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# MODULE J
# Electrodes for manual arc welding

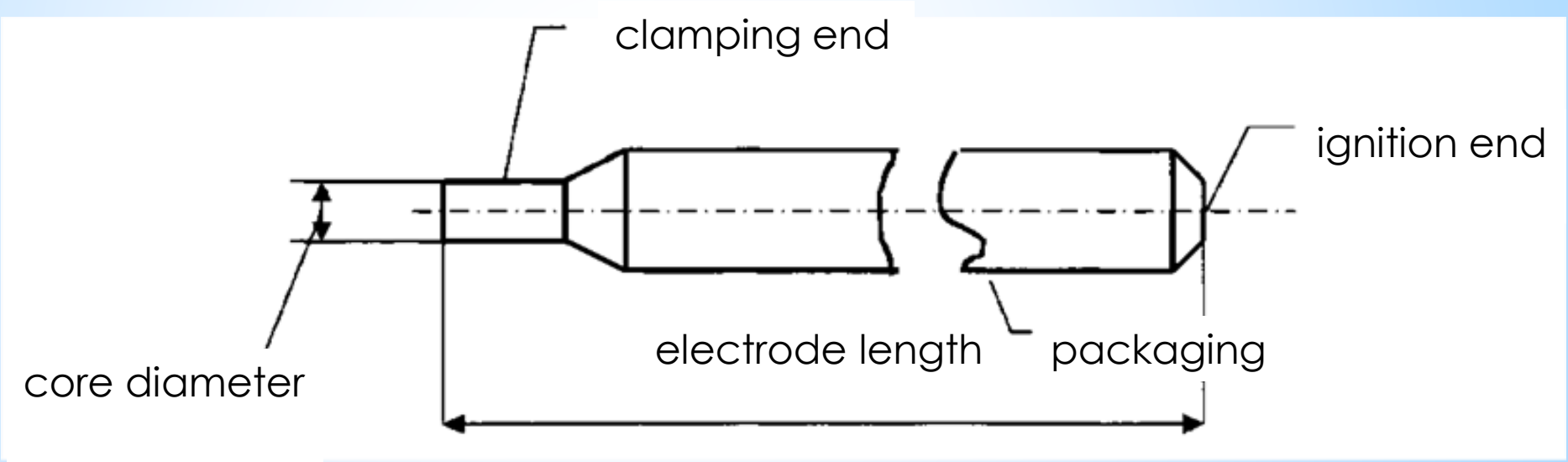
Manual electrode welding

# Manual electrode welding

- Manual electrode welding is a welding method which can weld substantially all materials in all positions of welding current 10 A to 2000 A, a voltage of 10 V to 50 V.
- Temperature Arc is about 5000 C.
- Welds direct current polarity reversed direct and even alternating current source via a steep current-voltage characteristic.
- Welding MMA has been recently widely used welding technology.
- His characteristic is the covered electrode as filler material that provides a quality weld metal with a desired chemical composition.

# coated electrode

- The main part of the coated electrodes




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. 110.

# Coated electrode

- The base electrode is coated with a metal rod, called. Electrode core, which is coated packaging material.
- The basic task package is to facilitate welding, the welding bead shape, improve the quality of the weld in terms of metallurgical and increase productivity welding.
- The packaging has fulfilled all requirements must contain the following ingredients:
  - Slag - acid ($SiO_2$), or basic (CaO, MgO), Or a chemically inactive (rutile - $TiO_2$).
  - Slag It reacts with the weld metal as slag, electric arc furnace.
  - Except It covers the weld bead and protects it from the action of the external atmosphere, and slows down the solidification of the weld metal and thus allows the gas from the weld.
  - Slag substances are decisive for the properties of the electrode.

# Slag formers and alloying additives:

a) Refining agents are tasked dezoxidovat weld metal. It is mainly used ferromanganese, ferrosilicon andFerrotitanium. The formed oxide should not be soluble in the weld metal and slag have to pass.

b) The alloying additives in the container permits the economical production of special electrodes that provide a weld metal with a chemical composition quite different from the core composition.

c) Gassing additives in the arc burns and produces a sufficient amount of gases to displace air from the weld point and thus protects the molten metal from direct contact with air.

d) Ionization ingredients are the elements that have low ionization potential. Facilitate arc ignition and ensure its smooth burning.

e) Binding agents must provide strength, cohesion and flexibility of the packaging.

# According to the composition of the packaging divided electrodes

- Stabilizing,
- Rutile (Ref. R or RR)
- Rutil-cellulose (RC)
- Rutile-acid (RA),
- Rutile base (RB),
- Acid (A)
- Base (B)
- Cellulose (C).

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# Electrodes

- Catalogs of manufacturers of additional materials produced electrodes assigned to specific groups of welded materials, eg .: electrodes for welding unalloyed and low-alloy steels, electrodes for iron, nonferrous metals, etc.
- Each electrode manufacturer chooses labeling electrode your specific system.
- Improvement orientation in selecting electrode brings a new classification system of electrodes according to EN ISO 2560.

# Manufacture of coated electrodes

- Manufacture of coated electrodes can be divided into three stages:
  - Preparing the core
  - Preparing the coating mixture,
  - Applying the mixture to the core.

