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Study of melting process of Fe-Ni-Cr system in iron-carbon melt

© **Vladimir I. Zhuchkov**,[1,2] **Oleg V. Zayakin**,[1]*+ **Elizabeth Y. Lozovaya**,[2] and **Dmitry S. Renev**[1,2]
[1] *Institute of Metallurgy of Ural Division of Russian Academy of Science. Amundsen St., 101. Ekaterinburg, 620016. Sverdlovsk Region. Russia. Phone: +7 (343) 23-29-139. E-mail: zferro@mail.ru;*
[2] *Ural Federal University. Mira St., 19. Ekaterinburg, 620002. Sverdlovsk Region. Russia. Phone: +7 (343) 37-54-464. E-mail: elizaveta_lozova@mail.ru*

*Supervising author; +Corresponding author

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Abstract

Melting kinetics of Fe-Ni-Cr alloys (containing 10% of Ni; 25-45% of Cr; 2% C; 0.2% of Si; Fe – the mass balance) were investigated in static conditions by mathematical modelling using approach developed by scientists of Ural Federal University and IMET UB RAS. The model is based on two segments considering hydrodynamic and heat transfer aspects. The velocity of ferroalloy motion relative to melt of treated alloy is determined by hydraulic segment of the model taking into account the forces actuating on the alloy at any one time. The heat transfer segment of the model is based on ferroalloys classification by relation to their melting temperature, furnace bath temperature, and crystallization temperature of iron-carbon melt. These temperatures are the key and limiting ones for a progress of melting process. Thermophysical properties of the alloys were also investigated. It was established that the melting is occurred in the three periods. During the first period the ferroalloy is heated up to a melting temperature and steel skin is frozen on it; during the second period a ferroalloy and skin are melted until complete meltdown (fusion); during the third period a core of ferroalloy is melted down. The influence of initial dimensions of ferroalloy charge on the melting time of Fe-Ni-Cr alloys was determined, namely, the larger charge particles are, the longer melting time is. The melting time is increased in 180-200 times (from 0.09 up to 17 sec) when the particle size is increased in 25 times (from 2 up to 50 mm). The stronger influence on the melting time is exerted by the temperature of liquid steel (1520-1620 ^{o}C) especially at the decreased temperature (lower than 1560 ^{o}C). An abrupt decrease of total melting time is possible to achieve by shortening of the second melting period characterized by steel skin fusion. The increase of chromium content from 25% up to 45% in alloys under consideration causes insignificant gain of melting time, but the gain is in direct proportion to charge particles size and the impact of chromium content change becomes more noticeable at decreased temperatures of melting bath (lower than 1560 ^{o}C). It was determined that in comparison with standard alloys of high- and low-carbon ferrochromium of the same granulometric composition the investigated alloys are characterized by 100-200 shorter melting times.

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