

<https://doi.org/10.26160/2572-4347-2019-8-30-33>

METHODS FOR IMPROVING OPERATIONAL INDICATORS OF WELDED JOINTS

Papsheva N.D., Mladentseva O.A.

Keywords: preheating, concurrent heating, performance indicators, welded joints.

Abstract. The article presents the methodology and scheme for measuring the temperature of preliminary and concurrent heating during welding of large diameter pipes.

МЕТОДЫ ПОВЫШЕНИЯ ЭКСПЛУАТАЦИОННЫХ ПОКАЗАТЕЛЕЙ СВАРНЫХ СОЕДИНЕНИЙ

Паншева Н.Д., Младенцева О.А.

Ключевые слова: предварительный подогрев, сопутствующий подогрев, эксплуатационные показатели, сварные соединения

Аннотация. В статье приведена методика и схема измерения температуры предварительного и сопутствующего подогрева при сварке труб большого диаметра.

Introduction. Pipelines, the construction of which welding, the technology which has fairly high requirements is widely applied, are used for the transportation of oil at the enterprises of oil refining complex and petrochemical enterprises. Defects in welded joints are the underestimated size of the cast core, the presence of cracks, shrinkage shells, lack of penetration, etc. These defects can occur due to insufficient or excessive heating of the welding zone and lead to deterioration of the mechanical properties of the joints. Since the heated section is surrounded on all sides by cold metal, due to the uneven distribution of temperature, structural transformations of the metal sections of the heat-affected zone occur, which are heated above critical points during welding. Residual stresses, which can lead to deformation of the product, arise in the welded structures due to structural transformations.

Research goals. Preliminary or concurrent heating is used to reduce the temperature difference between the sections of the welded joint and reduce internal stresses in the welds [1, 2].

Preliminary or concomitant heating of the heat-affected zone is used to reduce internal stresses in welds. The heating temperature is selected taking into account the steel grade and structural rigidity.

Preheating consists in heating the base metal before welding. The accompanying one provides a certain level of background temperature of the surfaces being welded to ensure the required quality of welding. The preheating temperature is determined by the following factors:

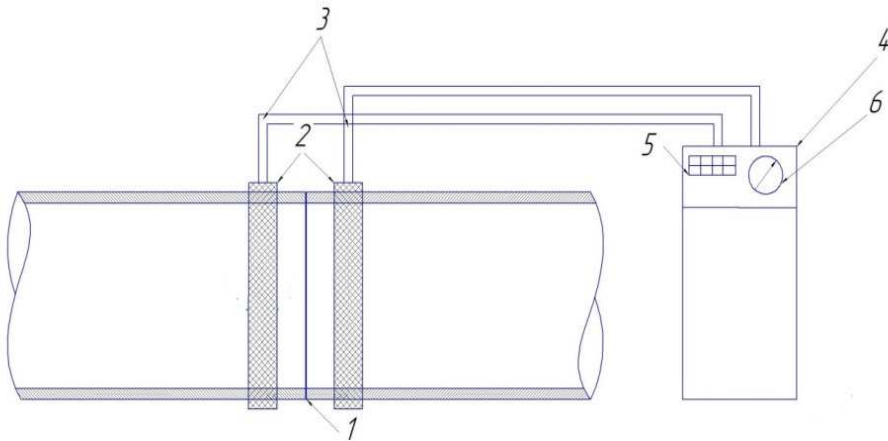
- carbon content in the base metal;
- the content of alloying elements in the base metal;
- dimensions of the welding zone;
- ambient temperature;
- welding speed;

– diameter of welding electrodes or wire.

The preheating temperature increases with increasing diameter and thickness of the welded metals and for low alloy steels is 150 ... 250 0 C.

The required preheating temperature is maintained throughout the entire welding process, then slow cooling is performed.

Methodology. Preliminary and concurrent heating is carried out in installations for induction heating of large diameter pipes, heating is carried out to a width of 100 mm on both sides of the joint (Fig. 1). Preheating reduces the risk of hydrogen cracking and hardness in the heat affected zone. Concurrent heating protects the weld from the formation of excessively high residual stresses during cooling at low temperatures, and therefore, from the possible formation of cold cracks.



