100 Hz, for welding thicknesses from 0.8 mm to 5 mm

- An important parameter is the welding speed, which may be the greater, the greater the pulse frequency.

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Benefits pulse welding

- Good integrity, mechanical and plastic properties of welds,
- Lower thermal influence on the material, the smaller the deformation,
- Nice bead appearance,
- Lower susceptibility to weld formation intergranular corrosion on high-alloy steels,
- The preferred cross section of the weld,
- Sheet metal welding tl. 0.5 mm and 5 mm without the use of shims,
- Extensive areas of regulation welding current.

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Use of pulse welding in practice

- Suitable for welding thin sheets,
- Suitable for welding non-ferrous metals,
- Suitable for welding unilaterally accessible welds,
- Suitable for welding in welding positions,
- Suitable for welding of tubes of larger thicknesses.

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TIG welding torches

- Welding torches provide electrical power to the electrode, supplying and directing shielding gas, fixing the position of the tungsten electrode inlet and outlet of cooling water.
- Burners divided to passing cooled gas to about 150 A and water-cooled torches 350 A to 500 A for the manual, but especially machine welding.
- Burners have interchangeable collet which ensures secure holding and power supply to the tungsten electrodes.
- Other thermally loaded part of a gas nozzle that directs gas flow to the weld.

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TIG welding torches

- Ceramic nozzles are used for manual torches passing cooled gas and the metal most often copper and chrome, are suitable for machine torches cooled by water.
- The protective gas should ideally provide protection against the effects of the surrounding atmosphere to avoid contamination of the weld pool oxygen or nitrogen, and the tungsten electrode is protected from oxidation.

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Parameters for optimal gas flow

- The type of material to be welded,
- Type of shielding gas,
- Current value,
- Size of the gas nozzle,
- Angle of inclination of the burner,
- Velocity of the air,
- Joint type,
- Welding position.

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TIG welding torches

- The flow of argon is dependent on the welding current and material.
- For 150 A flow of 4 l / min - 6 l / min for steel, 6 l / min - 8 l / min for aluminum and 8 l / min - 12 l / min for copper, nickel, titanium, magnesium etc.
- When using mixtures of argon-helium gas flow rate should increase by about 30% when padesátiprocentním proportion of helium in argon.

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TIG welding torches

- To ensure the perfect environment for gas arc welding machine is equipped with the counterblow gas.
- Ignition the arc is delayed from the beginning of the gas flow of 2 sec to 5 sec.
- conversely cooling of the electrode and weld metal to a temperature of about 300 ° C when there is no oxidation function is ensured Final blow.
- This function ensures the flow of protective gas for 15 sec to 30 sec after turning off the power. When the electrode is blue or black colouring is insufficient protection for gas flow and should be extended.

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TIG welding torches

- Each burner is equipped with a switch of the electric current, which enables the two-stroke or four-stroke operation of switching the welding current.
- Burners new modern resources enable change during welding the welding current continuously or stepwise at a predetermined current value.

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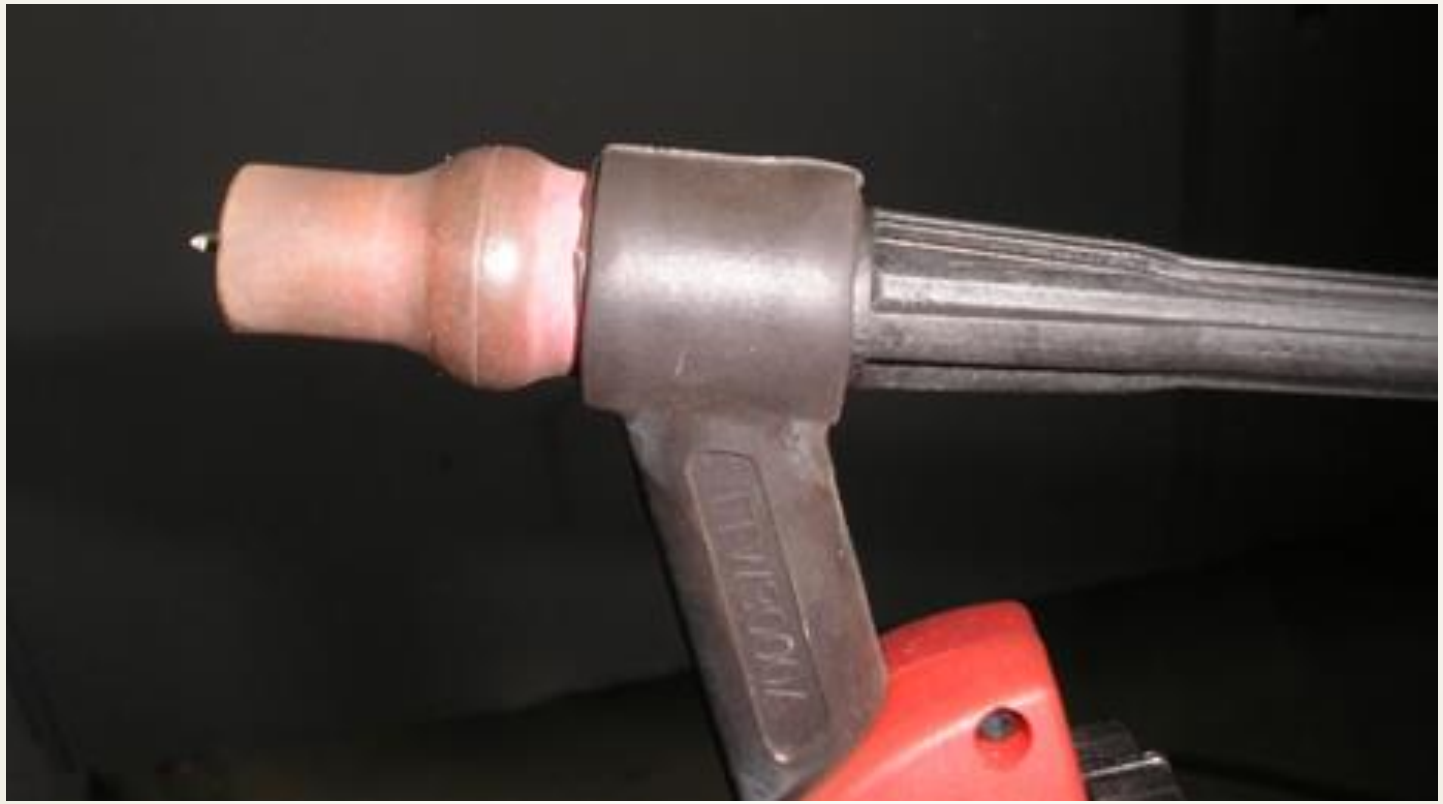
The welding torch for the TIG method with tungsten



