

# Effect of Chemical Composition on the Scraper Conveyor Parts Hardness and Wear Resistance

**D. Glushkova**

In this paper the optimal chemical composition of steel that provides high hardness and wear resistance of scraper conveyor parts is offered has been presented

**Key words:** scraper conveyor parts, friction, corrosion, fatigue, mining equipment, interacting surfaces, plastic deformation, pulling unit, durability, alloying.

The need in the continuing growth of coal production facilitating the working conditions in mines and increase of safety impose high requirements for mining equipment and, in particular, to the chain conveyor which is one of the main hoisting elements of the mechanized complex.

The analysis of operating experience of the given equipment shows that the cause of failure is the wear of conjugated units, corrosion, and fatigue caused by the influence of abrasive masses of coal and rock as well as high dynamic loads.

The analysis of operating conditions of the most wearing parts of scraper conveyors shows that friction conditions and wear processes can be divided into three groups:

- abrasive (purely mechanical);
- thermo-mechanical;
- corrosion and mechanical [1]

Such division of the interacting surfaces does not fully reflect the effects that occur at the wear of scraper conveyor parts.

At study of panlines worn surfaces and other parts of the scraper conveyor it can be concluded showed that the chutes, and in particular, the bottom during the operation are more exposed to abrasive wear.

From this perspective friction materials should be as harder as possible.

## Materials and methods

At the interaction of the between a conveyor conveyor pan with the and coal mass there takes place the causes abrasive wear with multiple plastic deformation of the conveyor surface resulting in fatigue failure.

In pans there occurs wearing The wearing of pans affects mostly of bottoms and contact points with the pulling unit. The most intensive wearing occurs on the docking stations of pans. In the Fig 1 shows the surface after a cycle of operation is shown.

One of the factors that reduces the wear rate is the increase in the hardness of chain links surface layers to values that are greater than the hardness of the elements included in the resulting layer of rock [2].

Analyzing the data concerning the materials used to manufacture the parts of scraper conveyors and opportunities for enhancing their durability it can be noted that so far there has been no optimal solution of this issue.

Based on the terms of scraper conveyor parts operation when selecting the proper material for their production one must consider the effect of the chemical composition on the hardness and wear resistance of the latter.

With abrasive wear the main element determining the wear resistance is carbon.

The introduction of alloying elements into the steel (chromium, silicon, tungsten) in small amounts (1 ... 2%) slightly increases the wear resistance at carbon content of 0.6 ... 0.7%. This is due to the fact that carbon in such amounts provides high hardness even without additional alloying.

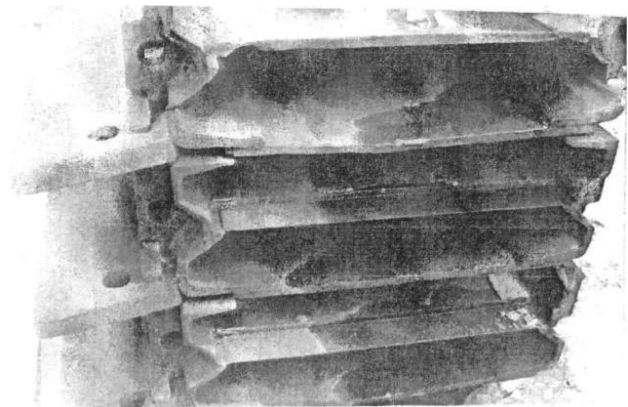


Fig. 1. The nature of damage of working surfaces of the bottom after operation

However, given the need for welding in the manufacture of pans, the carbon content of steel should not exceed 0.3 ... 0.35%, and the alloying elements must be integrated, increasing the strength and durability, avoiding negative impact on weldability property.

The excessive alloying can be not only useless but even harmful as it increases the overall fragility of steel and reduces the ability of steel to deformation of wearing micro volumes. And in terms of abrasive wear the surface layers of parts undergo severe plastic deformation which results in continuity violation and the friction surface comes into a state of pre-destruction.

Therefore, for such parts they take into account not only the hardness but also a high margin of plasticity which delays the formation of microscopic cracks take into account. It is especially important to dwell on the influence of boron. Introduction of boron into steel allows obtaining a high degree of hardness at a big depth in relatively massive products such as the sides of coal scraper conveyor pans immediately after heat treatment.

The increase of steels hardness penetration containing boron results in the reduction of the critical quenching rate. The positive effect of boron on strength characteristics is due to low concentrations of boron.

As the experience ofIn the domestic and foreign production of parts for mining equipment reveals they mostly use the following abrasion-resistant steels are typically used: 45G2, 15HSND, 35, 30G, A335/A335 M grade P22 (ASTM, USA), 25HGSR.

**Results and discussion**

In the presented reseach this paper the material researched was steel 30G, 25HGSR and A335/A335M.

Based on the actual conditions of the pairing parts operation "bottom-link of the pulling chain " of the mine scraper conveyor comparative tests of steels for resistance was performed on the basis of "block-disc" scheme on the lab bench SMC-2.

There was investigated tThe wear resistance of steels 30G, 25HGSR A335/A335M and the pair of friction with steel 35HGSA were investigated.

