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Multi-Strand Slitting of the Stock in Section Bar Production

A.S. Nefedyev[1], S.P. Nefedyev[2], Ya. E. Beygelzimer[3]

[1] Research & Production Company "Donix"
44 Kuybyshev St., Donetsk 83102, Ukraine
[2] Metinvest Holding LLC
130 Artem St., Donetsk 83048, Ukraine
[3] Donetsk Institute for Physics and Engineering named after O.O. Galkin of National Academy of Sciences of Ukraine
72, R.Luxemburg St., Donetsk 83114, Ukraine

Abstract

The method of lengthwise slitting of multi-strand stock in the mill train is worked out. This method is considered to be the promising trend in development of multi-strand rolling-slitting by means of breaking the bridge.

Keywords: *multi-strand rolling-slitting, multi-strand stock, pair of rolls, billet, breaking the bridge*

Introduction

Multistrand rolling-slitting (MRS) is one the most widespread technological innovations in the area of intensification of section bars production [1]. The MRS technology consists in forming the stock composed of several strands coupled by the bridges of definite height and in their further slitting by means of breaking the bridge. In comparison with the conventional one-strand rolling, the MRS technologies have the following advantages: expanding the rolled stock range towards the production of light cross sections or enlargement of incoming billet cross-section without installation of additional equipment; increase in the rolling mill yield; energy and fuel saving; reduction of production cost; rational combination of the rolling mills with continuous casting machines.

According to the method of breaking the bridge, the MRS technology consists of two large groups of the methods of multi-strand stock slitting, including slitting by means of creating tensile stresses and shear stresses in the bridge area. The method of multi-strand stock slitting by means of creating the tensile stresses in the bridge area has turned out to be more technological and become more widely used in metallurgical industry.

The tensile forces can be created by stock rolling in passes with longer distance between groove axes, in the rolls with wedge-shaped tongues, by bending of coupled billets in a cross-wise direction at the exit from the rolls by indirect rolling of the multi-strand stock, by turning equiaxial sections around their lengthwise axis in opposite directions [1].

The first two methods appeared to be the easiest for implementation and applied in practice. They ensure lengthening of the bridge by means of stock rolling in the passes with longer distance between groove axes and in the wedge-shaped rolls [2]. These two methods are also known as controlled and uncontrolled break. The process of billets slitting with the application of methods described occurs under the action of tensile stresses in the bridge area. The tensile stresses originate under the action of axial forces created by the side surfaces of slitting pass tongues (Figure 1).

In the process of uncontrolled breaking the bridge (Figure 1a), the formed stock that consists of two or more billets with round cross sections coupled by thin bridges is slit with the help of idle rolls having the top angle close to 90 deg. The drawbacks of this method of breaking the bridge are as follows:

– the neck which appears after the bridge breaking at the point of slitting and can cause lap in the finished section;

– to ensure stable slitting it is necessary to form the multi-strand stock with ultra-thin bridges (0.8 - 1 mm), which decreases service life of the forming pass rolls;

– low lengthwise stability of the stock in the process of merchant-mill products rolling;

– low durability of slitting wedge-shaped rolls;

– shape deformation of billets during their crushing by rolls in the process of slitting.

When slitting the stock consisting of three strands (Figure 1b) by means of breaking the bridge, the end and middle strands can have the different cross section area because of shape deformation of the end strands [3], which has a negative effect upon further stock rolling. This negative effect can be explained by difficulties related to adjustment of successive stands owing to different drawing of the middle and end stocks.

When slitting by means of controlled break (Figure 1c, d), the stock is formed from square, rectangular or round billets coupled by thick bridges in the rolls with top tongue angle of 60-90 deg. When rolling in the slitting pass, the bridge is elongated in deformation zone and, at the same time, is thinned owing to reduction by pass tongues.

It should be noted that the method of two-strand rolling-slitting (Figure 1c) [1] has been adopted and developed on the rolling mills in Ukraine long ago, while the method of three-strand rolling-slitting (Figure 1d) is not adopted yet. The main difficulty preventing implementation of three-strand rolling-slitting lies in the fact that when cobbing the bridges by tongues, the central strand is reduced as well by inner tilted surfaces of the roll tongues. This results in overflow of the central strand metal and metal supply of thinned bridges.

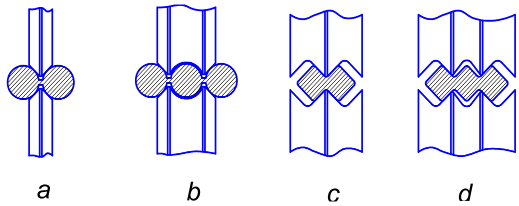

Figure 1. The patterns of slitting under uncontrolled (a) and controlled (c) two-strand process and three-strand uncontrolled (b) and controlled (d) process

The main drawback of this method consists in the necessity to apply such a powerful unit as a rolling stand for the process requiring low energy costs. Loading of the slitting stand drive in the process of rolling-slitting can make only 5-10 % from estimated driver size.