1-welding seam; 2-inductor belt; 3-cable; 4-power supply; 5- control keys, 6-voltage controller
Fig. 1. Installation of preliminary and concurrent heating of welded joints of the pipeline

The main part. A measuring system has been developed, and is intended for automatic temperature measurement, data processing and output of results. A thermal imager is used as a control device, due to which the temperature field of the object is recorded [3, 4]. The multiplexer perceives the indications and converts them into a value that is convenient for measurement. To display a digital signal, a special indicator is used.

A thermal imager is an optical-electronic system designed to obtain a visible image of objects that emit invisible thermal (infrared) radiation. Most often, a thermal imager is used as a device to obtain the temperature field of an object. Using a thermal imager, you can instantly measure the temperature of tens of thousands of points of an object. The operation of the thermal imager is based on the principle of converting the infrared radiation flux from an object perceived by a sensitive element into an electrical signal proportional to the thermal spectral power of the radiation flux. The thermal imager forms an image of the object on the recording screen, and different temperature points are displayed in different colors.

Thermal imager lens must be transparent to infrared radiation. Lenses for thermal imagers are made in Germany. Almost the same requirements are imposed on the quality of the lens (enlightenment) as on the lenses for visible light (photography), and they introduce the same distortion (aberration) when transmitting the thermal radiation of an object to a bolometric matrix. Permanent and interchangeable lenses are made individually for each type of thermal imager, taking into account its design and matrix characteristics (pixel size).

The matrix of the thermal imager receives and converts the energy of the optical radiation of the infrared spectrum into an electrical signal proportional to the power of the absorbed infrared radiation by their sensitive areas. The thermal imager matrix is the most complex and expensive element, it consists of a matrix of photosensitive MIS capacitors and a silicon multiplexer with individual readout cells of signals from each capacitor [4, 1].

Silicon multiplexer is an integral part of the photodetector, which outputs the video signal from the matrix of photodiodes.

The signal received from the multiplexer gets on the display which captures the slightest temperature difference between two neighboring points, which the thermal imager can recognize. The temperature range of the thermal imager indicates the temperature range visible (and stored in memory) on the display of the thermal imager. Points having a temperature below or above the temperature range of the thermal imager will not be reflected but will be visible as a background.

Conclusion. Thus, the refresh rate of the thermal image frames on the device display is 9 Hz, which means how many times per second the thermal image is updated on the device display. The thermal imager is connected to the PC through the USB port. The software processes and analyzes infrared images. You can display the temperature distribution in a particular area using the histogram function. One can set the boundaries of their limit values to visualize critical temperatures in the image.

References

1. Non-destructive testing: Reference: In 7 vol. Under the general ed. V.V. Klyuev. Vol. 5: Book 1: Thermal control / V.P. Vavilov. – M.: Engineering, 2004. – 189p.
2. Bailey N. Weldability of steel / Translated from English. – M.: Mir, 1995. – 204p.
3. Vavilov V.A., Aleksandrov A.N. Infrared thermographic diagnostics in construction and energy. – M.: NTF "Energoprogress", 2003. – 76 p.
4. Lloyd J. Thermal imaging systems / Translated from English under the editorship of A.I. Goryachev. – M.: Mir, 1978. – 416p.

Список литературы

1. Неразрушающий контроль: Справочник: В 7 т. Под общ. ред. В.В. Клюева. Т.5: Кн.1: Тепловой контроль / В.П. Вавилов. – М.: Машиностроение, 2004. – 189с.

2. Бэйли Н. Свариваемость сталей / Пер. с англ. – М.: Мир, 1995. – 204с.
3. Вавилов В.А., Александров А.Н.. Инфракрасная термографическая диагностика в строительстве и энергетике. – М.: НТФ "Энергопрогресс", 2003. – 76 с.
4. Ллойд Дж. Системы тепловидения / Пер. с англ. под ред. А.И. Горячева. – М.: Мир, 1978. – 416с.

Папшева Нина Дмитриевна – кандидат технических наук, доцент	Papsheva Nina Dmitrieva – candidate of technical sciences, associate professor
Младенцева Ольга Алексеевна – старший преподаватель	Mladentseva Olga Alexeevna – senior lecturer
Кафедра «Технология машиностроения, станки и инструменты», Самарский государственный технический университет, г. Самара, Россия	Department "Machine-Building Technology, Machines and Instruments", Samara State Technical University, Samara, Russia

Received 29.10.2019