The investigated steels had different structure after the same cooling rate from the austenitic state: steel 30G - ferrite-pearlite, steel A335/A335M - sorbitol-troostite, steel 25HGSR - troostite that led to their difference in their hardness. In the Fig. 2 shows the histograms of steel hardness are shown.

Each option of conjugated materials had four pairs of friction "block- disc". As the wear resistance of coupling materials was estimated according to the mass loss ( P, d) of samples, their weighing was carried out prior to the test, and every 6 hours during testing that allowed observing the dynamics of the wear process.

Average results (fourfold tests) of the mass loss value of experimental blocks indicate that 25HGSR steel has max-

imum durability, the chemical composition of which is presented in table 1.

Over 36 hours of testing in conjunction with the counterbody made of steel 35HGSA at the same load-speed mode the wear of the block made of 25HGSR steel consti-

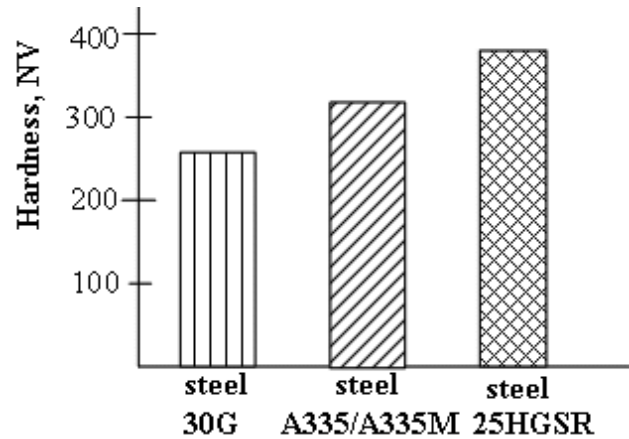


Fig. 2. Hardness histograms of investigated steels

Table 1. Chemical composition of 25HGSR steel

Elements content, %					
C	Si	Mn	Cr	B	Fe
0,25	0,60	0,95	0,50	0,001	The rest

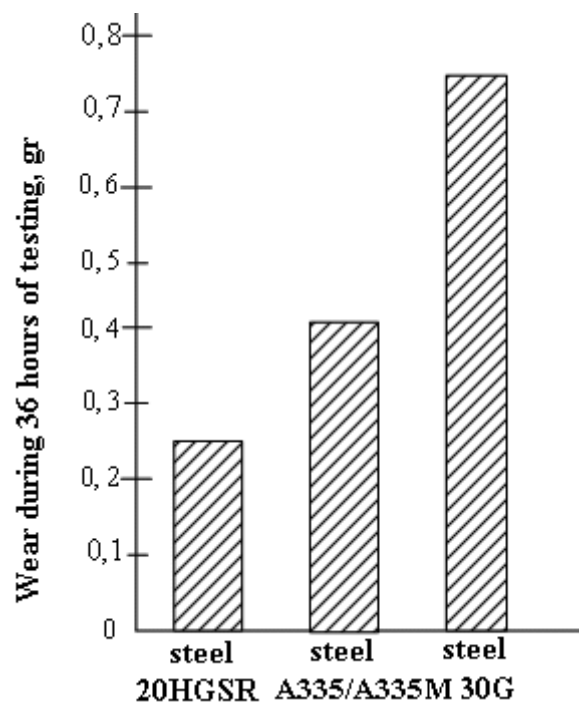


Fig. 3. Wear histograms of steels after 36 hours of testing

tuted 0.2439 gr. Steel A335/A335M and in particular steel 30G under identical conditions have a significantly lower wear resistance and the absolute weight loss of blocks made of them are, respectively, 0.4086 and 0.7022 gr. In the Fig. 3 shows histograms of these steels wear during 36 hours of testing are presented

Such a difference in terms of wear values of compared steel samples is associated with the chemical composition of steel 25HGSR, namely, with the optimum content of carbon and alloying elements and, above all, with the presence of boron.

High efficiency of microalloying with boron is due to the fact that boron coagulates submicroscopic particles of nitride aluminum which can be a cause of crack nucleation and promote the formation of a fairly solid structure.

## Conclusions

1. The conducted comparative tests on durability of steels 30G, A335/A335 M 25HGSR showed that steel 25HGSR has the minimum wear.

2. Wear of steel 25HGSR over 36 hours of testing is 3 times less than that of steel 30G and 17 times less than that of steel A335/A335 M.
3. Following the same cooling rate from the austenitic state steel 25HGSR has the hardness of 1.8 times bigger than steel 30G and 1.3 more than steel A335/A335M.
4. High hardness and wear resistance of steel 25HGSR in comparison with steels 30G and A335/A335 M is related to the chemical composition of the steel, namely, the presence of chromium, manganese, and silicon. A special role in increasing the wear resistance of hardness plays is played by boron.

## References

- [1] M. Tenenbaum. The main types of coal destruction of machines parts/M.Tenenbaum.-Moscow: Ugletekhizdat. - 1990. - P.90.
- [2] A. Fainleib. The influence of components hardness on the abrasive wear of coupling resistance /A Fainleib// Metallurgy and heat treatment of metals. - 1997. - 4. - P. - 64-65.