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ABOUT RECONSTRUCTION OF BROADBAND FIGURES

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It is executed the analysis of structure and technological parameters of rolling processes at existent SFGR and CFCR. There are considered and offered the variants of reconstruction of figures with the change of layout for equipment disposition, providing reduction of duration and increasing of rolling temperature, declines of power inputs and increasing of the quality for finished products.
Keywords: rolling, mill, stripe, disposition, temperature, parameters, quality

During the last years in metallurgy there is intensive preparation of technology production of hot-rolled wide-band-rolling steel from thick cast slabs on the complexes of MCCB + WFGR (CMWS), and also thin and middle thickness of cast slabs on CRA (casting-rental aggregate), which eliminate the intermediates of receipt of bar and slabs on a slabber [1-3]. Replacement of slabber in traditional technology of production band (bar-slab-band) on MCCB is provided substantial reduction of expense of metal and energy on rolling band. The process CMWS is applied both at creation of new productions and reconstructions of existent WFGR with traditional technology of rolling band. On WFGR second and next generations, and also on CRA, rolling mills have practically the same chart placing of working cages: draft group (3-5 cages in first case with addition of the cage for reducing of slab on a width and 1-2 cage in the second case) and clean group (5-7 cages), but with more high-quality descriptions of equipment, which allow to roll to the band with the thickness $h < 1,5$ mm for speeds of $v \geq 20$ m/s.

However existent CMWS at the use of technology of WFGR are characterized by next defects:

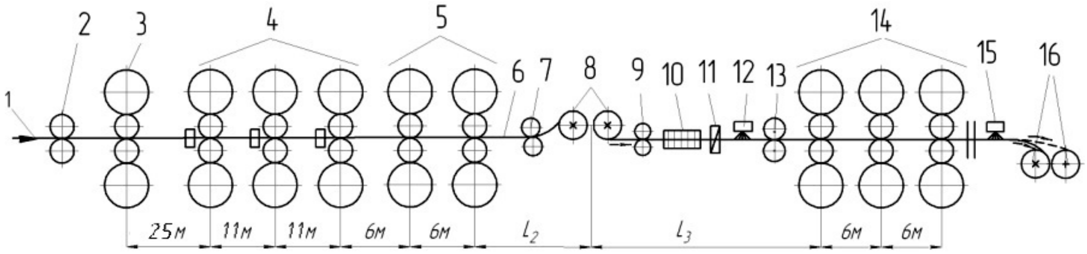
- is large distance between the pair of cages (19-65 m) in draft groups and between draft and clean groups (intermediate roller-conveyer by long (60-130 m) assist the decline of temperature of breakdown-bar on 100-200 °C on an area between the first cages of draft and clean groups, that results in the origin of the considerable power loading on rollers and main drive of the mill, and, thus, to the increased power charges;
- the unevenness of distribution of temperature on length of intermediate breakdown-bar before the first cage of clean group promotes longitudinal polythickness band;
- is absence of pull at rolling of eventual areas band of coditionalє of their boss and increase of expense of metal in clipping;
- are substantial power charges, which are related to the acceleration of rollers of clean group of the mill (CMWS, CRA) all cages of group participate at rolling band.

The defects of structure and technological process (except for the last point) at full degree belong to WFGR 1680 (OAJ «Metallurgical combine «Zaporozhstal′»)

and WFGR 1700 (OAJ «Metallurgical combine of Illych name». Mariupol′), which are the mills of first generation and need native reconstruction. In this connection authors of works [4,5] mark, that practically all metallurgical plant of Ukraine walked up to the threshold of profitability, that is why a problem of their modernization is peracute and more actual.

In literature some variants of reconstruction of WFGR 1680 and 1700 are examined, but they have cosmetic character and partly can improve the technique and economics factors of production.

One of variants of native reconstruction of WFGR is offered in works [6-9], where the main difference of new technology of rolling (NT) from existent WFGR is moving of basic deformation of breakdown-bar on the cages of continuous draft group, the quantity of which increases to 6-7, that provides deformation of breakdown-bar at the greater temperature of metal, diminishing of general quantity of clean cages to three with placing before them IRE (intermediate rewinding equipment) and divuces for adjusting of temperature band, application of deformation-speed regime of rolling band, that eliminates the overcharge of rollers, and also main drive of the mill (fig. 1) the independent in groups.



