TEMPERATURE OF THE STEEL IN VACUUM TREATMENT IN THE LADLE*

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In the development of the technology of alloying steel with chromium and vanadium by their direct reduction from the corresponding oxides in the process of tapping the heat followed by vacuum treatment, an investigation was made of the conditions required for promoting uniformity of the gas content, chemical composition, and temperature of the metal.

A uniform composition of the steel after a relatively short period of vacuum treatment (9-12 min) is achieved by intensive agitation of the steel throughout the depth of the metal. The intensive motion of the metal in the

![Diagram](image)

Fig. 1. General view of vacuum chamber and location of the thermocouples in the ladle: 1) casing of vacuum chamber; 2) lining; 3) support; 4) steel ladle; 5) ladle lining; 6) thermocouple PR-30/6; 7) compensating lead; 8) detachable sleeve; 9) potentiometer EPP-0.9; 10) bunker; 11) vacuum chamber cover; 12) rubber gasket.


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Fig. 2. Construction and method of mounting the thermocouples for measuring the temperature of the liquid steel in the ladle: 1) junction of thermocouple PR30/6; 2) two-channel porcelain tube; 3) packing of Al₂O₃; 4) quartz cap, diameter 12 x 4; 5) steel tube, diameter 18 x 3; 6) asbestos cord, luted; 7) quartz sand; 8) steel tube; 9) nut M 20 x 2.5; 10) body; 11) terminal block; 12) terminal; 13) thermoelectrodes Pt - Pt + Rh; 14) asbestos cord; 15) compensation lead.

Fig. 3. Detachable connector: 1) compensation lead; 2) asbestos cord; 3) 6-mm-diam. rod with two-way screw thread; 4) nut M 6 x 1; 5) casing of plug; 6) guide groove; 7) screw M 6 x 1 (guide); 8) connector casing; 9) vacuum chamber lining; 10) vacuum chamber casing; 11) connector casing; 12) rubber gasket; 13) nut M 80 x 3; 14) textolite block; 15) epoxy compound (filling); 16) textolite cover; 17) connector sockets; 18) rod, diam. 6 mm; 19) textolite block; 20) copper pin; 21) copper socket; 22) nut M 6 x 1; 23) compensation lead.

Ladle and the "depth of its treatment" by the liberated gases at a residual pressure in the vacuum chamber of 0.26-1.3 x 10² kg/m² were studied by the method of the continuous measurement of the metal temperature simultaneously at three levels situated at a height of 200, 1000, and 1800 mm from the ladle bottom.

The heats were made in 50-ton open-hearth furnaces. The alloying materials used were natural chrome ores and vanadium-containing converter slag NTMK charged on the ladle bottom together with 45% FeSi 18 to 20 rain before tapping the heat. The ladle was then heated by gas burners to 700-800°C as in ordinary cases. After tapping the heat, the ladle containing the metal was placed in the vacuum chamber. Final deoxidation of the metal of the experimental heats and comparison heats was carried out with FeAl (200-250 g/ton of steel) and 45% FeSi (from a calculation of the introduction of 0.50% Si) at the end of the vacuum treatment. The temperature of the liquid steel was measured in three experimental heats and three comparison heats, using chrome ores and vanadium-containing slags.