The increasing amount of steel being treated outside the furnace and the increase in the quantity of molten metal being transported by rail in ladles are making it necessary to tighten standards on the durability and service life of the ladle linings. Plans developed for a new department at the Chelyabinsk Metallurgical Combine to line steel-pouring ladles will make it possible to replace the traditional brick lining by cast linings composed of refractory concrete. This change will make the lining considerably more durable, decrease accidents, and sharply reduce the amount of manual labor required in the lining operation. This article describes the process and equipment used to make the new monolithic linings.

The planned increase in steel production at the Chelyabinsk Metallurgical Combine will involve a substantial boost in the percentage of steel that is treated on a special treatment unit and cast on a continuous caster. That will in turn entail an increase in the amount of steel that is transported from shop to shop by rail and, thus, an increase in the length of time the steel spends in the steel-pouring ladles. As a result, it will be necessary to raise the temperature of the steel during its transfer from vessel to vessel. That will in turn make it necessary to increase the rate of cooling of the ladle lining after casting, which will shorten the lining’s life.

The combine is still using the traditional technology for lining steel-pouring ladles, with the use of shaped refractories. The shortcomings of the technology are well-known:
• the presence of seams in the metal region, which can lead to an accidental release of molten steel from the ladle;
• the use of large quantities of refractory bricks composed of various materials of different dimensions and grades;
• the use of manual lining and thus, the large role of the human element in the overall process.
These problems can be avoided by using rammed linings.

The combine’s R&D center has developed a new technology for the monolithic lining of steel-pouring ladles. The technology employs refractory concretes and incorporates the latest findings from domestic and foreign practice.

Creation of the monolithic lining entails the use of a mechanized procedure to apply a protective layer to the walls and bottom of the ladle. The monolithic lining is composed of readily compactible concrete mixtures based on aluminum oxide.

The technology used to form the lining includes two main operations:
• formation of the complete new lining – the application of a refractory concrete layer to newly laid heat-insulating and reinforcement layers on the walls and bottom of the ladle;
• restoration of the working layer of the monolithic lining during service.

The planning and design center of the combine has drawn up plans for a monolithic lining department (MLD) that will prepare linings for KS-160 steel-pouring ladles. The department will be located on the site of the former open-hearth shop No. 1, which is currently occupied by a section that repairs metallurgical ladles under the direction of the Metallurgical Furnace Repair Services (MFRS) of the combine.
To organize the new department, a plan has been developed to dismantle the metal structures of the old working platform at the +6440 mm level and break up part of the remaining reinforced concrete foundations of the furnaces and the auxiliary equipment. The total area of the new department will be 2000 m². The plan also provides for relocation of the lines that currently supply power to the MFRS and the construction of new lines for the lining department.

The specifications of the new technology stipulate that the lining operation should not be performed at temperatures below 5°C. Thus, the combine has built a new thermally insulated building 45 m long, 12 m wide, and 16 m high. Wintertime temperatures in the building are not supposed to go below 15°C. The building has a working platform for lining two ladles at a time. Part of the building extends into the warehouse used to store bags of concrete. Two single-rail 10-ton overhead travelling cranes are provided for loading and unloading. The area of the building is laid out in such a way that the platform can eventually be used to line four ladles simultaneously.

The ventilation system provides for the necessary exchange of air in the building and employs both natural and mechanical draft ventilation. The dust-laden air from the charging hopper of the pump-mixer is aspirated.

Figure 1 shows the building as a whole, the production space, and the equipment layout.

The monolithic lining is formed in KS-160 steel-pouring ladles, with the following operations being performed:

- the use of rock crusher 1 to completely remove the old worn lining in existing Department No. 1 of the MFRS; this is followed by the formation of the heat-insulating and reinforcement layers of the lining at two work stations in lining pit 2;

- the use of special cutting machine 3 to partially condition the concrete layer, this operation being part of the maintenance administered to the lining as it wears.