# Manufacture of coated electrodes

- Preparation of the core consists in drawing the blank (wire rod) in a die to exact dimensions (range of diameters is 1.6 mm - 2.0 mm - 2.5 mm - 3.2 mm - 4.0 mm - 5.0 mm - 6 3 and 8 mm).
- Wire Furthermore, flat, clean and cut to a specified length of 150 mm, 200 mm, 250 mm, 300 mm, 350 mm or 450 mm, the coating mixture is made up of several components, namely:
  a) *Ore mineral raw materials such as fluorspar, limestone, dolomite, feldspar,*
  b) *ferroalloys - ferromanganese, ferrosilicon, ferrotitanium and ferowolfram.*
  c) *chemicals - soda, potash water glass etc.,*
  d) *organic materials - cellulose, starch, flour, peat etc..*

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# Manufacture of coated electrodes

- According to the recipe, the components are dispensed, homogenized using a binder and a thick dough (or in the case of dipped electrode slurry) material.
- Packaging the core in most cases applied by pressing in special presses.
- Packing the core material is compressed in a nozzle at a pressure of about 160 MPa at high speed about 18 pieces per second electrodes.
- Then followed by grinding and clamping the end of the ignition electrode, drying in an oven for 2-6 hours at 200 ° C to 400 ° C.
- Dried and cooled electrode in color indicates to the entire core at the clamping end, they are printed and packed in boxes and cartons.
- Only in exceptional cases, the production of certain special electrodes and a small number are still using the wetting and drying.

# According to the ratio of the diameter of the electrode (casing) and the diameter of the core is divided electrodes on:

- Thinner packages, wherein D / d <1.2,
- Medium thick packed wherein D / d is 1.2 to 1.45,
- Thickly packed, wherein D / d is from 1.45 to 1.8 and
- Very thickly packed, where D / d is> 1.8.

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# Electrodes

- A random visual inspection can be detected some defects in the packaging.
- Surface electrodes must be connected, on the shell surface are permissible only defects such as abrasions, bruises and crease to maximum depth of one quarter of the coating thickness.
- Permissible are also axial crack length to maximum five times the diameter of the core is given by the smallest possible distance between them.
- Scans Also eccentricity casing that at larger values than the values admissible cause uneven melting of the electrode.

# Principles for storage and drying of electrodes

- Storage and drying electrodes should be paid special attention, as a breach of regulatory requirements directly negative impact on the quality of the weld metal.
- Electrodes are stored in a dry and well ventilated space in the original intact packaging at the lowest permissible temperature of + 10 ° C and relative humidity of 50%.
- Height the stack can only be such as to not violate the weight of stacked electrodes of the electrode in the lower layers.
- Damp electrodes must be dry out according to manufacturer's recommendations.

# Suggested modes of drying

| Packaging | drying mode |
|---|---|
| Basic | 100 ° C / 1 hr., 350 ° C to 400 ° C / 2 hrs. |
| Sour | 120 ° C to 150 ° C / 2 hrs. |
| rutile | 120 ° C / 2 hrs. |

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# Principles for storage and drying of electrodes

- Moisture container adversely affects the hydrogen content in the weld metal.
- At dried electrode is stated content 15 cm3 of hydrogen per 100 g of weld metal.
- Hydrogen then the weld metal diffuses into the heat affected zone, which becomes fragile.
- Humidity packaging is most evident at the base electrode.

# Requirements electrodes

- Electrodes must meet the mechanical properties of the weld metal at the same time must also have adequate operational characteristics. Among the operational characteristics of electrodes mainly include:
  - Suitability for working electrodes in various welding positions, manageability arc and weld pool in these positions,
  - A method of melting of the electrodes and a transition metal into the weld pool,
  - Properties and the amount of slag, gases etc.

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# When selecting electrode must be taken into account in particular the following aspects:

- Properties of the base material,
- The size and type of stress weldments and individual welds,
- Requirements for weld
- Position welding,
- The need for further processing weldments, type and value of the welding current, cost and efficiency.

# Labeling electrodes

- Electrodes are labeled according to CSN EN 499th
- Electrodes currently represents the yield strength, ultimate strength and ductility.
- Marking electrode according to this standard has a binding portion, that has 5 data and the optional part, that has 8 data.
- In binding part indicates a type of product strength, elongation, chemical composition and type of packaging.

# Labeling the electrodes on the package

# Labeling the electrodes on the package

# Electrode welding technology

- Electrode welding is one of the most common methods used for easy setup of welding parameters, then this method can be welded in all positions.
- Welding current welder usually adjusts according to the manufacturer's recommendations on the box.

# Electrode welding technology

- If the recommendations are not available, controls the empirical values:
  - For electrodes with acid and rutile is the welding current I (A) = I (40-55) .d.
  - For electrodes having a basic shell I = (35-50) .d where d is the diameter of the core electrodes.

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# Electrode welding technology

- Welder voltage is changed, balanced static characteristic curve.
- When welding is to be conducted and the arc electrode so that the electrode is slightly tilted against the weld bead, in order not to disturb the molten slag arc and avoid slag inclusions in the weld metal.
- Length arch corresponds approximately to the core diameter of the electrode.
- At the end of the weld bead must not shrink, i.e. the end of the bead is therefore still necessary to add a certain amount of liquid metal.
- That is achieved by splicing or arc small step back.

# Special arc welding

- These techniques include mainly pulse welding (used mainly for MIG and MAG).

# Questions to ponder

1. What does the package electrode which contains the substance?
2. Explain why for manual arc welding power sources use flat static characteristic.
3. Justify the importance of drying electrodes.
4. What are the limits of temperature and humidity for storage of electrodes?
5. What aspects We take into account when selecting the electrodes?

# 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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