INTERVIEW WITH PROF. S.I. KUCHUK-YATSENKO, THE DEPUTY DIRECTOR OF THE E.O. PATON ELECTRIC WELDING INSTITUTE

The welding society in Ukraine and far abroad is familiar with the amazing achievements of the E.O. Paton Electric Welding Institute (PWI) in the field of flash-butt welding. This direction is headed by Prof. Sergey I. Kuchuk-Yatsenko, the academician of the NAS of Ukraine, the merited worker of science and technology of the former UkrSSR. His research activity is associated with the fundamental research works of physical-metallurgical processes in welding of different metals in the solid phase, purposeful study of rapid-running processes of heating and fracture of single contacts at the high energy concentrations. He obtained new data on the peculiarities of formation of joints with the formation of thin layer of melt on the contact surfaces of parts being welded, its behavior under the effect of electrodynamic forces and interaction with gas environment in the contact zone. The new regularities were established characterizing power characteristics of the process of contact melting of metals, the algorithms of automatic control of basic process parameters were determined with the purpose of obtaining the best conditions of heating and deformations of the parts being welded.

The practical result of fundamental research works, carried out by Prof. S.I. Kuchuk-Yatsenko and his staff, was highly appraised:

1966 – the Lenin prize for the development and implementation of machines for flash-butt welding of rails in the repair and construction of seamless railroads;
1976 – the State Prize of the UkrSSR for creation and industrial implementation of new technology and highly-efficient assembly-welding complexes for serial production of large-sized structures of unified elements;
1986 – the State Prize of the USSR for creation of technologies and equipment for flash-butt welding of structures of high-strength aluminium alloys;
2000 – the E.O. Paton Prize of the NAS of Ukraine.

Prof. S.I. Kuchuk-Yatsenko published over 350 scientific papers in the authoritative specialized journals, received 740 author’s certificates and patents, prepared 11 Candidates and 2 Doctors of Technical Sciences. He was decorated with two orders of the Red Banner of Labour, Order of the «Badge of Honour», Order of Prince Yaroslav the Wise of the Fourth and the Fifth classes, and medals.

On the eve of the 85th birthday anniversary of Prof. S.I. Kuchuk-Yatsenko the Editorial Board of the Journal recorded the interview with the jubilee person connected to one of the directions of his activity: welding of rails.

Dear Professor, how the permanent interest to the topic «Welding of rails» may be explained?

Indeed, the publication of articles on the topics related to welding of rails is regularly continuing in «The Paton Welding Journal», and at the PWI scientists deal with this problem for several decades. In fact, the PWI deals with creation of flash-butt welding technology of rails and design of equipment from the early 1960s.

At the PWI for the first time in the world practice the technology of flash-butt welding of thick-walled parts was developed using the continuous flashing of large-section parts, providing a great improvement of power characteristics of the process, namely 3–4 times reduction of the specified capacity of the source and enabling its full automation. In the development of this technology Professors B.E. Paton and V.K. Lebedev actively participated. On the basis of this technology the original generation of welding equipment was created patented in the leading countries of the world. For the first time in the world flash-butt welding was used to join the rails directly on the track in the construction of seamless high-speed railways.

How widespread did the created technology of welding rails become at that time? Was there a feeling that the problem had been solved completely?

The technology and equipment quickly gained a wide application on the railroads of the USSR. The production of new welding equipment according to the PWI documentation was mastered by Kakhovka Plant of Electric Welding Equipment, with which we have many years of fruitful cooperation. This development was highly appraised by the state: it was awarded the Lenin Prize. We had every reason «to rest on laurels». But the development of any direction does not allow even a temporary stop. At first, new production demands arise with the development of transport systems, and secondly, under competitive conditions there is a need for continuous improvement of the technology and equipment. For these
high-speed mainline railroads required solving of two main problems: the use of high-strength rails, characterized by an increased wear resistance, and meeting the higher requirements to the geometrical dimensions of track.

In the last decade many countries experience an intense reconstruction of railways and rail track. Here, high-strength rails having hardness of up to HB 400 are used. According to the technological specifications a practical full strength of welded joints with the base metal of rail steel and high plastic properties are required. It was not managed to obtain these characteristics using the traditional technology. At the PWI the systematic studies of weldability of new high-strength rails of different world producers (Austria, China, Russia, USA, Ukraine, Japan) are carried out to develop welding technologies, providing the required mechanical properties. This meantime raises the need in a substantial change of control systems of welding machines and designs of their separate units.

