DEFINITION INFLUENCE OF THE PLASTIC WORKING ON TUBE HOLLOW MICROSTRUCTURE

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Abstract
This analyse presents influence of roll pass design and positioning of the plug piercing in the strain area on the microstructure in transverse and longitudinal section of the tube hollow. The differences in volume and grain distribution were shown as well as micro-hardness of the phases of ferrite and pearlite in the internal, external and middle part of the pipe wall.

1. PRESENTATION OF THE SKEW ROLLING
The rotary piercing carried out in skew rolling mill characterizes of a combination of the conditions of skew and longitudinal rolling within one strain area [1]. In the transverse section appropriate rolling of the disc guides’ pass result in strain area closing, while in the longitudinal section the strain area is closed due to appropriate selection of quotients of the external diameters of the disc guide towards the roll. The stress condition, similar to that of triaxial compression, appears; the sleeve’s guiding in the strain area is facilitated by imposing peripheral speed of the disc guides higher than the rolling speed. In this method simultaneous piercing and spreading process is taking place and the sleeve’s diameter is bigger than the charge’s diameter. The rotary piercing process with simultaneous expanding of the pipes external diameter in the skew rolling mill with disc guides is a new technological trend. Therefore it is possible to apply this technology in the modernizing tasks carried out in the plants which produce seamless pipes [2]. Sizing of the straining tools in the skew piercing rolling mill with Diescher’s disc guides is selected on the basis of the known technological premises and research [3, 4]. When roll pass designing the barrel-type rolls there is one cylindrical part and two conical parts forming. Roll pass design of the conical rolls is selected so as to provide their inclination to the rolling axle by the rolling angle much wider than zero. The plug piercing is a rotary object, in its shape reminding a cone with a characteristic cylindrical finish – ‘a little nose’.

2. RANGE OF STUDY
The samples that resulted from plastic working by the piercing – spreading process in Diescher’s mill were used in the tests.
Table 1 shows the diameters $d_g$ and piercing head positions $m$ as well as the remaining geometrical parameters of the strain area in the piercing - spreading process.

Table 1. Geometrical parameters of deformation zone of the piercing – spreading process.

<table>
<thead>
<tr>
<th>Number of samples</th>
<th>$m$ mm</th>
<th>$d_g$ mm</th>
<th>$g_t$ mm</th>
<th>$d_t$ mm</th>
<th>$g_t$ mm</th>
<th>Roll pass design</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>16</td>
<td>46</td>
<td>10</td>
<td>68,5</td>
<td>9,6</td>
<td>cone</td>
</tr>
<tr>
<td>16</td>
<td>16</td>
<td>46</td>
<td>10</td>
<td>70,7</td>
<td>11,7</td>
<td>barrel</td>
</tr>
<tr>
<td>17</td>
<td>40</td>
<td>46</td>
<td>10</td>
<td>65,5</td>
<td>8,8</td>
<td>barrel</td>
</tr>
</tbody>
</table>
The rolling process was carried out in temperature of 1200°C within a dozen of seconds. The obtained sleeves made of C45 carbon steel were cut into rings. Next, the samples were prepared to metallographic tests on the transverse and longitudinal sections. (Figure 1). The samples were selected so as the influence of sizing the working tools (barrel-type roll and cone-type roll, piercing head) and their positions in the strain area on the shape and character of changes in the sleeve’s internal structure on the transverse and longitudinal sections could be found and specified.

