The welding was carried out at direct current of reverse polarity from the rectifier VD-306. The conditions of welding are given in Table 7, the chemical composition of HCWA — in Table 8, specific precipitation of HCWA — in Figure 3.

The results, as in previous series for electrodes with rutile coating, show that increase in content of alkali metals in electrode coating leads firstly to decrease in precipitation of HCWA and at high content of potassium compounds — to the growth of HCWA precipitation. Such dependence is explained by the effect of two opposite acting factors: on the one hand, by decrease in arc power as a result of drop of voltage and, respectively, the decrease in temperature of melts of metal and slag that leads to the reduction in intensity of evaporation, and, on the other hand, by increase in content of compounds of alkali metals with high vapor pressure in slag that leads to the growth of evaporation intensity. At the certain stage (at high content of potassium compounds) the second factor is prevailed and leads to the growth of precipitation of HCWA (K-3).

It was found using X-ray fluorescent analysis of chemical composition of HCWA that with the growth of content of compounds of potassium in the electrode coating of the basic type the content of potassium in HCWA is increased, whereas content of manganese, silicon, sodium and calcium is decreased (Table 8).

The carried out investigations prove the possibility of improvement of sanitary-hygienic characteristics of electrodes due to regulation of composition of coating. The obtained results represent a practical interest and will be used in future development of universal electrodes with coating of a rutile type.

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MODERN WELDING MARKET OF THE NORTH AMERICA

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In the article the statistical data characterizing the state-of-the-art and main trends in development of welding market in the North America are given.

Keywords: *welding equipment, welding consumables, main values, market, statistics*

The market of welding equipment of the North America is one of the largest regional markets in the world (30 % of the world welding market). According to the data of the American Bureau of Statistics, in the USA in 2011 the cost volume of the production of equipment (excluding transformers) and accessories for welding and brazing, such as equipment for arc, resistance, gas, plasma, laser, electron beam, ultrasonic welding; welding electrodes, welding wire (coated and with a core); equipment for brazing (except manual soldering irons) amounted to 4.9 bln USD (2009 — 3.6 bln USD, 2010 — 4.1 bln USD). The volume of import from 76 countries of the world amounted to 1.4 bln USD, and export — 1.8 bln USD (163 countries). Thus, the cost volume of consumption of equipment and materials for welding and brazing in the USA in 2011 amounted to 4.6 bln USD. It should be noted that in spite of 25 % annual growth of production the welding industry of the USA in 2011 did not reach the pre-crisis volume of production which amounted to 5.1 bln USD in 2008 [1].

In Figure 1 the structure of production of the main types of products for welding and brazing in the USA in 2011 is presented.

In the structure of US production 79 % account for the equipment and accessories for welding and brazing and 21 % — materials. The main share of production of welding equipment (about

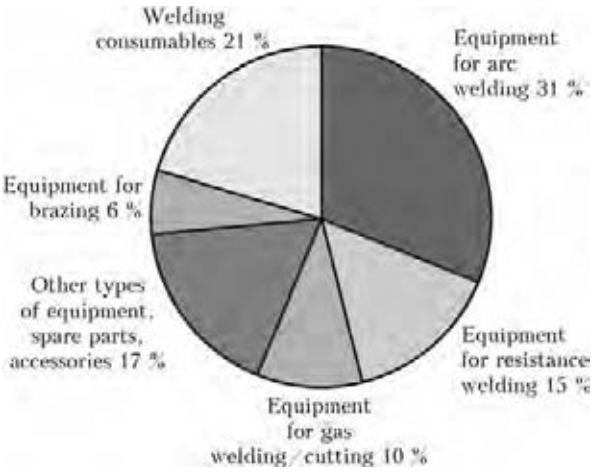

Figure 1. Cost structure of volumes of production of equipment and consumables for welding and brazing per 2011

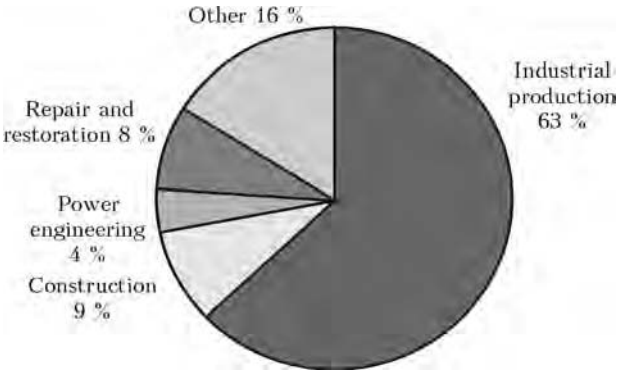

Figure 2. Branch structure of consumption of welding equipment in the USA per 2010

70 %) amounts for machines for arc and resistance welding.