What new approaches were realized in welding of rails?

In particular, it was found that for a high quality welding of high-strength rails the technology of contact heating and mechanical part of design of machines need a substantial change to provide 1.5—2 times increase in compression forces. It was also found that to produce the stable high quality of high-strength rails joining the strictly preset energy input in welding is required. For this purpose the electronic system was developed providing the stabilization of energy input at changes of different conditions of operation of the equipment, as well as at its operation under the field conditions. In the development of systems of automatic computerized control of weld-
During the welding process another significant problem was solved allowing during welding the simultaneous stabilization of the position of long-rail sections after welding.

It is known that in the process of service of seamless track the stresses occur in fixed rails caused by change in temperature, i.e. under the influence of environment. Their effect leads to deformation of rail sections, violation of preset sizes of the track, and in critical situations leads to accidents. The most dangerous are compressive stresses, which may lead to «ejection» of a section.

A bold decision was suggested: in welding of rails of infinite length to create tensile stresses in the sections of such value that at the preset range of changing temperatures in the rails the compressive stresses could not occur. For this purpose during welding it is necessary to provide the tension for value, correlating with proper calculated value of drop of temperatures. The applied technology of flash-butt welding allows performing this operation, as it envisages the bringing the parts together in the process of flashing. An understanding was reached that it is necessary to provide control of welding process with simultaneous control of tension force of sections being welded. This problem was solved by creation of algorithms of control of the welding process basic parameters.

What types of the designed equipment allow meeting the updated requirements of the customers?

As a result of carried out developments a new generation of welding machines and technology, named «pulsating flashing», was developed and patented in the leading foreign countries. The first machines of this type K900, K920 and K921 were designed at the PWI and tested at the railways of the USA together with «Norfolk Southern Corporation» and other US customers.

From the mid-1990s at the PWI a new generation of rail welding machines for welding of rail sections with tension of K922 type was designed. Their production was mastered by Kakhovka Plant of Electric Welding Equipment. All the rail welding enterprises of Ukraine were equipped with these machines (more than 10 machines). They were also delivered...
to the rail welding enterprises of Russia and China, where with their help the construction of seamless high-speed railways was realized.

**How promising is the use of high-strength rails?**

Since 2011, at the Ukrainian enterprises the production of high-strength rails was started and at the same time at the PWI the technology of their welding is being tested. In addition, on demands from different countries the developments of welding technologies of new generations of high-strength rails are performed at the PWI. At the present time, the task of laying out the rails is put forward, providing a cargo capacity of 1.2 billion gross tons, which is 2–3 times higher than wear resistance of the operated rails. The organizing of works on laying out the rails during construction of high-speed roads is improved. At the request of English company «Network Rail» a new generation of rail welding machines such as K945, designed for welding with tension of long sections of up to 1000 m was developed at the PWI, was patented and manufactured at Kakhovka Plant of Electric Welding Equipment in 2014.

**How is the quality control of rail joints organized?**

The algorithms for estimation of quality of welded rails in real time were determined. Computerized system of in-process quality control of the rails joints on the basis of integrated evaluation of the influence of real deviations of welding parameters from the set optimal values was developed. In the system of rail welding enterprises of «Ukrzaliznytsya» a unified system with the use of Internet for system control of quality of welded joints of rails on the main areas of railway communications was created, allowing processing information for 60,000 butts per year, evaluating their quality, performing rejection and providing information on the state of equipment and need in its preventive measures.

The readers are probably interested to know whether there is an experience in the application of rail welding machines, designed and manufactured in Ukraine, for welding rails in the subway?

Yes, today there is a successful experience in welding of rail tracks using the developed equipment and technology for the subway in the USA, China, Singapore, Russia and Azerbaijan, and the joining of sections is carried out directly in the tunnels.

**Thank you, Professor, for the interesting and detailed information on the touched topic. We wish you a good health, many long years of successful work, every happiness and prosperity.**

Editorial Board of «The Paton Welding Journal»