Non-consumable tungsten electrode

- TIG welding is used with non-consumable tungsten electrode having a high melting point (which is determined by high temperature tungsten - 3,380 ° C).
- Electrodes must be clean and free of impurities, ie., they contain almost 100% tungsten.
- Service life electrodes can be increased by adding oxides which lower the heating temperature of the electrode 1000° C.

The melting point of metal used as an ingredient in TE

- oxide thorium ThO_2 3 300° C
- oxide lanthanum La_2O_3 2 300° C
- oxide zirconia ZrO_2 2 700° C
- cerium oxide CeO_2 2 600° C
- oxide hafnium HfO_2 2 900° C
- oxide yttrium Y_2O_3 2 700° C

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The melting point of metal used as an ingredient in TE

- In contrast, the tungsten trioxide WO_3 has a melting point of only 1 473 ° C.
- Substantially higher melting points are nitrides of said metals in comparison to tungsten nitride.
- The choice of electrode type depends on the type and power applications.
- electrodes They are standardized in EN ISO 6848
- Consumption of non-consumable electrode with a load current is about 4 mm per hour.

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A review of the tungsten electrodes produced. (EN ISO 6848)

Designation	Weight percent of		Color coding
WP	without oxides		green
WT 10	ThO_2	0.9 to 1.2	Yellow
WT 20	ThO_2	1.8 - 2.2	red
WT 30	ThO_2	2.8 to 3.2	purple
WT 40	ThO_2	3.8 to 4.2	Orange
WZ 3	ZrO_2	0.15 to 0.4	Light brown
WZ 8	ZrO_2	0.7 to 0.9	white
WL 10	La_2O_3	0.9 to 1.2	black
WL 15	La_2O_3	1.4 - 1.6	Gold
WL 20	La_2O_3	1.8 - 2.2	blue
WC 20	CeO_2	1.8 - 2.2	Grey
Lymox	$La_2O_3 + Y_2O_3$	+ CeO_2 1.8 - 2.2	Pink

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A review of the tungsten electrodes produced. (CSN EN ISO 6848)

- Manufactured Diameter: 0.5; 1.0; 1.6; 2.0; 2.4; 3.2; 4.0; 4.8; 6.0; Manufactured in 6.4 mm length: 175 standard, 50; 75; 150 on order.
- Labeling of tungsten electrodes is governed by the following principles:

1. first letter W denotes tungsten as an essential element electrodes;
2. second letter characterizes doped T - oxide thorium Z – oxide zirconium, L - oxide lanthanum, C - cerium oxide
3. The second letter P (pure) characterizes a pure tungsten electrode,
4. ID tag indicates when the basic oxides concentrations tenfold.

KUBICEK, J. DANEK, L. KANDUS B. *Welding technology and equipment. Textbooks courses for welding engineers and technologists.* Plzeň: ŠKODA WELDING sro, 2011. p. 71.

Protective gases

- TIG welding is used most frequently pure argon or a gas mixture with argon.
  - Mixtures of argon and helium.
  - Mixtures of argon and hydrogen.
  - Mixtures of argon with nitrogen.

Mixtures of argon and helium

- Mixture of Ar and He are inert gases have very good properties for welding, they are therefore often used in practice.
- They use especially a mixture of 70% Ar + 30% He, Ar-H 50/50, 30% Ar + 70% He.
- The higher helium content, thereby increasing the voltage, which influences the shape and size of the weld.
- Use a mixture of argon and helium is especially for non-ferrous metals or welding thick materials.

