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WELDING AND RELATED PROCESSES

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Welding and related processes

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The manual outlines the basics of welding and related processes in the discipline «Welding and Related Processes» for PhD-level higher education students studying in the specialty G08 «Materials Science».

The purpose of the manual is to provide applicants with the opportunity to study in more detail the basics of the theory and practice of welding technologies and obtain factual data for application in production and in scientific work.

The list and content of topics correspond to the program of the above-mentioned discipline.

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INTRODUCTION

Welding is one of the main technological processes in mechanical engineering and construction. It is difficult to name a branch of the national economy where welding is not used.

Welding has made it possible to make fundamental changes in production technology, to create fundamentally new machine designs. For example, the use of welded structures instead of riveted ones in construction has allowed to save about 20% of metal, to reduce the labor intensity of manufacturing structures by 5...30%.

Development of welding. The main type of welding is arc welding.

In 1802, for the first time in the world, professor of physics Vasily Vladimirovich Petrov discovered and observed an arc discharge from a super-powerful “volt pillar” he made, which consisted of 2100 pairs of dissimilar circles-elements (copper + zinc), laid with paper circles moistened with an aqueous solution of ammonia. This pillar, or battery, as V. V. Petrov called it, was the most powerful source of electric current at that time. Having conducted a large number of experiments with this battery, he showed the possibility of using an electric arc for lighting and melting metals. By the time of the discovery of the arc discharge, electrical engineering was just beginning to be created, V. V. Petrov’s discovery was significantly ahead of its time, and about 80 years passed before the practical application of the arc for welding purposes.

This was done by the Ukrainian inventor Mykola Mykolayovich Benardos - the author of many inventions in the field of electrical engineering. In 1881, he first used an electric arc between a carbon electrode and metal for welding. After detailed development of his invention, M. M. Benardos received patents for it in England, Belgium, Germany, Italy, France, the USA and other countries. M. M. Benardos used the method he created not only for welding, but also for surfacing and cutting metals. Almost simultaneously with M. M. Benardos, another inventor worked - Mykola Gavrylovich Slavyanov, who did a lot for the development of arc welding. He developed a method of arc welding with a metal electrode with protection of the welded zone with a layer of powdered substance (flux) and the world's first mechanism - "electrofusion" - for semi-automatic feeding of the electrode rod into the welding zone. The method of welding with a consumable metal electrode was called "arc welding according to the Slavyanov method". The first public demonstration of the new method took place in 1888 in Perm.

The inventions of M. M. Benardos and M. G. Slavyanov found notable application at that time, primarily on railways, and then at several large machine-building and metallurgical plants.

A significant contribution to the development of the theoretical foundations of welding was made by scientists: V. P. Vologdin, V. P. Nikitin, K. Kh.

Khrenov, E. O. Paton, G. O. Nikolaev, N. O. Okerblom, N. N. Rykalin, K. V. Lyubavsky, B. E. Paton and others.

At the present stage of the development of welding production, due to the development of the scientific and technological revolution, the range of welded thicknesses, materials, and types of welding has greatly increased. Nowadays, materials with a thickness of several micrometers (in microelectronics) to several meters (in heavy engineering) are welded. Along with traditional structural steels, special steels and alloys based on titanium, zirconium, molybdenum, niobium and other materials are welded, as well as dissimilar materials.

The conditions for welding have expanded significantly. Along with the usual conditions, welding is performed under high temperatures, radiation, underwater, in deep vacuum, in weightlessness. New types of welding are being rapidly introduced - laser, electron beam, ion, light, diffusion, ultrasonic, electromagnetic, explosive, and the capabilities of arc and contact welding are significantly expanding.

The main means of accelerating scientific and technological progress and the development of production is to increase labor productivity and quality of work. In the field of welding production, this task is solved by mechanization and automation of the welding processes themselves, that is, by the transition from manual labor of the welder to mechanized, and by complex mechanization, which includes the mechanization of preparation, assembly, welding, finishing, auxiliary and control operations.

The main operations of welding production. Welding is the process of manufacturing inseparable joints by establishing interatomic bonds between the welded parts during their local (general) heating or plastic deformation, or their combined action. The essence of welding is to bring the elementary particles of the welded parts together so that interatomic bonds begin to act between them, which ensure the strength of the connection.

Welding production is a complex of production processes with the widespread use of welding equipment, which forms an independent, complete technology for manufacturing welded products.

The entire complex of welding production can be divided into six groups of operations: 1 - preparatory, 2 - assembly, 3 - welding, 4 - finishing, 5 - auxiliary, 6 - control.

Preliminary operations - operations for the manufacture of parts of welded structures. When performing preparatory operations, the following types of metal processing are used: cutting - mechanical and thermal, planing on machine tools;

stamping on presses; cleaning the edges and surfaces of parts from scale, rust, burrs; straightening and bending parts on rollers, presses, plates; mechanical processing of large parts - turning, planing, milling, drilling holes in them.

Assembly operations ensure the correct mutual placement and fastening of parts of the product being assembled and welded on a plate, rack, stand or special device.

In addition to the actual welding operations, welding operations include some auxiliary operations inextricably linked with welding, such as installing the product for welding or the welding head at the beginning of the seam, directing the electrode along the joint, turning the product during welding, moving the welder, etc.

Finishing operations include cleaning the seams, removing metal spatter and burrs, painting, packaging, as well as thermal and mechanical treatment of finished products, if they are performed in the welding shop.

Auxiliary operations include crane, transport, lifting and reloading operations: adjustment work with welding, gas-cutting and other equipment; assembly of parts and distribution of work; work on receiving and issuing material and tools, manufacturing electrodes, winding cassettes with welding wire; other auxiliary work related to the main production.

Control work includes a set of control operations at each stage of manufacturing a welded structure, including control of the initial welded and welded materials, quality control of preparatory, assembly, welding and finishing operations, control of welded joints and finished products.

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Study guide

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