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METALS AND STRENGTH ISSUES

The Application of Tubes Produced by the Electroslag Melting Process in Tubing of Thermal Power Plants and Boilers

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Abstract—The results of a chemical analysis to determine the short-term mechanical and metallographic properties of boiler tubes manufactured by the electroslag melting process are presented. The paper also contains the data on the long-term strength of the above tubes.

Keywords: boiler tube, tubing, long-term strength, microstructure

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Currently, users of tubes are constantly facing the problem of on-time delivery of boiler tubes—as a rule, on a tight schedule—and technicians working in tube-rolling mills, that of high rolling rates.

The tubes produced by the electroslag melting (ESM) process are offered as an alternative to hot-worked tubes produced according to the technical specifications TU 14-3R-55-2001 and TU 3-923-75 and to centrifugal-cast tubes produced according to the TU 108.874-95 specification that are within the competence of Rostekhnadzor.

Electroslag processes used to manufacture products of various geometries have been known for a long time. Thus, tubular billets were used in the Chekhov reinforcement works to produce reinforcing steel for nuclear power units and other items as far back as the early 1980s.

In principle, the up-to-date electroslag melting process applied to the manufacturing of tubes does not differ significantly from the process developed many years ago [1]. A novelty is that the tubular billets obtained by the electroslag melting process (ESM billets) are used to produce tubes designed for steam pipelines in thermal power plants and for tubing of nuclear power units.

The process of producing ESM tubes involves the following stages:

the melting of cast billets: The consumable electrode is assembled of a tubular rolling billet of the required steel grade and is smelted in a space formed by an external and an internal movable casting mold. The entire melting process and its variables, including the energy operating conditions, speeds of the upper and lower movable furnace carriages, and the rates of metal building-up and its solidification, are controlled by an industrial automatic control system whose operating algorithm is based on a hot-metal-line sensor that allows for the following operations to be carried out:

a smooth changing of the speed of accessories depending on the level of the built-up and solidified metal;

the heat treatment;

the cutting-off of stock left for machining;

the sampling and control of mechanical and metallographic properties;

the machining of tubes; and

the non-destructive inspection.

The production process is not oriented towards the rolling specifications, every individual tube can be interpreted as a lot, and a delivery can consist of one tube.

Rolling stock manufactured according to the GOST 1050, GOST 19281, TU 14-1-1529, and TU 14-1-4616 specifications is used as the starting material for melting tubular billets.

The ESM tubes are produced according to the requirements of the TU 1301-039-00212179-2010 specifications developed in OAO NPO TsNIITmash and approved in accordance with established procedures. The production of tubes 273–920 mm in diameter with a wall thickness from 22 to 100 mm has been mastered.

MATERIAL AND RESEARCH TECHNIQUES

ESM tubes 273–920 mm in diameter produced of the 20-Sh, 15GS-Sh, 16GS-Sh, 15Kh1M1F-Sh, and 10Kh9MFB-Sh steel grades were used as research materials. The research was carried out in OAO NPO TsNIITmash, OAO VTI, OAO NPO TsKTI, and ZAO Energomash (Belgorod)–BZEM. More than 30 tubes altogether were investigated. Currently, a feasibility study of applying ESM tubes at power engineering