RESEARCHES REGARDING THE BEHAVIOUR OF CYLINDERS IN THE HOT-ROLL TECHNOLOGICAL PROCESS, ENVISAGE OF IMPROVING EXPLOITING ENDURANCE

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Abstract: The research of thermal fatigue of the cylinders for hot-roll, constitute a novelty, and the study of its breakage and rupturing, represents one of the most important issues from the theoretic point of view, and practice, as well.
To increase exploiting endurance of these cylinders were made three types of experiments which leaded to the conclusion that the best results at fatigue were given by the hypereutectoid steel, ADAMIT – OTA – 3, type.
In the same perspective of increasing exploiting endurance, through split up decrement of thermal fatigue, was created a device to roll the surfaces of lamination cylinders' calibers.

Heat treatment cycles presentation and analyzation applied on cast steel drums, particular for hypoeutectonic steel (adamite steel).

Obtained results are searched in exlpoitation to shape's rolling from middle range, estimating the drum's durability for different shapes.

Choosing the optimal quality of drums for a particular reason assume a detail knowledge of requirement article, of work conditions anf od different drum quality's characteristics; this is a quite heavy and complex operation. Resolving this problem takes study, logic and experience for each rolling mil, because the obtained experience at one rolling mil, can't be transffered in totality and unconditional, even at another one of the same type.

In drum's choosing, it is necesarry to take in consideration the rolling mill type, the efficiency, the stands, which the drums are adjusting for, the value of reductions, the steel mark which is rolling, the minimum and maximum diameter of drums, drum's work temperature in rolling process and the cooling way of drum in rolling time.

Considering the phenomena which are taking place in rolling process, the drums need to satisfy the following requirements>

- high fracture strenght, due to bending and torsional strenght;
- resistance of wear, due to friction between rolling material and drums;
- crack resistance, due to heat shocks;
- to enssure a good shape of rolled steel.

All heat treatment types applied on cast steel drums provide simultaneous with obtaining of wear resistance and internal stress reduction, which are very high at hypoeuretoide cast steel drums. In this scope, the drums are heated with low velocity at 550 – 650^{o} C. The drums are maintained at this temperature 6 – 12 hours.

As increasing the drum's diameters and their carbon content is reducing the heat velocity, and the maintained time is increasing.

After maintanance, heating will continue with a increased velocity of 1,5 – 2,0 times untill the touching of provided temperature from heat treatment diagram.

To avoid straining again, the drums are maintained a bigger period of time at 550 – 650o C, and then the cooling is realised with lower velocities or equal with the heating velocity.

The most resistance drums are the hypoeutectoide cast steel drums (0,5 – 0,8% C), pearlitic – ferrite structure, which they have, don't have the capacity of wear resistance, and the rolled material has the tendency to accede of those shapes.

For obtaining a fine-grain structure, with high resistance and hardness, the hypoeutectoide cast steel drums are normalizing at 900 – 950 oC, after that with a second normalization at 850 – 870 oC, after cooling in air is obtaining fine dispersed structure, ehich enssure hardness of about 270 HB.

The heat treatment condition of hypoeutectoid cast steel drums (C = 0,5 – 0,6%) alloy with 0,5 – 0,6% Cr and 0,8 – 1,0 % Ni is presented in Figure no. 1.

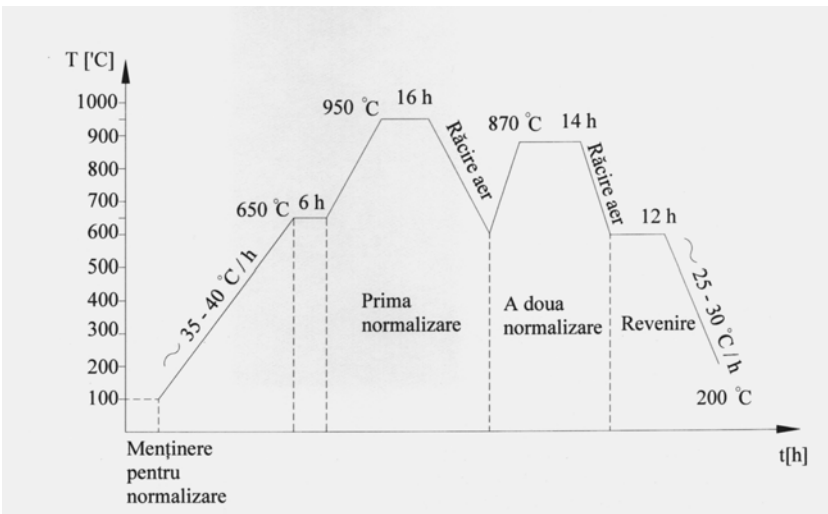

Figure 1 – Heat treatment cycle for hypoeutectoid cast steel drums

Hypoeutectoid cast steel drums have the most application (C = 0,9 – 2,0%), which have a structure composed from pearlitic granule surrounded by a cementite net. At C = 1,7 – 2,0% besides of cementite is building up ledeburite zones.
Compact cementite net cause a sudden reduce of these resistance and due of this, the rising of fracture number in exploitation time.

