JPRS: 17,356
29 January 1963

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THE INFLUENCE OF HEAT TREATMENT

BY A CURRENT OF HIGH FREQUENCY

ON THE CORROSION OF WELDED JOINTS OF 1Kh18N9T STEEL

by V. A. Suprunov and V. N. Kisel'nikov

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U. S. DEPARTMENT OF COMMERCE
OFFICE OF TECHNICAL SERVICES
JOINT PUBLICATIONS RESEARCH SERVICE
Building T-30
Ohio Drive and Independence Avenue, S.W.
Washington 25, D. C.

Price: $.50

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process -- is a transition zone which may be further differentiated into a number of subzones; d -- is the zone of the construction material in the state in which it was received. Such a distribution of the structures is the main cause of the low resistance to corrosion of a welded joint. This is especially true of the transition zone b and c, and of the zone a, since they include a large amount of anodic components.

The increase of corrosion resistance of a welded joint by means of a thermal treatment must be achieved by an elimination of electrochemical segregation into zones, produced as a result of welding.

One of the procedures for increasing the corrosion resistance of welded joints is a thermal treatment: hardening and stabilizing annealing [4,5]. However, the recommended methods of heating are superficial, require the use of cumbersome equipment and do not always yield the necessary results. Thus, the thermal treatment by surface heating, used by Medovar and Langer [1,3], when applied to welded joints of 1Kh18N9T steel, resulted in no increase of corrosion resistance, in corrosion tests of the treated specimens with boiling 65% nitric acid, and the rate of corrosion was found to be even higher in some individual instances.

The corrosion resistance of welded structures can be enhanced by hardening utilizing the induction method of heating. This method had been studied by a number of authors [6-8], and was used by us to increase corrosion resistance of chromium-nickel austenite steels. The induction method of thermal treatment ensures a high rate of heating, makes it possible to control the depth of heat penetration, to increase the rate of dissolution of carbides by utilizing high temperatures, and to achieve substantial rates of phase transitions. An important advantage of the induction method of heating is the possibility of its use for the thermal treatment of structures of any configuration and size.

Experimental Part

In the present work a study was made of the effect of a hardening of welded joints of chromium-nickel 1Kh18N9T austenite steel by induction heating with high frequency current. The welding of the specimens was effected by the electric arc method, using Sv00Kh18N9T electrodes and BKF-1 sheathing. The resultant welded joints were then subjected to thermal treatment with high frequency current (30,000-40,000 cps) in a GLZ-10 unit, at temperatures from 850 to 1300° for 0.5-1 second.

with well defined boundaries (zone c), and the next zone of austenite (zone d).

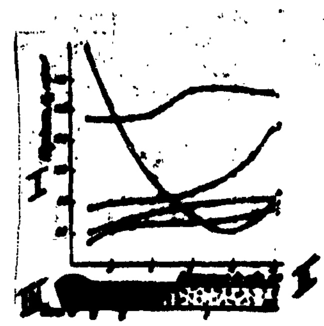

Fig. 3 Change in hardness of metal, depending on the distance from welded seam and temparature of hardening.

1 -- untreated seam; 2 -- 850°; 3 -- 1000°; 4 -- 1100°; 5 -- 1300°
I -- H_R hardness, kg/mm²; II -- distance from seam, mm; III -- zones.

The non-uniform distribution of structure components is confirmed by Fig.3, which characterized change in the Vickers hardness depending on distance from the welded seam. Induction heating with subsequent hardening alters the nature of distribution of hardness and structural components. The specimens show a general trend toward an equalization of hardness. On heating at 850° a general increase of hardness is observed, which apparently may be attributed to separation of excess phases. Heating at 1000, 1100 and 1300°C results in a general equalization and decrease of the hardness, which is due to austenitization of the structure.

The high rate of induction heating, the proximity effect (i.e., heating of the metal only near the inductor), as well as accurate control of the temperature of heating, result in a sharp narrowing of the dangerous temperature zones and cause a uniform distribution of structural components which affect the increase of corrosion resistance. The character of distribution of structural components can be seen in Fig.4.

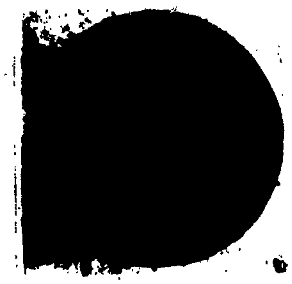

Fig. 4 Structure of the metal near the welded seam after hardening following induction heating at 1100°C.

