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MODULE 5

Special methods of fusion welding

Electron beam welding



Electron beam welding

- Electron beam welding is a fusion welding process in which the kinetic energy of flying electrons rapidly converted into heat upon impact with the surface of the welded material.
- This method is currently used in all industrialized countries of the world including the Czech Republic.

KUBÍČEK, J. DANĚK, L. KANDUŠ, B. *Technologie svařování a zařízení. Učební texty pro kurzy svařovacích inženýrů a technologů.* Plzeň: ŠKODA WELDING, s. r. o., 2011. s. 141.



The principle of the electron beam welding

- The actual electron source is a cylindrical vacuum vessel provided at one end directly or indirectly thermionic emission electrode and at the other end with a separating cap, which is combined with the observation prism optics.
- Source electrons is called the electron gun or an electron gun and the pump is pumped at high vacuum.
- To ensuring the thermal emission of electrons is necessary vacuum.
- Size working chambers is different from small contents of up to tens of meters³.

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Weldability

- ▶ Welded joints formed by electron beam welding are used in particular in aeronautics and space technology.
- ▶ Welding enables joining in vacuo and chemically very active metals - Ti, Zr. Mo. Nb. HfW et al., Which have a high affinity for oxygen, nitrogen and hydrogen.
- ▶ These gases react with the metal in substantial deterioration of mechanical properties, particularly by reducing the toughness.
- ▶ Yippee can weld high-yielding Fireproof metals and alloys of the type Inconel, Nimonic.
- ▶ In recently, electron welding, joining by fusion weldable materials due to formation of brittle intermetallic phases.



Weldability

- ▶ Intermetallic phases cause a significant reduction in plastic and strength properties of the weld metal and may cause cracking of the joint.
- ▶ At welding accelerated electrons is limited to a narrow weld pool formation of brittle phases and exact focusing can achieve a desired mutual solubility of metals and give a solid solution with suitable plastic properties.
- ▶ In this manner can weld these combinations of materials: Ti - Al, stainless steel - Al, Cu - Al, Cu - steel, Al - Ni, etc.



Weldability

- ▶ When welding low carbon and low alloy steels, high purity material, particularly phosphorus and sulfur content should not exceed 0.015% (to cause significant decrease of plasticity with possibility of cracking).
- ▶ Very well weldable high-alloy austenitic stainless steel whose breaking strength is lower by 8% - 10% and a yield strength higher than that of even the base material.



Use of electron beam welding in engineering practice

- ▶ Electron beam welding is used especially for very thin sheets, as in this way successfully welded pipes (heat exchangers), their utilization is the welding of both nuclear and classical energy.
- ▶ The increasingly advocated in aviation and space technology.



Benefits of electron beam welding

- Very good weld appearance with fine surface pattern.
- Narrow melting and heat-affected zone of the weld.
- Minimal distortion.
- Possibility of welding in inaccessible places for traditional technologies.
- Perfect protection against the effects of weld airy atmosphere.
- Vacuum refining effect.
- Possibility of power transmission at distances greater than 500 mm.
- Very easy and programmable power control beam.
- Welding beam in one pass.
- Weldability wide range of materials and combinations thereof.
- A high degree of automation, without affecting the weld human factor.



Disadvantages of electron beam welding

- ▶ High demands on the cleanliness of the weld surfaces and precise machining.
- ▶ Exactly the beam in the joint.
- ▶ High investment costs.
- ▶ Need vacuum and a long time for its use.
- ▶ Requirement inner purity materials.



Hygiene and safety during the electron beam welding

- ▶ Electron beam welding has no adverse effects on the air because any metal vapor condenses on the inner surface of the working chamber.
- ▶ FROM therefore, the chamber interprets removable aluminum foil.
- ▶ When working with electron welding devices it is necessary to follow the instructions to operate with high voltage and ionizing radiation, since the concomitant formation of X-ray radiation.
- ▶ This radiation is eliminated by jacket chambers and lead glass viewport.