UDC 621.74:658.2

Foundry of Ukraine on the Verge of New Trials

V. E. Khrychikov[1], T. V. Semenova[1], V. V. Lesovoy[2]

[1]National Metallurgical Academy of Ukraine
4 Gagarin Ave., Dnipropetrovsk, 49600, Ukraine
[2] Production Economical Association"Metallurgprom"
1 Lenin Square, Dnipropetrovsk, 49000, Ukraine

Additional manufacturing facilities of foundry shops appear in conjunction with expansion of continuous cast billet production. However, the absence of equipment necessary for shaped casting production determines their low competitiveness as compared to foundry shops of mechanical-engineering enterprises. One of alternative methods of foundry shops reorientation is adoption of roll and roller manufacture for continuous-casting machines using own resources.

Keywords: BILLET CONTINUOUS CASTING, SHAPED CASTING, ROLLS, ROLLERS, COMPETITIVENESS

Introduction

The most widely used methods for casting making in machine industry are following: casting, press forming, forging, metal forming, welding and also combinations of these methods. Approximately 34 % of total output of castings, 13 % of forging-stamping manufacture, more than 52 % of welding fabrication with the use of castings produced via metal forming and casting, 1 % of powder metallurgy fall at foundry in Ukraine [1]. Despite the common decline of production, the relationship between particular methods did not almost change. Casting is still one of the basic production methods to produce components for machine industry and other branches of industry.

The possibility of loading rational distribution in construction units, relationship of castings by shape and sizes to final article reduce the duration of mechanical operation and amount of waste in the form of swarf in 2-5 times in comparison with other kinds of castings, and over one third of castings is used without mechanical operation, and this amount will continue growing in the process of adoption of advanced methods of casting [2].

The output of castings will decrease further as adoption of continuous casting will cause decrease of steel mold casting. It will be difficult to reorient additional facilities of foundry shops on other products as equipment and manufacturing process were focused on manufacture of large-sized articles. It is also difficult to substitute steel molds as steel molds were filled with iron of blast-furnace smelting after insignificant change of chemical composition in hot-metal ladle car or inoculation during casting. The new advanced foundry equipment requires considerable capital investments. One of alternative ways to reorient the current foundry shops of metallurgical plants is manufacture of mill rolls and rollers for continuous-casting machines by own efforts.

Results and Discussion

Forming rolls have rather simple configuration (**Figure 1**), however they are referred to special kinds of casting because of specific features of manufacture [3]. All rolls should have wear-resistant and heat-proof (for hot rolling rolls) working layer, strong and viscous center of roll body and necks. The rolls are made of cast iron (~90 %) and hypereutectoid or graphitized steel. Amount of forged rolls is ~5 %. The rolls made of cast iron, in particular, with spheroidal graphite provide high wear-resistance of working layer and satisfactory strength of axial zone. There are following basic types of rolls: sheet-rolling, section-rolling and pipe-rolling; paperboard and papermaking; mechanical rubber; flour-grinding, oil pressing and color mixing.

More than 50 % of rolls are made of high-strength cast iron.

Die casting (**Figure 1**) through the bottom gate with tangential feeder in the lower roll neck (17) ensures intensive running of melt in the mold and displacement of flux contaminations from a working layer of body into axial zone. Solidification of necks in sandy-argillaceous elements of the mold reduces heat-removal. Therefore, there is insignificant amount of fragile cement component in the structure, which raises operation durability of rolls.

Cast iron mold provides intensive heat-removal in the initial stage of roll body solidification and formation of wear-resistant but fragile cementite structures. Subsequent heating of metal mold and shrinking between the roll body and metal mold decrease heat-removal and formation of graphite inclusions in the intermediate and axial layers of roll body. This strengthen axial zone of the roll. Hardness of body working layer expressed in Shor`s units and its depth in mm are important indexes of roll wear. Body diameter and its length (mm) are the basic sizes of rolls. Depending on cast iron type (chilled or with spheroidal graphite), properties of metal of working layer vary σ_{US}=10-90 kgs/mm^2 {~ (10-90) x10^7 Pa} and HB 200-675.

Rolls with appropriate structure and hardness ensuring the maximum operation durability under cyclically varying shock and bending loadings and friction forces at high-temperature effect are selected for various rolling mills. Amount of cementite should be minimal in the intermediate and axial zones of roll body with chilled working layer (**Figure 2**). Quality of smelted metal is estimated by technological samples. Ratio of chill depth to the sum of widths of chill and intermediate zone is considered to be a quality index of the rolls.

Application of center die casting for sheet rolls allows diminishing consumption of alloyed metal by 30-40 %, raising hardness and depth of working layer and strength of axial zone.

