STATE-OF-THE-ART OUT-OF-FURNACE STEEL MAKING AND STEEL CASTING SOLUTIONS
BY SME VULKAN-TM

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Abstract

SME Vulkan-TM (Russia) presents state-of-the-art solutions for out-of-furnace steel making and steel casting. The paper describes the main characteristics and design features of up-to-date slide gates, wire feeding machines and equipment for bottom metal blowing with argon. The most recent solutions of the equipment for vibroformed refractory products manufacture are also elaborated on.

Keywords: refractories, wire feeding machine, slide gate, bottom blowing plug, mixer

The current trend of the metallurgical industry development is construction of new metallurgical plants and foundries alongside with rehabilitation of the existing ones, utilizing high-capacity process modules. Extremely resistant refractory lining, bottom metal blowing, and stopless steel casting slide gate systems that replace obsolete bottom-pour ladles are required for extensive application of various out-of-furnace steel making methods [1].

Since 1997 VULKAN-TM, Russian Scientific-Manufacturing Enterprise, has been offering complete delivery of equipment for out-of-furnace metal making and modern stopless steel casting systems for ladies of 2 - 360 ton capacity. The company supplies its state-of-the-art solutions to domestic and foreign customers.

SME Vulkan-TM most recent development is a slide gate of VT-60/80 series (Fig. 1) with a set of multicasting refractories for ladles of up to 160 ton capacity; the unit has successfully passed all the tests and at the moment the company is engaged in its mass delivery.

This slide gate features a modular structure, a “foldable” configuration, and a good serviceability. The block replacement of the structure elements reduces time for the gate maintenance on the ladle. A unique mechanism for gate plate locking is the main feature of this gate that allows it to operate with plates by various manufacturers and of different nominal sizes; this feature is a distinctive advantage that makes it possible to use new plates with other operational properties as they appear in the course of time, eliminating the necessity of gate stock re-equipment or any modification of their designs [1].

Two gate variants (with a side or a vertical opening) are designed for various operation conditions. The gate design provides for gate installation on the existing mounting seats and for easy adaptation for connection to drive systems already used at the enterprises.

In addition to linear type slide gates SME Vulkan-TM has developed rotary-type gate designs (Fig. 2, a) specifically for foundries. The advantage of such gates is a possibility of its installation on small-capacity (up to 1 ton) ladles. The refractories are the main part of the gate, so it can be considered a “ceramic” gate [2].

Fig. 1 – VT-60/80 slide gate
The main problem still encountered with large-capacity casting ladles when casting into molds through a slide gate is possible hardening of steel casting channel; thus, Vulkan-TM has been working at designing a “non-hardening” gate and at reducing heat losses of existing gates.

![Diagram of a) Gate installed on the ladle of up to 1 ton capacity; b) 3D gate model under thermal effect](image)

**Fig. 2** – Rotary-type slide gate for casting ladles:
- a – Gate installed on the ladle of up to 1 ton capacity;
- b – 3D gate model under thermal effect

To optimize the designs of non-hardening gates the company’s specialists simulate slide gate operation by the finite elements method using modern software (Fig. 2 b).

For over 10 years SME Vulkan-TM has been manufacturing and delivering shaped castable articles for gate casting: the nozzle-collector in a metal shell, the cluster nozzle, the cluster blocks of various types and modifications. The company offers customized solutions and develops product configuration and materials that match operation conditions of a specific plant.

SME Vulkan-TM delivers the wire feeding machines of TAP model equipped with a semi-automatic stacker for out-of-furnace steel making. The machines feature one-, two-, three- or four-path designs and can be used for flux cored wire and aluminium rolled wire feed to the ladle. The wire feeding machine is equipped with exchangeable rubber-covered and heat-treated rollers. A small-size free-standing control cabinet has a remote connection and can be installed within 100 m radius. Monitoring and service friendliness are significantly increased due to a possibility of recording wire feeding machine operation parameters and relative density of passed wire.

For bottom metal blowing with inert gas immediately prior to and in the process of casting SME Vulkan-TM delivers bottom blowing plugs (tuyeres), installed in the ladle lining with and without the cluster block (Fig. 3), in a wide range of nominal sizes. The cluster blocks can be of square or round section (as agreed upon with the CUSTOMER). The bottom blowing tuyere is manufactured in a metal shell to protect it from gas permeability and can have from 15 to 54 slots 0.18-0.2 mm wide.
As agreed upon with the customer a gas delivery unit can be manufactured as a gas delivery tube or as an adapter.

Making refractory products with the aid of the vibroforming technique is reasonable as it is a relatively inexpensive method of high-grade end product manufacture provided the required processing equipment is available.

In the process of manufacturing the refractory products using the vibroforming technique, SME Vulkan-TM LLC has faced a necessity to design and manufacture special equipment: vibrating and mixing.

The vibrating equipment is a vibrating table with controlled-angle oscillation, preset amplitude and frequency of member oscillation. The vibrating tables with different vibration exciters have been tested and analysed. The air-powered vibration exciters providing regulation of the member operating modes within required technological limits are recognized as the most optimal ones.

The high-rate type mixer is one of the main equipment pieces used for manufacture of refractory products using the vibroforming technique. The quality and form of effective items depend on the quality of dry mix / water mixture and amount of water added in the process of refractory body preparation.

At the moment there are three types of the mixing equipment: SID-1, SID-2 and SID-3 (Fig. 4) engineered, manufactured and operated in the industry. The units ensure preparing the refractory body of proper quality.

Usage of the mixing and vibrating equipment made by SME Vulkan-TM LLC permits to manufacture refractories of various nominal sizes, compositions and quality, to update the manufactured products range and to meet all the customer’s requirements.

REFERENCES
