EXISTING REMELTING SOLUTIONS FOR LARGE VOLUMES OF CARBON STEEL SCRAP APPLIED TO TREAT METALS CONTAMINATED WITH RADIOACTIVE SUBSTANCES

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The paper proposes an alternative melting method, namely, the decontamination or reduction of metal radioactive waste volume based on the industrial designs of a plasma-arc furnace. It presents promising design options and technical solutions for the development of a purpose-designed plasma-arc furnace enabling the remelting of carbon steel with a low level of radioactive contamination. The paper recommends most promising process flowcharts and units for the removal of surface scale layers during the decontamination of the steel scrap.

Keywords: *radioactive waste, radioactive contamination, steel decontamination, induction remelting, plasma arc furnace (PAF), descaling.*

Accumulation of large low-level carbon steel volumes contaminated with radioactive substances prompts the development of specialized remelting technologies to recycle the purified metal or to reduce its volume sent for long-term storage. The economic efficiency associated with the decontamination of alloyed (stainless) steels via induction remelting is due to the high market value of steel in case of its recycling. Nevertheless, metal decontamination by induction remelting has some major disadvantages. First of all, low performance and low volume of the melter charge [1], thus, the melting method is considered economically infeasible for the decontamination of low-alloy carbon steels. Another important disadvantage of induction furnaces is the increased gas emission from the melter due to the required periodic loading of scrap into the melter since its working capacity is limited in its size, as well as gas emission during melt draining.

Available industrial designs of modern plasma arc furnaces of a new generation (PAP-NP) [2] with a melting period of 45—60 minutes and a charge weight of up to 12 tons used in Russian metallurgy are most expediently applied to decontaminate the steels mainly in the form of light-weight and medium-weight (up to 2.5 t/m^3) scrap.

Moreover, to develop specialized melting furnace designs applied to decontaminate or reduce the volume of metal RW, some promising design and technical solutions are in place: mobile gas exhaust shelter accomodating the entire furnace, industrial plasma torches used instead of graphite electrodes [3] providing opportunities for exhaust gases recirculation, bay or siphon channel outlet of the melt [1], which may reduce the volume of exhaust gases released into the gas treatment system. Installation of plasma torches in the side walls of the furnace may improve the loading and reloading of scrap through the roof of the furnace. The use of a rolling hearth and refractory lining of the roof and walls may facilitate periodic removal of a lining layer contaminated with radionuclides.

Before being supplied to the melter, steel scrap with its surface contaminated with radioactive substances shall be subject to surface decontamination. A most promising option was identified based on the evaluated information available on the engineering processes and installations providing the removal of the surface scale film: the use of a metal annealing furnace heating its surface to a temperature of 850—900 °C followed by descaling in a vibroabrasive installation with interchangeable chambers. Annealing furnace designs are recommended to provide for the metal loading on the furnace hearth in stands. At the same time, the furnace should be fitted with a roll-out hearth and a lining of walls and a vault made of ceramic-fiber thermal insulation. Up to 100-fold increase in the surface decontamination level may be provided by reagent thermal decontamination of the metal surface similar to the method developed by FSUE TsNIIChermet, as well as via local heating of contamination zones identified during dosimetric control with a plasma gun to a temperature of up to 1,350 °C.

The proposed technological flowchart, in case of its introduction into the management of carbon steel scrap contaminated with radioactive substances, may reduce its volume by up to 4—6 times providing for simultaneous averaging purge of the melt and the opportunities for its decontamination. Improved PAF decontamination degree is provided via intense oxidation of the scrap surface by arc rays and the melt temperature increased to remove impurities, including the radioactive contamination.

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