The authors have developed the method of multi-strand stock slitting in the mill train which has

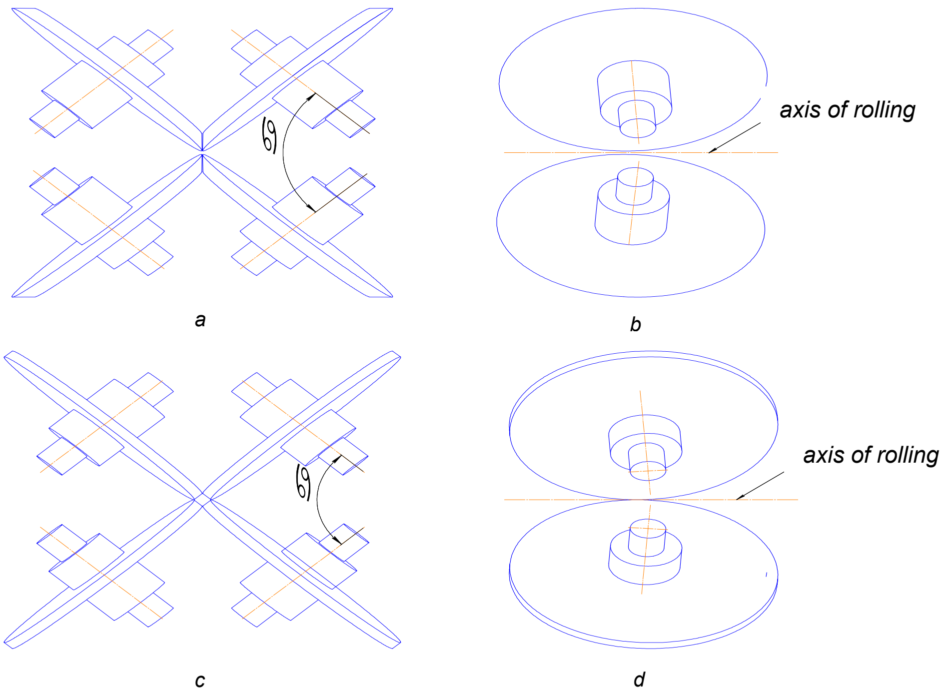

Figure 2. General layout of the slitting rolls for two-strand (a, b) and three-strand (c, d) rolling-slitting by a new method

no drawbacks mentioned above. The multi-strand stock slitting is carried out in a special four-roll device by disc-shaped rolls of either two-tapered roll surface (Figure 2, a,b) or cylindrical form (Figure 2c, d). The four-roll device can be driven or non-driven.

The rotation axes of left and right pairs of the rolls are arranged pairwise in two vertical planes and intersect at the angle α which is 90 deg or less (Figure 2a, c). The planes with rotation axes of each roll pair (left and right) are arranged symmetrically in relation to the rolling train and at the angle β less than 90 deg (Figure 3) that elongates the contact arc of stock and rolls. Upon that, from the moment of the first contact of rolls and strip and until forming the minimum gap between top and bottom rolls, the strip draft between top and bottom rolls takes place and the bridges of minimal height are formed.

Then, the stock is subjected only to the action of side roll surfaces, and the end strands are separated. The device that slits the stock in such a way can be of driven or non-driven type.

We will consider the process of the stock slitting by means of this method on the example of three-strand slitting. The formed three-strand stock of definite dimensions is fed into the pass (Figure 3).

When gripping, a billet is centered by side surfaces of the rolls (Figure 3, cross section A-A). As far as the billet is being rolled, the roll flanges reduce the bridges of end strands (Figure 3, B-B), while side surfaces of the rolls affect the inner surfaces of end strands of the stock (Figure 3, C-C), trying to aside them from the central strand (i.e. the left strand to the left, and the right strand to the right). That is accomplished because each pair of the rolls (top or bottom) is turned through a definite angle β in respect of the vertical plane where there is the rolling train. The bridges are thinned under the action of flanges, and then tensile stresses occur in them under the action of side surfaces of the rolls, which leads to breaking the bridges and to slitting of the end strands of the stock from the central one (Figure 3, cross section D-D). Meanwhile, the effect of side roll surfaces upon the end strands is longer in time than reduction of the bridges by flanges, which enables to eliminate the effect of metal supply of the central strand bridges.