Mixtures of argon and hydrogen

- In practice, they are used and the mixture of argon and hydrogen, in particular for their ability to maintain high purity of the weld surface, the disadvantage is that hydrogen can not be used for a plurality of materials.
- It uses Only for highly alloyed austenitic-ferritic and austenitic steels or for welding nickel.
- Basically these mixtures are not used for welding of martensitic and ferritic steels (cold cracking).
- Do not use even for welding non-ferrous metals (presence of a large amount of pores in the weld).

Mixtures of argon with nitrogen

- Such mixtures are mainly used for welding non-ferrous metals (copper).

Forming gases to protect the weld root

- Mostly used inert gases, the use of reason is to prevent oxidation of the weld root. They can use a mixture of argon, hydrogen or nitrogen.

additional materials

- Features additional materials TIG welding
  - Adjust the volume of the weld metal and the weld build the desired shape and cross section,
  - Alloying the weld metal additives which improve the quality of the weld,
  - Supplied to the weld metal additives which ensure deoxidation, degassing and favorably influence metallurgical happening in the weld metal,
  - Improve formation of the weld, weld wetting surfaces and operative in positional welding.

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Additional materials are designed according to these principles

- Chemical composition of the filler materials having the same or similar as the base material,
- For dynamically stressed steel structures it is necessary to select additional materials such that the weld metal had better mechanical properties than the base material,
- Welding of materials sensitive to hot cracking is necessary to use additional materials reducing this cracking,
- Welding materials with high corrosion resistance is necessary to use additional materials of the same chemical composition and the same purity as the basic material,
- For welding stainless steel stabilized with titanium is necessary to apply additional materials stabilized with niobium because of their lower burn when passing through an electric arc.

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Additional materials

- Additional materials are divided into welding rod for manual welding and welding wires for mechanical methods.
- They suitable chemical composition and good surface quality.
- Welding rods are round wires with sufficient rigidity diameter of 1 mm to 8 mm and a length of 600 mm to 1000 mm.
- At welding rods are used in full section, or filled with alloying, or carbidic additives for surfacing.
- Welding wires for mechanized welding methods are accurate circular cross-section wires wound evenly on the coils.
- Welding wires are delivered from a diameter of 0.6 mm to 2.4 mm for welding to 5 mm.
- Wires of copper, aluminum and their alloys must have medium hardness after deformation hardening, which provides rigidity mechanized feeding into the weld area.

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Marking of additional materials

- The new classification standards introduced two different classification approaches.
- System A series based on the original classification standards EN and is based on the size of the yield strength and impact work 47 J weld metal at a specific test temperature.
- System B (North and South America, Pacific region) based on the yield strength of weld metal and minutes. impact energy of 27 J at a certain temperature.
- Classification under both systems are comparable.
- In EN ISO 14343 for high-alloy steel system A classification based on the nominal chemical composition of the wire.
- In System B is additive material classified according to the type of alloy.

Example indications filler material is alloy steel according to the classification standard A

- Rod EN ISO 636 - 46 3 W W3Si1 EN ISO standard number =
- W = rod / wire or weld metal arc welding, tungsten inert gas
- 46 = tensile strength and elongation in accordance with the appropriate table (yield strength 460 MPa)
- 3 = impact strength (47 J at -30 ° C)
- W3Sil = chemical composition

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Manual welding technology

- Manual TIG welding is used where it is necessary to create a weld that will have a clean surface and a very good quality, use is mainly in piece and small series productions.
- The technique is characterized by manual welding position, movement and speed of the torch and the filler material.
- This It is determined by reference to the resulting weld pool.
- Technique TIG welding (141) is similar to the technique autogenous welding (311) are not active protective atmosphere.

Manual welding technology

- With this method it is possible to produce welds in all positions, used welding technology forward. The burner must be tilted about 10 ° and the filler material should be tilted about 70 ° from perpendicular to the weld area.
- Standard welding position corresponding to the inclination and orientation of the torch with an auxiliary material and its movement in the weld joints are given type of weld.
- The electrode is ejected from the ceramic gas nozzle a distance which is about 2 times larger than the electrode diameter. This principle applies for butt welds, fillet welds, the electrode extends further by addition of 3 to 5 mm.

Adjusting welding parameters at TIG

- Before welding it is necessary to adjust the weld area.
- On treatment has the greatest impact type of welding material and its thickness.

Questions to ponder

1. What are the most common methods for shielded welding?
2. What is the principle at work methods shielded welding?
3. What are the advantages shielded welding?
4. What is the current density?
5. What are the advantages of welding back and forth?
6. What is the dependence of the weld bead on stress?
7. Explain the concept of direct and indirect polarity current.
8. Shielding gases that are suitable for MIG and MAG?
9. What welding device is used for TIG welding?
10. What is the technique of TIG and WIG?
11. What shielding gases They are used for TIG welding WIG?

Recommended literature and information sources

- AMBROŽ, O. A KOL. *Technologie svařování a zařízení: učební texty pro kurzy svářečských inženýrů a technologů*. Ostrava: ZEROSS, 2001, 395 s. Svařování. ISBN 80-85771-81-0.
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