Solving problems of Eicotrack chainless haulage system

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Řešení problémů bezřetězových pojezdů eicotrackového typu

Téma příspěvku „Řešení problémů bezřetězových pojezdů eicotrackového typu" vyplynulo z nutnosti řešit zásadní problémy vyskytující se na hlubinných dolech v oblasti samotného dobývání uhlí kombajnovými komplexy. Avizované problémy se týkají zvyšující se četnosti poruch vrátkové části dobývacích kombajnů. Konkrétně jde o cévové kolo a trať, respektive ozubenice jenž jsou nedílnou součástí hřeblového dopravníku, po kterém kombajn pojíždí. Jedná se o neúměrné opotřebování obou zmíněných částí pojezdu, které vedou k jejich destrukci a následnému zastavení dobývání. K tomu se v poslední době přidal stále častěji objevující se výlom zubu cévového kola a podélná deformace tratě. Prostoje tímto způsobené zmenšují efektivnost a produktivitu práce a tím následně zvyšují náklady na vydobytou tunu uhlí. Tyto problémy, by se bez jejich řešení objevovali stále častější, neboť výrobci dobývacích kombajnů již nyní zahájili výrobu této techniky o vyšším instalovaném výkonu (o 33 %), jenž se pohybuje v oblasti kolem 1000 kW a výše.

Key words: *longwall shearer; chainless haulage; shearer sumping; Eicotrack*

Introduction

Increased heftiness to exploitation of mineral deposits and mainly quantity of coal mining, apart from worsening of mine-geological conditions which are done by underground mining of coal seams at bigger depth, steered engineers to increasing power of longwall shearers. Therefore often happen to overload of haulage unit. The most failure parts are hydraulics and mainly idler wheel, which is at contact with rack bar (Eicotrack).

Haulage unit

Haulage unit is one of basic parts of longwall shearer and determines about shearer conditions and dependability. This important constructional part is instrumental to draggle of shearer along face and it has to serve a few requirements like as eduction of tensile, operation speed and its stepless regulation, operating of haulage unit by minimum component units, which are located at one accessible place and atc.

Outside part of haulage unit

Outside part of haulage unit of longwall shearer includes idler wheel. This wheel and rack bar (Eicotrack) fixed to face conveyor are cardinal parts of shearer haulage. When I wrote earlier, machine timedowns for crankiness are more frequently mainly for increase installed power. Reason of frequent disturbances or machine timedown is mainly:

- Breakage of tooth of idler wheel,
- Very big wear of teeth of rack bar (Eicotrack),
- Big deformation of rack bar.

Elimination of machine timedown and disturbances

Relatively big wear of teeth of idler wheel or rack bar with breakage of tooth of idler wheel is big problem. Attrition of same material depends on a contact pressure between two catch parts. Pressure is determined by tensile of haulage unit or by his power. This power increases when I wrote earlier.

One of occasions to decrease this unfavourable phenomenon is also selection of advisable material. We have to choice material, which meets to sophisticated conditions with its characteristics and molecular structure. For example, idler wheel could be designed by designer and technologist to acceptable admeasurement and at the same time has to be abrasionless, hard, tenacious because it is ensemble loaded by dynamic forces.

In primary line, it is construction design of catch components, which affected length of frictional areas of driving elements. For example figure 1. shows catch of idler wheel with roller rack bar used just now at coal deep mines.

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(Reviewed, revised version received August 15, 2002)

It is position, when axis of rack bar's rollers is tangent to basic circle of idler wheel's teeth. From catch theory of evolvent gear we know, that normal of immediate catch of idler wheel with rack bar's rollers is congruent to common normal of all phases of gradual catch of idler wheel and roller. However, it stands good only for "ideal" position [Semenov, 1988]. Mangers of face conveyor can skew itself at horizontal plane due to foot-wall indirectness. Therefore we can't keep idler wheel at same plane (required by constructor) owing to a few factors such as quantity wear of shearer guides, quantity wear of rack bar – reason about tooth breakage, distance catch point of idler wheel with rack bar from the shearer guides, foot-wall indirectness atc. During change of axis distance of together catching parts (Figure 2), decrease catch length and particular phases already haven't coincident normal. It lead up to bigger dynamic loading of components and herewith whole shearer and to bigger wear of catch areas too.