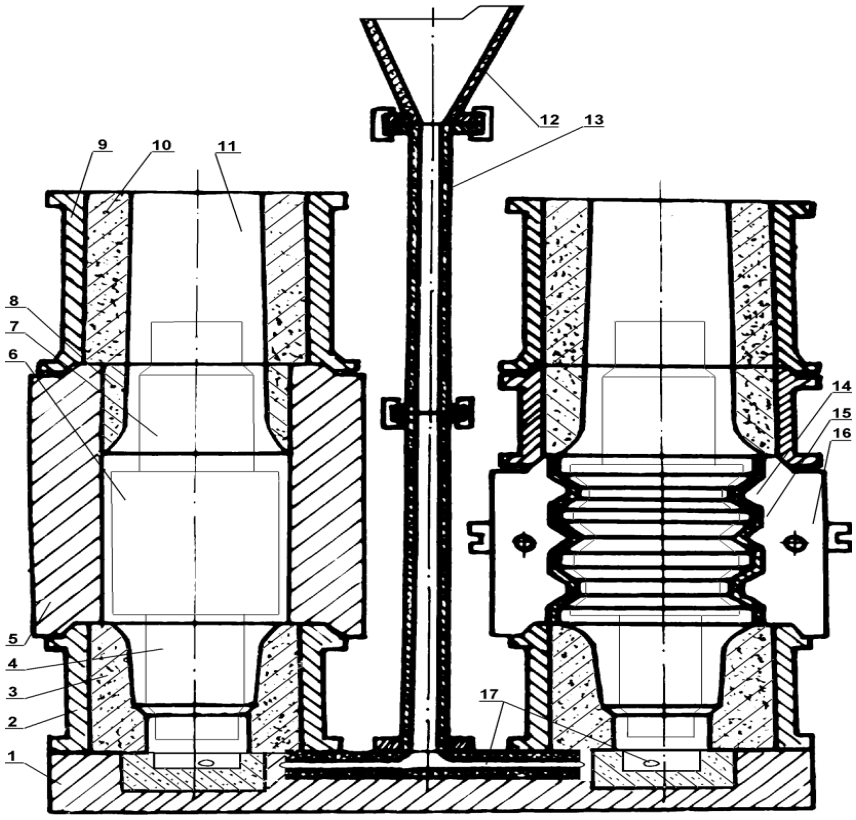

Figure 1. Mold for roll casting with a smooth body and cast roll pass design (fine lines mark the finished size of rolls): *1* - two-place tray; *2* - shape of lower neck; *3* - foundry molding sand; *4* - lower roll neck; *5* - chill mold; *6* - roll body; *7* - upper roll neck; *8* - foundry molding sand in the metal mold; *9* - deadhead shape; *10* - deadhead sand; *11* - deadhead; *12* - riser; *13* - downright; *14* – bulge of chill mold groove; *15* - cavity of chill mold groove; *16* - metal mold with cast grooves and vertical connector; *17* - tangential feeder

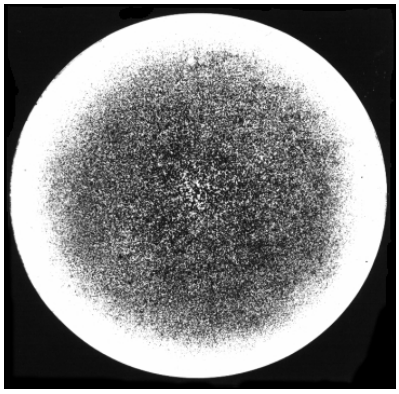

Figure 2. Macrostructure of chilled cast iron forming roll body with diameter 431 mm

The working layer is made of high alloys with increased content of Cr, Ni, W and other expensive alloying elements. This is the most advanced way of sheet roll manufacture requiring the special equipment and strict compliance of casting process. Iron smelting is carried out in inductive, open-flame and arc furnaces. The important factor of high-quality roll manufacture is the use of roll scrap in the charge.

Out-of-furnace treatment of cast iron is applied for adjusting chill depth and spheroidal graphite. When inoculating by magnesium metal, its specific consumption is 2.7-4.0 kg/t and depends on the original content of sulfur (0.028-0.065 %). When making cast iron with spheroidal graphite, the specific consumption of rich alloy varies from 0.8 to 1.5 kg/t and depends on magnesium mass fraction in the rich alloy and original content of sulfur in the melt. Application of doped and inoculated alloys ensures high physic-mechanical and operation properties of forming rolls [4].

Conclusions

1. Foundry of Ukraine faces the problem of decline in steel mold production due to expansion of casting making by continuous casting method that is more cost-efficient.
2. Additional facilities of foundry shops of metallurgical plants are not properly equipped for shaped casting making and are not competitive with foundry shops of engineering enterprises.
3. The one of alternative ways of reorientation is adoption of manufacture of forming rolls and rollers for continuous-casting machines by own efforts.

References

1. T. V. Semenova (*Ph.D. thesis*, National Metallurgical Academy of Ukraine, 2001)*
2. A. E. Krivosheev *Cast Rolls*, Metallurgizdat, Moscow, 1957, 360 p.*
3. V. A. Leybenzon, V. L. Pilyushenko, V. M. Kondratenko et al. S*olidification of Metals and Metal Compositions*, College Textbook, Naukova dumka, Kyiv, 2009, 410 p.*
4. V. E. Khrychikov, L. K. Ivanova. *Suchasni Problemy Metallurgii*, Vol. 9, Sistemnye tekhnologii, Dnipropetrovsk, 2006, pp. 27-36.*

*Published in Russian

Received December 01, 2009

Литейное производство Украины на пороге новых испытаний

Хрычиков В.Е., Семенова Т.В.,
Лесовой В.В.

В связи с расширением производства заготовок непрерывным способом литья, который более экономичен, высвобождаются мощности литейных цехов металлургических заводов. Однако отсутствие оборудования, необходимого для производства фасонного литья, обусловливает их низкую конкурентоспособность с литейными цехами машиностроительных предприятий. Одним из альтернативных способов переориентации литейных цехов металлургических заводов является освоение производства прокатных валков, привалковой арматуры и роликов для МНЛЗ собственными силами.