The developed method of rolling-slitting enables:

– not to apply the rolling stand for stock slitting;

– to separate the formed multi-strand stock by

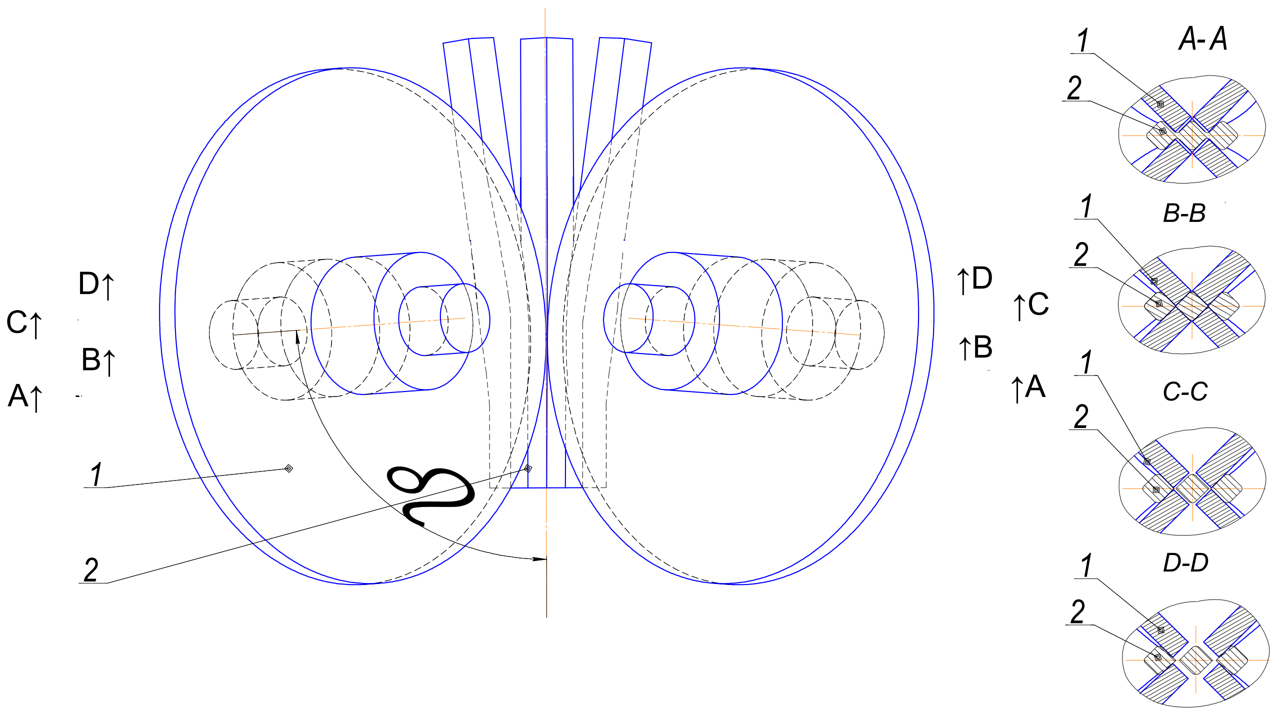

Figure 3. Three-strand slitting according to the method suggested (top view) and deformation zone in the process of slitting

bridges, thickness of which can be compared to the bridge thickness of the stock formed for controlled break. So, this will make it possible to eliminate appearance of the neck in the stock and to increase durability of the forming pass;

– to modify slitting ability of the device due to turning the left and right pairs of the rolls through a definite angle β in respect of the vertical plane with the rolling train. This enables to increase durability of the slitting rolls and to compensate for wear by means of decreasing the angle β.

Summary

The new method of multi-strand rolling-slitting by means of breaking the bridge is worked out. This method has all the advantages of widely used methods of rolling-slitting by means of breaking the bridge and has no major drawbacks. This method can be applied both in two-strand and in multi-strand rolling-slitting with the use of the bridge breaking method.

References

1. Teoria i praktika protsessa mnogoruchyevoi prokatki-razdelenia (*Theory and Practice of Multistrand Rolling-Slitting*)/ G.M. Shulgin, O.V. Dubina, V.F. Gubaydulin et al. - Sevastopol: Veber, 2003. – 622 p.

2. Mnogoruchyevaya prokatka-razdelenie. Nauchnye i technologicheskie osnovy (*Multistrand Rolling-Slitting. Scientific and Technological Fundamentals*) / V.M. Klimenko, S.P. Efimenko, V.F. Gubaydullin, G.M. Shulgin. – M.: Metallurgia, 1987. - 168 p.

3. V.S. Solod, A.G. Manshylin, V.A. Nechiporenko Teoreticheskiy analiz razlichnykh modifikatsyi sposoba razryva pri prodolnom razdelenii raskatov v mnogorychyevych kalibrakh (*Theoretical Analysis of Various Modifications of Breaking under Lengthwise Slitting of Stock in Multi-Strand Passes*) // Metallurgicheskaya i gornorudnaya promyshlennost. – 2002. – No. 8-9. – P. 273-277.

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Развитие способа многоручьевого продольного разделения раската при производстве сортовых профилей

Нефедьев А.С., Нефедьев С.П., Бейгельзимер Я.Е.

Разработан способ продольного разделения многониточного раската в потоке стана. Этот способ является перспективным направлением развития многоручьевой прокатки-разделения методом разрыва перемычки.