In the first operation, shop crane No. 1 moves prepared ladle 4 onto transfer cart 5 in bay A–B and the cart takes the ladle to bay B–D. Then shop crane No. 2 moves the ladle to transfer cart 6 or 7.

In the second operation, crane No. 2 transfers the ladle on steel-ladle car 8 to a work station where it undergoes partial conditioning (on a working platform located at the +6440 mm elevation). Then the same crane moves the ladle from the conditioning section to transfer cart No. 2 or No. 3 in bay B–D.

The cart transports the ladle into the special building and up to the working platform, moving through double gates. The ladle is placed in its initial position on the platform, and dry concrete mixture begins to be pumped through pump-mixer 9. A filled bag 13 is transported from the warehouse to the working platform by overhead crane 10 and lowered into the receiving hopper of the pump-mixer. A blade located in the center of the hopper cuts the bag open, and its contents fall into the 600-liter mixing chamber. The quantity of water needed to mix the concrete is delivered to the chamber through a pro-
grammable metering nozzle. After careful mixing, the concrete is ready for use. The finished concrete is transferred to the ladle for the lining operation through a flexible hose/conduit by compressed air.

The lining operation is begun with guniting of the bottom of the ladle. The concrete is compacted as it is delivered to the bottom by heavy-duty submersible electric vibrators. The application of concrete to the walls is begun after the concrete on the bottom of the ladle has hardened. The overhead crane and cross-arm 14 are used to install template vibrator 15 inside the ladle. The template vibrator is equipped with electric vibrators positioned at different levels. An air line is installed in the lower part of the template vibrator to force the latter against the bottom of the ladle about its perimeter. The pump-mixer is turned on after the template vibrator has been centered and installed firmly in place. The electric vibrators located at different levels are turned on or off in accordance with the specifications for the job as the gap between the template vibrator and the wall of the ladle is filled with concrete. When all the concrete has been poured, the moisture content of the concrete and frequency of vibration of the vibrators are increased in order to obtain a smooth load-bearing surface for subsequent lining of the slag zone with bricks. The above-indicated parameters are changed automatically in accordance with a program incorporated into the control system of the pump-mixer. Concrete is applied to the walls of the ladle from the bottom to the beginning of the slag zone.

The length of time between the end of application of the concrete and removal of the template vibrator depends on the temperature and is within the range 4–6 h. After the template vibrator has been removed, the ladle is air-dried inside the production building for 24 h. This removes some of the bound water that was originally used in mixing the concrete. The air-drying period is followed by heating of the concrete to continue its drying. The transfer cart then takes the ladle out under the working platform and moves it to a temporary storage area. Crane No. 2 subsequently removes the ladle from the cart and transfers it to a special drying section that contains two drying units 11. Each unit consists of a stand on which the ladle is positioned vertically. The stands have a hinged cover, a gas burner, and a gas outlet pipe 12. The operation of the burner is regulated by a programmable control system which ensures that the ladle lining is heated in accordance with a specified drying regime. After thermal drying, the ladle is fully ready for high-temperature heating of the lining to its working temperature of 1100°C in the steelmaking shops of the combine.

The technology described above for forming monolithic ladle linings makes use of both domestic and foreign equipment. Nonstandard equipment is made in the repair shops of the combine.

The increase in profits realized due to the reduction in direct and indirect costs incurred in the refractory lining of ladles will allow the combine to recover its capital investment in 15 months.
学霸图书馆

www.xuebalib.com

本文献由“学霸图书馆-文献云下载”收集自网络，仅供学习交流使用。

学霸图书馆（www.xuebalib.com）是一个“整合众多图书馆数据库资源，提供一站式文献检索和下载服务”的24小时在线不限IP图书馆。

图书馆致力于便利、促进学习与科研，提供最强文献下载服务。

图书馆导航：

图书馆首页    文献云下载    图书馆入口    外文数据库大全    疑难文献辅助工具