For increasing the mechanical and heat resistance, the drums are submitted to heat treatment, and due to this, the cementite net is destroyed and forms the bedeburite zones.

After the heating with a low velocity and maintaining for internal stress reduction, the heating is continue with 50 – 60 ^{o}C/h until the normalization temperature. After maintaining of 12 – 20 h at 900 – 950 oC, the drums are cooling in air until 600 ^{o}C, where they are maintained 8 – 10 h, next follow a slowly cooling with a lower velocity or equal with 25 ^{o}C/h, with the purpose to avoid the straining again.

At hypoeutectoid cast steel drums range CrNiMo, the heat treatment has two purposes:

- obtaining both a high resistence and hardness of drums used in roughing mill stand, and hardness of 230 – 260 HB;
- obtaining some hardness till 300 HB at smoothing drums of continue prepared rolls and with hardness till 440 HB at drums from shape's rolling.

Heat treatment condition represents a combination of 2 … 3 normalizing periods, which are ending with a soaking for excluding the internal stress through slowly cooling from 600 ^{o}C to 100 – 150 ^{o}C. Heat treatment condition of 150 CrNiMo steel is presented in Figure no. 2.

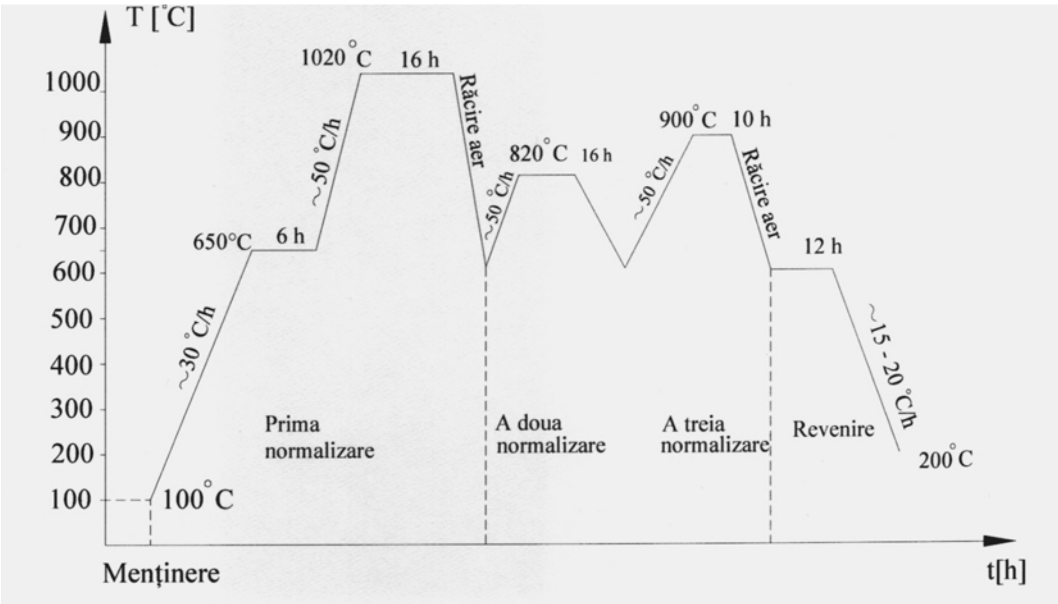

Figure 2 – Heat treatment cycle for 150 CrNiMO steel

Adamite is an hypoeutectoid steel, at white cast iron limit, having in carbons net ledeburite zones on a pearlitic methalic baze.

C	Mn	Si	S	P	Cr	Ni	Mo
1,8	0,7	0,6	max.	max.	1,0	1,5	0,3
2,0	0,9	0,8	0,02	0,04	1,2	1,8	0,5

The possibility of obtaining a hardness in 230 – 450 HB limits, as result of heat treatment, allows using these materials for drums at more stands types. High resistance in drum's exploitation provide with condition of formation a structure with equally loaded carbide phases release.

Introducing Cr, Ni and Mo lead to a obvious change of kinetics process. In a hypoeutectoid steel alloyed with Cr, Ni and Mo at 850 – 900 ^oC, the cementite net is disolving in totality and the eutectite cementite only partial. However, it doesn't take place the slight graphitization, and on field and on austenitic grains limits is released carbons phase. Heating forward till 1100 ^oC bring about the complete resolution of eutectid cementite and superficial graphitization. Elements content for carbons formation in this case is not sufficiently for binding in totality the carbons with special carbons.