3. ANALYSIS AND EXPERIMENT RESULTS

Having carried out the metallographic tests the influence of the strain conditions on the sleeve’s microstructure on its transverse section and the external longitudinal surface going along the rolling direction was defined. When observing under the microscope the metallographic microsections it was noticed that on the longitudinal section the tested sleeves’ structure was typical for coal steel after standardization. Little grains of ferrite and pearlite are evenly distributed as if they were after heat refining. The volume of the grains and their distribution is analogical to every selected sample. (Figure 2). In that case influence of the geometrical parameters of the rolling process on the change of the structure is not visible. However, some distinct changes of the structure may be seen on the transverse section. In that case, every sample shows characteristic diminishing of the pearlite phase. Decarbonizing on the sleeve’s external surface takes place, which may result from high temperature corrosion. (Figure 3a). In the middle part of the transverse section bigger grains appear in comparison to the superficial layer. (Figure 3b). Distinct changes in the structure are visible in the internal part where the material touches the piercing head. Figure 3 c clearly exemplifies the impact of the geometrical parameters of the internal tool on the structure of the material. Sample No. 16 was rolled with a piercing head slightly protruded. In that case substantial pressure forces of the working tool on the material occurred [5] and so did large values of the stranding deformations. Such conditions could have influenced the occurrence of ferrite grains texture which arranged evenly on the edges of the sleeve’s internal surface. There is no distinct ferrite grain texture on the sample No. 5, where conical sizing of the rolls were used. Then the most favourable conditions of the sleeve’s piercing-spreading process in the Diescher-type skew rolling mill appeared.
Fig. 2. The pipe’s microstructure on the longitudinal section along the rolling direction: a) sample No. 5, b) sample No. 16, c) sample No. 17, magnification 500x

Fig. 3. Microstructure of the pipes in the cross-section, a) external part, b) middle part and c) internal part, magnification 200x
The micro-hardness of the structural phases of sample No. 16 were measured on the transverse section in its external, middle and internal parts. Some imprints were made with an indenter having the Vickers’ shape by means of micro-hardness meter of H-type, with load of 0.01 kG, and the value of the scale interval - 0.2 \( \mu \)m. Next, the lengths of the quadrangle’s diagonals were read and the micro-hardness was computed. For the sample after normalizing, the micro-hardness for ferrite was HV0.01 = 71, and for the pearlite was HV0.01 = 220. However, after measuring the micro-hardness for the samples obtained in result of rolling it may be found that there are some differences in values on their transverse section. Figure 4 shows the results of the measurements for sample No. 16. It turned out that in the internal part of pipe the micro-hardness of the structural phase of the ferrite HV0.01 = 146 and of the pearlite HV0.01 = 225 was much lower than the value of micro-hardness of the ferrite HV0.01 = 178 and pearlite HV0.01 = 264, respectively, in the sleeve’s external part. It is also visible (Figure 4) that micro-hardness of ferrite is much bigger than this phase’s value in normal conditions. This may have resulted from strengthening of the material in the mechanical working. In the piercing – spreading process there are considerable pressing forces of the metal onto the roll, almost double bigger than the forces that occur in the plug piercing [5]. It may account for bigger values of the structure’s micro-hardness in the metal’s external part.

**4. CONCLUSION AND SUMMARY**

The experiments referring to the piercing-spreading process in the Diescher’s skew rolling mill were carried out [5]. These tests inspected the influence of the strain conditions (power-engineering and stranding ones) onto the geometrical parameters. A new piercing  spreading process which was joined to one technological operation was elaborated. Optimal sizing was specified and so was the way of the working tools’ positioning in the strain area. Yet, the metallographic tests on the ready-made sleeves were not performed at all. This is an essential problem as they are semi-products used in further production of seamless pipes. Those products are widely applied in shipbuilding industry and they may be used in corrosive environments. Therefore, it is significant to test the qualities of a particular product. Preliminary metallographic tests were carried out as well as the test of micro-hardness of the
structural phases in the sleeves obtained from mechanical working. After the research it was found that the geometrical parameters of the rolling process influence the micro-structure of the strained material. Certainly the positioning in the strain area of the internal tool – namely the piercing head – has a considerable influence on the quality of the internal layers of the material. Too little protruding may have an unfavorable impact and cause deformations of the internal layers of the material (Figure 3 for sample No. 16), which is a negative phenomenon as the structure is not homogeneous any more. There are also some deformations of the sleeve’s internal surface, it is folded, and in further mechanical working they will be rolled up in consequence of which the ready-made pipe will lose much in its quality. To produce sample No. 5 the same protruding was applied as in case of sample No. 16, but the sizing type was changed to conical roll pass design. It can be seen that the grains are evenly distributed in the sleeve’s internal part (Figure 3c for sample No. 5) and no superficial defects are noticed. Therefore, one may conclude that the favorable conditions of deformation influence improvement of the sleeves’ quality, which are semi-products used in seamless pipes’ production.

BIBLIOGRAPHY
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