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Metallurgy

Pipe Rolling from Continuous Cast Metal

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ABSTRACT. The approach to manufacturing of high quality pipes as a result of solid and hollow billet rolling from continuous cast metal is shown. Optimal parameters of piercing, temperature of piercing and piercing rolling mill rollers speed have been experimentally established. *© 2007 Bull. Georg. Natl. Acad. Sci.*

Key words: *continuous cast, helical rolling, pipe quality, optimal parameters.*

Billets from continuously cast metal are widely used for manufacturing of seamless drawn pipes. Reception of pipe billet on the plant of continuous cast excludes blooming and in some cases even pipe billet rolling mill from the subsequent processes, which causes the decrease in the manufacturing cost of pipes. Billets made of continuous cast metal have noticeable homogeneity of structure on length and are characterized by less developed liquation.

Ingots of continuous metal from steel 10 with section 310x270 mm and 3.0 m of length were cast and rolled according to the existing technology into pipe billet with diameter110 and 220 mm. Altogether 170 billets with diameter 110 mm for mill "140" and 62 billets with diameter 200 mm for mill "400" were manufactured. On mill "140" billets made of continuous metal were rolled on pipes of 73x50 mm size, on mill "400" billets were rolled on pipes of 219x8 mm size. Heating and piercing was 1200-1220°C on both "140" and "400" mills. Reduction in pinching of piercing mill rollers on mill "140" was 16% and on mill "400" it was 12.5% (first piercing rolling mill).

The results of ready-made pipes examination are presented in Table 1.

The quality of inner pipe surface was satisfactory. Microstructural examinations of defect places made it possible to establish the fact that the outer scab was of metallurgic origin.

The second party of continuous cast metal was completely rolled on aggregate "400". Unlike the first batch, the ingots were cast by continuous casting under synthetic slags. Pipe billet with diameter 200 mm was rolled out of continuous cast ingot with section 310x270 mm and 3.0 m long. Piercing was made by the same regimes that were used for the first batch with one difference: the

Table 1

Quality of pipes rolled out of continuous cast metal

	1 grade, %	2 grade, %	Reject	Identification 2 grade	Identification of reject
Mill "400" Pipes 219x8	59.5	40.5	-	Outer scab	-
Mill "140" Pipes 73x5	17.3	64.5	15.9	Outer scab	Outer scab

temperature of piercing for billets of the second batch was 1180-1220°C.

All the pipes were accepted according to grade 1 without repair of outer and inner surfaces.

The third batch of continuous cast metal round ingots 270 mm in diameter (length 2.0 m) obtained on the plant of continuous cast; steel brand - 10. The batch consisted of 114 billets and was directly pierced and rolled on plant "400", omitting pipe billet mill. The state of the obtained ingot surfaces was satisfactory. On the ingot surfaces there were periodically repeated imprints in the form of ring belts and ditches with step 25-30 mm and depth up to 1.0-1.5 mm caused by reciprocal motion of the crystallizer of continuous cast plant and by casting under slag.

Turning of several ingots to the depth up to 6 mm proved the absence of underskin bubbles, rippled surfaces, cracks, slag inclusions and other defects of outer surfaces.

All the ingots had 3-6 mm ovality, which corresponded to admissible deviation for rolled billet. During the rolling on plant "400" two sleeves were put off (one after the first piercing mill, the other one after the second piercing mill) for additional examinations.

Billets were rolled on pipes with diameter 325 mm. As for manufacturing of pipes with diameter 325 mm on the plant, a round rolled billet with diameter 270 mm was used, then for piercing of the mentioned billets a Table of rolling was drawn (see Table 2).

The sizes of ready-made pipes are 325x15 mm. All the pipes satisfy the requirements of State Standard (GOST), the surface of ready-made pipes was satisfactory. The pressure of ring ditches and belts on the ingots did not affect the grade of the outer surface. Out of the whole batch only one pipe was accepted as 2^{nd} grade because of inner scab.

As is seen from Table 2, billets of the third batch were pierced at a large number of revolutions of piercing mill rollers, making 120 and 140 revolutions per minute instead of the earlier accepted 55-70 revolutions per minute. Earlier in [1] it was established that the geometry of sleeves out of ready-made pipes significantly improves while the number of roller revolutions increases.