Addition of molibden in Cr – Ni steel in 0,3 % quantity, provoke eutectite cementite stabilization reducing, because cementite is disolving at aproximatively 1000 ^oC. Superficial graphitization is correcting and the carbon is binding in special stabile carbide. At heat treatment condition choice, which enssure the obtaining of some uniform loaded carbide in hypoeurectoid steels, casted for rolls drums, it is necessarry to take in consideration the fact that the cementite net on austenitic grains limits are dizolving in temperature interval 850 – 1100 ^oC.

In steels with a lower content of elements that form the carbide, eutectite cementite doesn't disolve at these temperature. As increasing the heating temperature from 850 – 1100 ^oC begins intense graphitization of the test shape, wich indicate the possibility of formation the graphite inclusions at volumetric heat treatment.

Obtaining a carbon's strucure uniform loaded at heat treatment is possible only in steels which contained about 2% Cr and minimum 3% Mo.

The first normalization is destroyed the cementite net, and through the second normalization is globulited the perlite and is obtaining a very fine granulation. To increase the drum's characteristics, including the hardness, is appling the third normalization at 900 – 920 ^{o}C, followed of cooling in air. Through cooling velocity adjusments in the third normalization can increase or decrease the hardness.

Thus, drum's hardness for wire and smoothing drums too from rolls stands shape can be increasing till 400 HB at a cooling in air. For big and middle drums, ussually it limit the first and second normalization, but in all cases the last normalization is ending with a return.

In SIDERURGICA S.A. is treating drums for middle shape roll with diameters between θ 460 – θ 570 mm. These drums is made up from T190MoCrNi17 steel (adamite) which have the following chemical compozition:

C	Si	Mn	P	S	Cr	Ni	Mo	Cu
1,8 - 2,0	0,6 - 0,8	0,7 - 0,8	max. 0,04	max. 0,02	1,0 - 1,2	1,6 - 2,0	0,3 - 0,5	max. 0,2

Drums are using to continuue rolls of middle shapes at shapes producing (I and U profile) in dimension range 60 – 120 mm.

Heat treatment which apply these in SIDERURGICA S.A. is presented in Figure no. 3.

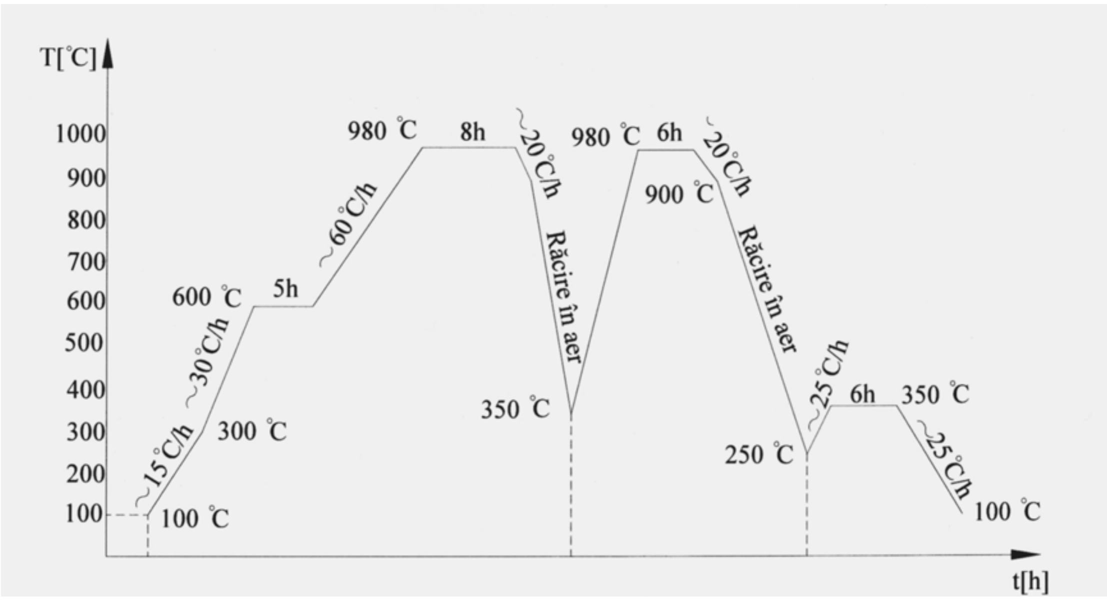

Figure 3. Heat treatment cycle for T190MoCrNi17 steel drums

Heat treatment application presented upper led to realization some drums, wich have a good behaviour in exploitation, especially to shape's production, realising the following durabilities:

Profile shape	U - 50	U - 65	U - 80	U - 100	U - 120	I - 80	I - 100	I - 120	L50 - 100
Durability t/1mm drum	100	190	160	160	170	160	150	140	450

Due durabilities realised are comparable with those obtained on world level we consider that heat treatment cycle aplied at SIDERURGICA S.A. is suitable for drums mark T190MoCrNi17, being also improvement possibilities of durabilities in those exploitation, through particulating the heat treatment on drum’s dimensions.