1 is slab; 2 is a descaler; 3 is a draft cage «quarto» (universal cage); 4 are universal draft cages «quarto» with vertical rollers; 5 are draft cages «quarto»; 6 - intermediate breakdown-bar; 7 are sending rollers; 8 - IRE with a hratsaving screen (drum reels); 9 are draw rollers; 10 is a pusher induction furnace; 11 are cuttors; 12 is a spraying device; 13 is a clean descaler; 14 is a continuous clean group of cages; 15 is a spraying device of ready band; 16 - coiler of ready band

Figure 1 - Chart of ninecage WFGR (HT)**:**

Technical description of offered WFGR (NT) meets standards, accepted in world practice for the mills of rolling of wide band and to the conditions of their reconstruction, and given in a table 1.

Detailed comparative analysis of parameters of rolling band over on WFGR (NT) and WFGR are brought in literature [6-9,14], therefore below data in relation to the mill 1680 OAJ «Metallurgical combine «Zaporozhstal′» (speed of rolling is 10 m/s) and mill 1700 OAJ «Metallurgical combine of the Illych name» (speed of rolling, m/s: 10, 15 and 20) [8,13] are presented. Calculations of parameters of rolling band are executed at the known tested methods [8-11] (H = 165 mm, $h_{ПР}$ = 23.0/6.1 mm, h = 2.5 mm, width B = 1250 mm, temperature before the cage № 1 t_k = 1180 °C, steel 08). Below is brought comparison of some parameters of rolling on the mills of WFGR and WFGR (NT) for the proximately identical thickness of breakdown-bar (table 2).

Table 1 - Technical description of offered WFGR (HT)

Parameter	Numeral value
Thickness, mm:	
- slab	*H* = 160-250
- intermediate semifinished rolled products	*h*ПР = 3.14
- ready band	*h* =1,0.6,0
Diameter of rollers, mm :	
- workers	600-1200
- supporting	1300-1650
Circuitous speed of working rollers, m/s:	
- is a cage N 6	6-14
- is a cage N 9	10-≥20

Table 2 - Parameters of rolling band 2.,5 x 1250 mm on WFGR and WFGR (NT)

Parameters	WFGR 1680			WFGR (NT) 1680		
Cages	5	7	10	4	6	9
t_k, °C	981	934	832	1106	1053	871
h, mm	14.0	5.7	2.5	16.0	6.1	2.5
f	0.331	0.265	0.204	0.269	0.195	0.201
v, m/s	1.79	4.39	10.0	2.48	6.5	10,0
P_{mid}, Pa	217	298	289	149	206	260
P, MH	14.4	11.9	4.6	10.7	8.0	4.3

As follows from a table 2, due to the continuous location of cages in a draft group on WFGR (NT) for the compared thickness of breakdown-bar in cages NN 5,7 and NN 4,6 temperature of metal appears higher on ~ 118 °C, and at producing of ready band - on 39 °C. Here on WFGR (NT) coefficient of friction in the cages №№ 4-9 decrease on 5-15 % flow stress of metal - on 15-20 %, and middle normal contact tension - on 25-30 %. Properly force, torque moment and power of rolling for band go down.

At rolling of the same type band (*v* = 10 m/s in the last cage) total power of rolling (table 3) in clean cages almost in two times below, and total power in all cages of WFGR (HT) on ~4,0-5,5 % less than, than on serial WFGR (band 2,5 x 1250 mm).

Yet greater effect of decline of power of rolling observed for speeds of *v* = 15-20 m/s, id est. after the acceleration of the mill. Yes, total power of rolling in all cages of the mill WFGR (HT) goes down comparatively with WFGR at *v* = 15 m/s on 15-16,5 % and at v = 20 m/s - on 26-27 % due to diminishing of power of rolling in the first three cages of the mill and at less speed of rolling. Except for that, more than power, which is spent on the acceleration of three clean cages of WFGR (HT) as a result of decline of mass of parts which are revolved, comparatively with the acceleration of six cages of WFGR diminishes in two times.