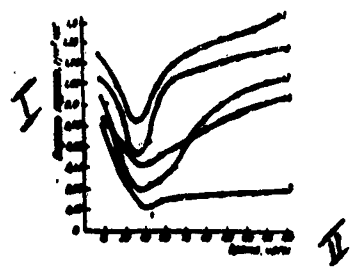

Fig. 5. Rate of corrosion of welded joint in boiling 65% HNO_3 depending on temperature of hardening.
1 -- untreated seam; 2 -- 850°; 3 -- 1000°; 4 -- 1300°; 5 -- 1100°.

I -- rate of corrosion, g/m² hour; II -- time in hours.

The corrosion tests were conducted in boiling 65% HNO_3 for 164 hours. During the period of testing of each specimen the solution was not renewed. Change in corrosion rate, depending on time and heating temperature before the hardening, is shown in Fig.5. The rate of corrosion of steel subjected to a thermal treatment at 1100° is 4 times lower than that of the untreated steel. The concurrently recorded electrode potentials (see Fig.6) correspond to the nature of the corrosion behavior. After the tests, determinations were made of the occurrence of intercrystallite corrosion, which was detected only in a seam not subjected to thermal treatment after welding (see Fig.7).

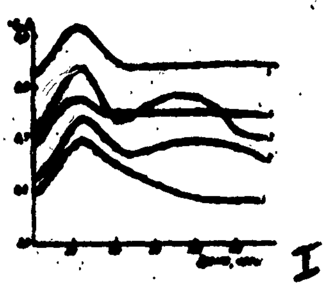

Fig. 6. Change of electrode potential of a welded joint in boiling 65% HNO_3 depending on temperature of hardening.

1 -- untreated seam; 2 -- 850°; 3 -- 1000°; 4 -- 1300°; 5 -- 1100°.

I -- time in hours.

The effect of thermal treatment and the corrosion behavior of the specimens in boiling 65% HNO_3 are confirmed by quantitative determinations of the content of iron, chromium and nickel in solution. Specimens not subjected to a thermal treatment show a maximal dissolution of iron. A minimal dissolution of iron was shown by specimens which were hardened at 1000 and 1100°. The content of iron, chromium, and nickel was determined colorimetrically in an FM-56 photocolorimeter (see Table).

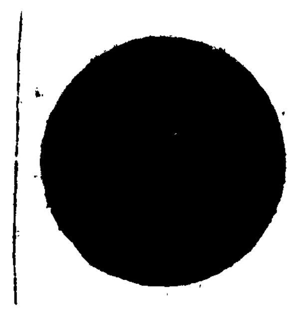

Fig. 7. Intercrystallitic corrosion in boiling 65% HNO_3 of a welded joint not subjected to a thermal treatment.

Change in the Content of Iron, Chromium and Nickel in the Solution, as a Function of the Temperature of Hardening on Induction Heating with High Frequency Current.

1 Температура закалки, °C	2 Содержание в растворе (в % к убыли веса образца):		
	3 железа	4 хрома	5 никеля
6 Без обработки	60,2	30,6	9,2
[illegible]	[illegible]	31,0	16
1000	51,4	[illegible]	16,0
1100	52,7	32,9	14,4
1200	55,7	32,7	11,6

1 -- temperature of hardening, °C; 2 -- content in solution (in % of weight loss of specimen); 3 -- iron; 4 -- chromium; 5 -- nickel; 6 -- untreated.

Conclusions

1. The method of hardening utilizing the procedure of induction heating with high frequency current makes it possible to increase the corrosion resistance of welded joints of 1Kh18N9T stainless steel by several times in comparison with those not subjected to the thermal treatment.

2. Thermal treatment of welded joints with high-frequency current permits to eliminate intercrystallite corrosion in the welded joint; at the same time it brings about an equalization of structure and hardness within the zones adjacent to the welded seam.

3. By utilizing uncomplicated devices, this method of enhancing corrosion resistance, can be employed at the chemical machinery building plants where welding is used to manufacture items made of chromium-nickel austenite steels.

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From the Department of Technology of Metals, Processes and Apparatus, Ivanovo Institute of Chemical Technology (Ivanovskiy Khimiko-Tekhnologicheskiy Institut).

Received for publication 27 July 1960.

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CSO: 7422-N