In order to determine the thickness variation a template of 1m long was cut from the front end of each pipe in refrigerator. The observation of the wall's thickness at eight points of the diameter showed that deviations on the wall's thickness did not decrease by 3-6% from nominal, i.e. piercing at great revolutions had a favourable effect on the geometry of pipes in the case of piercing.

Mechanical properties were identified on standard samples with 10 mm diameter. Technological testing for endurance strain were conducted on 50 mm wide rings . All the samples were subjected to test on flattening. The results of mechanical testing are presented in Table 3.

The macrostructure was examined on pipe templates after wet etching in hydrochloric acid at temperature 80°C. It was found to be satisfactory.

Microstructural investigations showed that impurities with nonmetallic inclusions (oxides, silicates, sulphides) did not exceed 2-5 points (according to a 10-point system), which was satisfactory.

The fourth batch of continuous cast metal consisted of very large ingots (sleeves) with diameter 270 mm, according to the improved technology. The batch consisted of 316 ingots. The state of the outer surface of ingots was satisfactory. The control and undercut of ingots did not exceed any underskin bubbles, rippled skin, cracks, spills, slag inclusions. Ingot ovality did not exceed 3-6 mm.

Ingots were cogged down on pipes 325x8 in size on automatic plant "400". Heating and cogging of the testing batch were conducted according to the plant existing technologic guide of cogging pipes from rolled billet.

Billets were pierced on the second piercing mill at increased roller revolutions (70-80 rev/min). Piercing at increased revolutions was conducted with the aim of getting sleeves with minimal variation in wall thickness [1], as the initial billets showed quite significant variation in wall thickness. At average thickness 74 mm variation was ±8 mm. Besides, taking into account the results of rolling of the first two batches, the regime of heating in ring stoves was corrected in order to support 1160-1190°C piercing temperature.

As a result, out of 316 pipes we obtained 311 pipes of the 1st grade, 5 pipes of the 2nd grade (3 of them with inner scab (1%) and 2 pipes with outer scab (7%)). These indices are considered to be quite high.

In order to determine the discharge coefficient, the ingots and pipes were weighed. The discharge coefficient of pipes manufactured from continuous cast metal was 1.118, while that of pipes made of cogging ingots was 1.129. There is a significant advantage of production of seamless drawn pipes from continuous cast metal, especially from large ingots.

Table 2

The Table of rolling on piercing mill N1, aggregate "400". Diameter of the billet 325 mm

NN	Distance		Reduction in pinching		Coefficient of ovalization,	Reduction in front of mandrel tip, %	Angle of feeding, degree	Rollers speed, rev/min
	between rollers, mm	between lines, mm	mm	%				
1	290	298	35	10.8	1.04	7.4	6	120
2	295	311	30	7.5	1.05	4.8	8	140

Table 3

Mechanical properties of pipes made of continuous cast round billets (steel 10)

NN		Yield limit, δ_s kg/mm^2	Yield limit, δ_s kg/mm^2	Relative elongation, δ, %	Relative reduction, δ, %
1	Requirements of State Standard 8731-58	21.0	34.0	24.0	55.0
2	Minimal values	27.0	44.5	29.0	64.0
3	Maximal values	28.0	45.0	35.0	66.4

Conclusions

1. As a result of rolling both solid and hollow billets from continuous cast metal high grade pipes have been manufactured on automatic plant. The obtained pipes in sizes: 73x5.0, 219x8.0 and 325x8 (15 altogether) completely satisfy the requirements of State Standards 8731-58 and 8732-58;

2. Pipes of all the batches practically had no scabs on their inner surfaces, which resulted in satisfactory microstructure and absence of impurities with nonmetallic inclusions;

3. Development of the technology of continuous casting (casting under synthetic slags) enables to reduce the quantity of outer scabs to the minimum;

4. The optimal temperature of piercing, especially for big hollow billets for steel 10 is 1170-1200°C. Such piercing temperature reduces outer scabs on pipes to the minimum;

5. To eliminate initial wall thickness variety on round cast billets it is necessary to carry out piercing at increased rollers' revolutions. The optimal value of revolutions for piercing mill "400" is 80 rev/min.

მეტალურგია

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REFERENCES

1. *L.N.Okley, I.V. Chkhartishvili, Z.N. Melashvili.* (1989), Soobshcheniya AN GSSR, 136, 2: 637-640 (Russian).

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