Table 3 - Total power of rolling in clean cages (N_{cl}) and total power in all cages (N_{Σ})

Parameter v, m/s	N_{cl}, *kW*		N_{Σ}, *kW*	
	WFGR	WFGR (NT)	WFGR	WFGR (NT)
10	21548	9823	38296	36772
15	31249	13572	47897	40521
20	42874	16011	59522	42960

At winding up of intermediate breakdown-bar on IRE after a cage N 6 thickness its back areas it appears more than front area on ~ 0.2 mm (the less temperature of breakdown-bar and absence of back pull) is designated. At unwinding of breakdown-bar to cage N 7 as the front is set its incrassate area, and the back area of breakdown-bar has a less thickness and greater temperature. Such transposition of eventual areas (even without the action of induction furnace and screw down) levels influence of absence of back pull band at rolling in a clean group WFGR (HT), as a result thickness of back area band the thickness of her appears on a 0.02 mm less than front area (id est. ($\delta_{h\Pi}$ = - 0.02 mm, against $\delta_{h\Pi}$ = 0.075 mm at rolling on serial WFGR from IRE).

Fourcage continuous mills of the cold rolling (CMCR) 1680 and 1700 note plants which are entered to exploitation more than sixty years ago [11], work and presently with some improvement of equipment and technogical process (construction of supporting nodes of necks of rollers, axial displacement and antibend of working rollers, profiling of rollers, regime of pull band). However the protracted exploitation of main equipment and main drives of working rollers without replacement stipulates a decline on 10-15 % speed of rolling band and, accordingly, to the productivity of the mill.

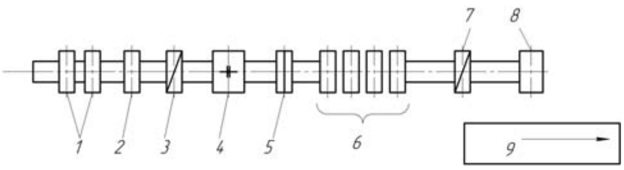
The existent defects of process of rolling on fourcage CMCR were made up at their planning. For a technological process pauses within the limits of 2-3 minutes between completion of rolling of one roll and beginning of rolling of next roll foresaw, producing from the mill of rolls with incrassate eventual areas that resulted in the considerable losses of metal in wastes at their exception (3-4 %). The presence of incrassate eventual areas is conditioned insufficient additional drafting at rolling without their pull. Such out-of-date technological process of rolling is remain on the noted mills and, presently, that does not provide necessary quality of products and level of techniques and economy factors of production. The cosmetic improvements of fully out-of-date technologies are unable to provide the necessary upgrading of quality for products and techniques and economy factors of production of rolled metal. Therefore necessary is native perfection of equipment and technological process of production band on fourcage CMCR.

A few variants of modernization of the noted mills are possible. Undoubtedly, the most attractive variant of reconstruction is transformation of technologies of the mills 1680 and 1700 on the classic endless process of rolling band with the successive location (continuous enchant aggregate) + CMCR. Obviously, it is possible, but needs considerable investments on building practically new production.

The most real variant of reconstruction, in our view, there is impurring to the technological process of new additional equipment, which provides endless or, at least, semiendless process of rolling band at unchanging composition of main equipment. Such processes, at fewer charges, can provide constraction band with high quality of geometrical parameters of profile, and also high technical and economy factors of production (fig. 1).

One of variants of perfection of production band by creation of contiguous of enchant-rental apparatus (CERA) on the existent area of workshop of the cold rolling, where band provide the endless ERA process of band rolling, are presented in works [6-9,14]. In this variant placing setting of cage «quarto» with a necessary ancillaries in tail part of CEA foresee for providing of hot-rolled band in 30-35 %, and in the lines of CMCR - additional placing of correct and correct-tensioning machines, volatile scissors and after the mill, mobile joint-welding machine for welding of ends contiguous band at rolling band on CMCR at a speed ~0.15 m/s, id est. without a stop the mill, and two coilers for winding up of ready band. Merites of this process of rolling are given in works [6-9,14].

By the next variant of reconstruction, with less investments, it can be creation of semiendless process of rolling band (fig. 2), where, unlike CERA, the working cage of is «quarto» absents at the line of CEA, on CMCR a stationary joint-welding machine, and also one coiler, is set after the mill.



