UDC 669.162.2

Technology Advancement and Equipment Upgrading in Agglomeration and Blast-Furnace Process

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Prospective trends in technology advancement and equipment upgrading in agglomeration and blast-furnace process on the basis of general operating experience of blast furnaces and analysis of modern publications are presented.

Keywords: CHARGE MATERIALS, BLAST-FURNACE SMELTING PRACTICE, OPERATING EXPERIENCE OF BLAST FURNACES, AGGLOMERATION AND BLAST-FURNACE PROCESS

Introduction

Analysis and discussion of investigation results of various authors [1-4] has confirmed that cone-free charging devices, as usually, essentially exceed conic loading devices by possibility to control radial distribution of charge, including their modernized and advanced types [4].

Results and Discussion

Analysis of experience of blast furnace No. 8 reconstruction at JSC "ArselorMittal Kryvyy Rih" described in paper [5] is worthy attention. A series of actual engineering solutions in relation to advancement of charge supply and iron receiver of the furnace with application of advanced refractories were implemented in this furnace. Furnace shaft cooling systems, equipment of casting yard and iron-notch tappers were improved, advanced aspiration systems were created.

New smelting process automated control systems were installed, however, they are not completely used for blast furnace control because of design deficiencies (in the construction of cone-free loading device with spade charge distributor in the interconic space). In our opinion, installation of cone-free loading device of any construction allows increasing possibilities of charge radial distribution in the furnace, enhancing productivity and reducing coke rate.

Paper [6] describes the experience of using anthracitic coal that after special treatment is charged into blast furnace and enables to substitute a part of coke for iron smelting. Today, this method is applied on a number of blast furnaces of Ukraine and ensures substitution of up to 50 kg of coke per each ton of pig-iron by approximately 70 kg of anthracitic coal. Attempts to increase anthracitic coal consumption (> 70 kg/t) led to problems in blast furnace operation because of declined permeability of melting-stock column.

The new possibilities of analysis of interrelation between charge distribution and gases in the furnace allowed Z.I. Nekrasov Iron & Steel Institute of National Academy of Sciences of Ukraine to create a combined mathematical model and also calculation procedure of charge materials distribution on 10 equal-sized ring zones of furnace cross-section [7]. This combined model allows studying processes of charge heating and smelting depending on charge materials distribution defined by loading program, estimating influence of parameters of axial and peripheral air holes on heat flow distribution pattern, which considerably defines coke rate, stability of blast furnace operation and heat loss.

Analysis of current state of pig iron production at iron & steel plants of Ukraine and foreign countries allows outlining the following trends of technology advancement, upgrading

equipment and iron smelting process control systems.

1. The key line in pig iron production efficiency increase and reduction of power consumption is improvement in quality of iron-bearing materials and coke. Iron content in the fluxed sinter should be 56-58 %, in fluxed pellets - 65-68 % at their basic capacity 0.15-0.7. It is necessary to screen off fractions 0-5 mm before furnace loading. Hot impact strength of coke CSR should be 65-75 %, and reactive capacity CRI = 30-40 %.

2. Energy cost reduction in pig iron production from 650-750 kg of coal equivalent per ton to 450-550 kg of coal equivalent per ton. For this purpose it is necessary to increase degree of utilization of regenerative and thermal energy of hearth gas (% CO_2 in blast-furnace gas should be not less than 18-22 % with CO_2 content adjustment in the crude chalkstone loaded into blast furnace) at temperature of gas on the blast-furnace mouth 250-350 °C. These indexes of blast-furnace operation can be achieved at controlled loading conditions and charge materials distribution on the blast-furnace mouth.

3. Maintenance of blast furnace stable operation on the fuel-enriched blast heated up to 1100-1200 °C without natural gas application. For this purpose it is necessary to maintain theoretical temperature of burning within 1950-2050 °C. This can be achieved, for example, by coal injection (approximately 2 kg of pulverized coal fuel instead of 1 m^3 of natural gas) or wet blowing (9 °C per 1 g/m^3 of blowing).

4. Implementation of constructive measures (not only at construction, but also during capital repairs and blast furnace reconstruction) in order to provide operation period till 18-20 years and iron smelting for this period of 45-60 million tons. It is necessary to equip blast furnaces with cone-free loading devices, advanced equipment of charge feeding and application of advanced automated control systems in order to solve this problem.

5. To ensure heating of blast up to 1100-1200 °C due to reconstruction of hot-blast stoves (external combustion chambers, Kalugin`s stoves, gas and air heating at the expense of smoke gas heat utilization, etc.) without natural gas application for hot-blast stove checkerwork heating.

6. Improvement of slag practice and application of nonblast-furnace pig-iron treatment in ladles, which will allow reducing sulfur content in pig-iron down to 0.005 %. Slag yield at Ukrainian plants is still great 450-550 kg/t of pig-iron. This is unsatisfactory quality index of charge materials.

7. Non-waste pig iron production – a complete utilization of blast-furnace dust, iron-bearing slurries and casting yard aspiration dust, slag processing, circulating scrap processing, blast-furnace gas usage. Installation of gas utilizing turbines allows compensating 20-30 % of electric power necessary for pig iron production.

8. Improved training of specialists. High schools are the principal "suppliers" of young specialists at the enterprises. However, additional knowledge and experience are required under conditions of market economic relations, so post-qualifying education of specialists, including second (allied) profession and further periodic training are required. State Institute of Personnel Training for Manufacturing Industry solves this problem for enterprises of mining and smelting industry in Ukraine.

Conclusions

Complicated, material and energy consuming metallurgical process of iron smelting requires further analysis and investigation related to advancement of technology, equipment and blast furnace operation automated control facilities. However, minimum money resources are provided for research work that should be carried out by scientists of scientific research institute and high schools. Such "saving" leads to decrease of competitive strength of products.

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*Published in Russian

Received February 01, 2010

Основные направления совершенствования технологии и оборудования аглодоменного производства

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На основании обобщения опыта эксплуатации доменных печей и анализа современных публикаций представлены перспективные направления совершенствования технологии и оборудования аглодоменного производства.