In the structure of welding equipment consumption the equipment for arc and resistance welding also dominates, the share of which is about 70 % of all the volume of consumption.

The structure of consumption of welding consumables the share of welding and filler materials amounts for 73 %, the rest is oxygen and shielding gases. Among the gases used for welding and cutting the consumption of oxygen and acetylene is prevailed. As shielding gases the argon and carbon dioxide are most widely applied [2].

According to the data of «The Japan Welding News for the World», in 2011 the share of countries of the North America (USA and Canada) in the world volume of consumption of welding consumables amounted to 7.2 % (430,000 t): volume of consumption of coated electrodes is 60,200 t, solid wire — 232,200 t, flux-cored wire — 94,600 t, consumables for submerged arc welding — 43,000 t.

In the Table the structure of consumption of the main types of welding consumables in separate regions and countries of the world, including the North America, is given [3, 4].

In the structure of consumption of welding consumables of the countries of the North America the solid and flux-cored wires prevail, the share of which in 2011 amounted to 54 and 22 %, respectively.

The quantitative volume of consumption of equipment for arc and resistance welding in the North America countries in 2010 amounted to 115,000 pcs, among which 94 % are the equipment for arc welding and cost volume was 596 mln USD (78 % — the equipment for arc welding).

In the countries of the North America the level of automation of welding production is growing constantly. In 2011 in the world 43,440 units of welding robots were installed, among which 9000 units — in the North America, that amount 20.7 % of the whole number of welding robots installed in the world. According to the structure of consumption, the share of robots for resistance welding amounts 2/3 and for the arc welding — 1/3 of the whole number of installed welding robots [5].

The branch structure of US welding equipment consumption is presented in Figure 2.

Structure of consumption of basic types of welding consumables in some regions and countries of the world, %

Region/country	Coated electrodes		Solid wire		Flux-cored wire		Consumables for submerged arc welding (wire + flux) and other		In total, thousand tons	
	2008	2011	2008	2011	2008	2011	2008	2011	2008	2011
North America	15	14	58	54	21	22	6	10	520	430
China	60	51	25	29	4	8	11	12	2600	3000
Europe	13	12	64	54	11	19	12	13	680	570
Japan	12	10.4	47	42.8	30	35.3	11	11.5	364.8	285.6
Korea	14	13	37	35	39	40	10	12	260	230
Russia and CIS countries	58	51	27	29	4	6	11	14	240	220
World, in total	44.2	41.1	35.9	35.1	10.0	12.6	9.9	11.2	5784.8	5945.6

According to the estimates of the American Welding Society the growth of consumption of welding equipment in the USA in the nearest years is expected in agricultural machine building, road and bridge construction, railway and communication transport, power engineering, petrochemical industry (including construction of oil and gas pipelines, tankers for transportation of oil and gas).

It is predicted that in 2015 at annual growth by 6.4 % the cost volume of consumption of equipment and consumables for welding and brazing in the USA will reach 7.1 bln USD. In the branches of industry the volume of consumption of welding equipment will amount to 4.4 bln USD, and in construction — 750 mln USD [6].

According to the data of the US Bureau of Statistics about 970,000 of employers and specialists-welders are engaged in the national economy [7].

The basic manufacturers of welding equipment in the USA are:

• Lincoln Electric Holdings Inc. — the leading world manufacturer of equipment and consumables for welding and brazing. It includes the brands like Brastek, Harris. The company has 40 plants in 19 countries of the world and its distribution network comprises more than 160 countries. The volume of sales of the company in 2011 achieved 2.7 bln USD, which amounted to about 50 % of the total volume of sales at the market of the USA and 16 % at the world market of welding equipment. By the end of 2011 the company occupied the 1st place in the rating of the largest world manufacturers of welding equipment [8];

• Illinois Tool Works — the largest diversified company. It comprises the brands like ITW, Miller Electric, Hobart, Bernard, Weldcraft, Jetline, Elga, Tian TVai, WIA. The production capacities and distribution network are located in 57 countries of the world. The volume of sales in 2010 amounted to 15.9 bln USD, among which 12 % cover welding consumables and equipment. According to the data of [9] it occupied the 3rd place in the rating of the largest world manufacturers of welding equipment;

• Thermadyne Holdings — the leading manufacturer of gas-flame equipment in the USA. It comprises the brands like Thermadyne Industries, Thermadyne Dynamics, Victor, Tweco, Arcair, Thermal Arc, Stoody, Turbo Torch, Firepower and Cigweld. The production capacities and distribution network are located in the America, Europe and Asia. The volume of sales amounted to 487.4 mln USD in 2010. According to the data of [10] it occupied the 7th place in the rating of the largest world manufacturers of welding equipment.

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