1 is uncoiler; 2 is a correct machine; 3 are volatile scissors; 4 is a стикозварювальна machine; 5 is a tightener; 6 - CMCR; 7 are volatile scissors; 8 is a coiler; 9 is a transceiver of rolls

Figure 2 is layout of equipment of CMCR chart with semiendless by the process of rolling:

During rolling a front end of the first roll is from one of uncoilerів 1 set in rollers cages N 1 for speeds of their rotation a 0.2-0.4 m/s, roll after the set mode on CMCR 6 and wind up on a coiler 8 with the increase of speed a to 10-12 m/s in a clean cage. After the exit of back area of the first roll from uncoilera a 1 speed of rolling in the last (clean) cage N 4 diminish a to 0.5-1.0 m/s. Speed of back area of hot-rolled band of the first roll for the cages of the mill in this case a 0.15-0.33 m/s. will be evened the back area band add stupors on a correct machine 2, a 150-300 mm cut off imperfect part long on volatile scissors 3 and trick into to the joint welding machine 4, where he expects approach of front area of next roll from second uncoilera 1, which is also added to the correction on a machine 2, to cutting on volatile scissors 3 and then give to the joint welding machine 4. The process of the butt welding of contiguous areas of rolls lasts to 50-60 s and for this time volatile scissors 7 band execute a separation, that is in the mill, from rolling band in a roll on a coiler 8. Farther a roll is taken off and pass him on a transceiver 9.

After welding of the noted areas (with a removal to flash) band the process of rolling and eventual areas of previous and next rolls for speeds a 0.5-2.0 m/s for a cage N 4 continue, and the rolled front area of previous (first) roll is set in a free coiler 8. After the set of two coils band on a coiler 8 the acceleration of the fourcage mill to speed a 10-12 m/s are carry out. On this addregate all process of rolling of the weld-fabricated rolls is executed at presence of permanent pull by band. After completion of rolling of the second roll the process of preparation of next roll to rolling is repeated. Application of semiendless process on CMCR allows to roll eventual areas band with a pull and assists the decline of energy-power parameters of rolling.

Dignity of such variant of modernization (reconstructions) of CMCR is also exclusion of incrassate areas and, thus and losses of metal in clipping in a quantity 3-4 %. In such process for a cage N 1, instead of notched (5-6 mcm Ra), working rollers with the polished surface and roughness 1.2-1.5 mcm Ra apply, that provides not only the decline of energy-power parameters of rolling but also diminishing of wear of especially supporting rollers. From data of works [14-16] diametral wear of every supportroller of cage N 1 CMCR 1680, that works with notched working rollers, folds ~1.0-2.0 mm, that in 3-5 times anymore comparatively with a wear at the use of the polished working rollers. Except for that, application for a cage N 1 the polished working rollers assists the improvement of quality of surface band.

The defect of the offered process creation serves as on the band of imprints from rollers at its stop for the butt welding of ends of contiguous rolls. However such defects partly can be removed to the end of rolling and not enough to influence on the expense of metal. In our view, even at presence of area band long a 10-15 m with imprints, but with a nominal thickness, but not with the thickness of hot-rolled band, at least, the expense of metal will grow short in clipping in three times. Except for that, in order to avoid these defects butt welding of ends contiguous hot-rolled band can be executed at rolling band on scramble speed, at presence of some supply band (bails) scope a to 10 m before a tensioning devices 5.

Conclusions. Reconstruction of working WFGR with transformation of them on the mills as WFGR (NT) with reduction of quantity of cages on one allows to provide:

- is a decline of total power of rolling on the mill on 4-27 % due to the increase of temperature of rolling and diminishing in the clean group of quantity of cages (from six to three), that participate in the process of acceleration band after gearing of its front area by a coiler;
- is an increase of exactness of rolling band and declines of expense of metal in clipping due to diminishing of thickness of back eventual area and temperature «wedge» (comparatively with traditional WFGR).

Application of semiendless process of rolling on fourcage CMCR at the obligatory presence of pull of eventual areas band provides:

- drafting of eventual areas with diminishing of their thickness to the basic value and decline of expense of metal in clipping;
- is an exclusion of unproductive periods of task band in the mill and to producing of it’s from the mill which diminishes duration of pauses;
- is a decline of energy-power parameters of rolling and increase of durability of supporting rollers at replacement in cage N 1 notched working rollers on the polished rollers.

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