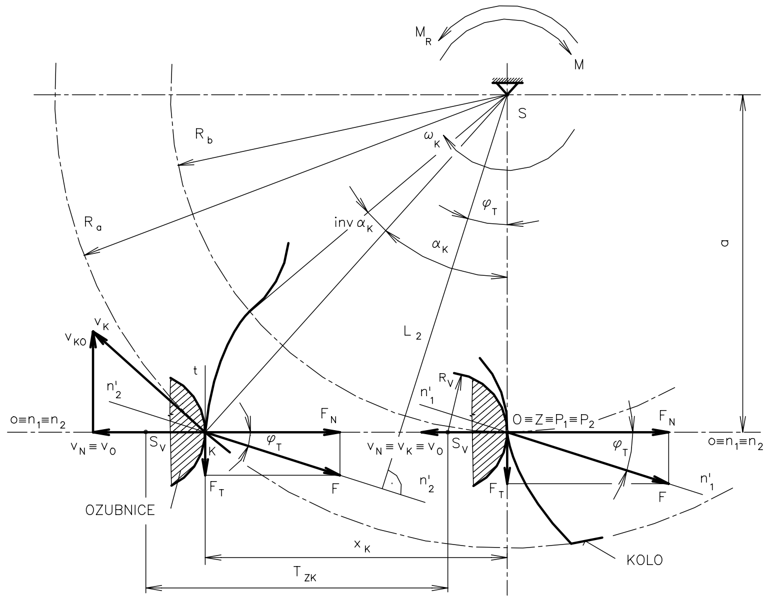

Fig. 1 „Ideal" position.
Obr. 1 Ideální pozice.

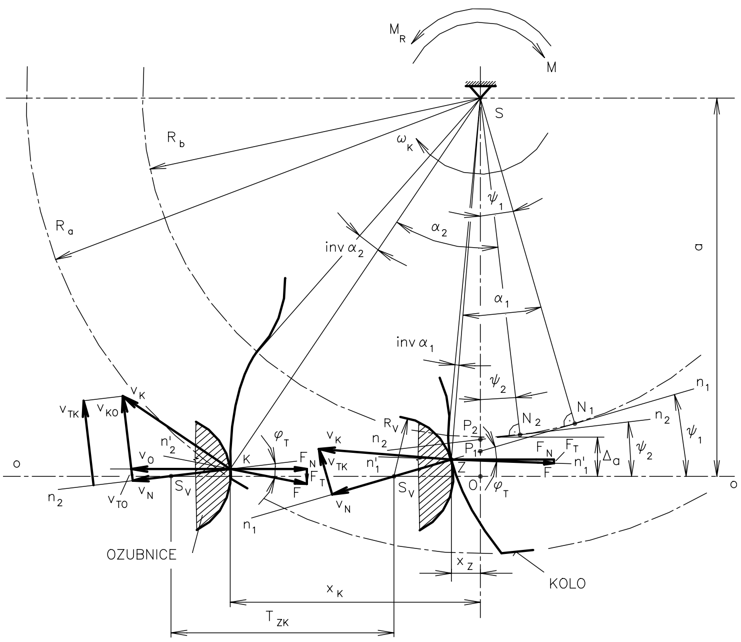

Fig. 2 Abaxial position.
Obr. 2 Vyosené kolo.

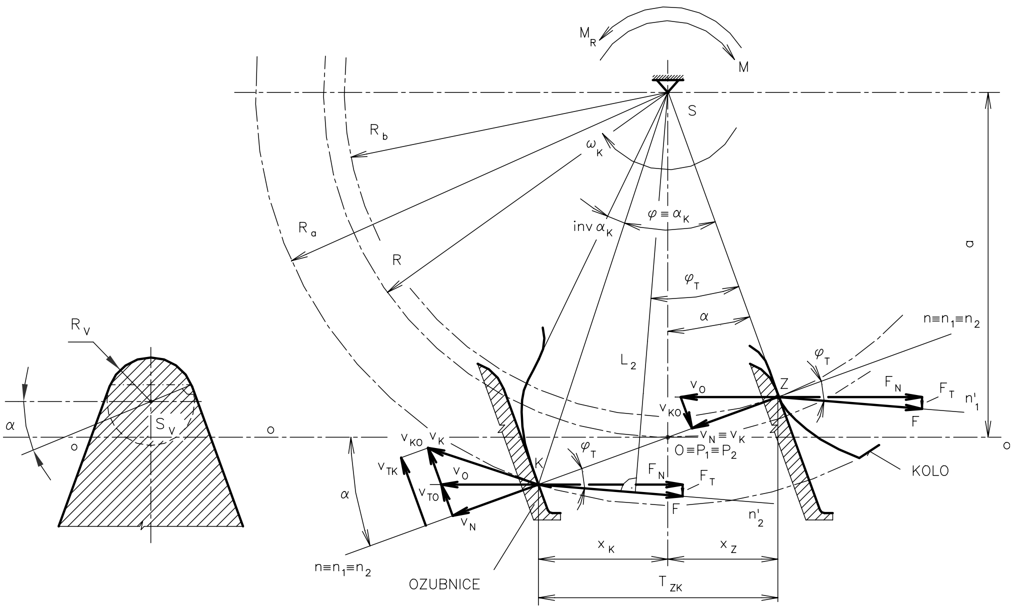

Fig. 3 Basic teeth profile.
Obr. 3 Základní profil ozubení

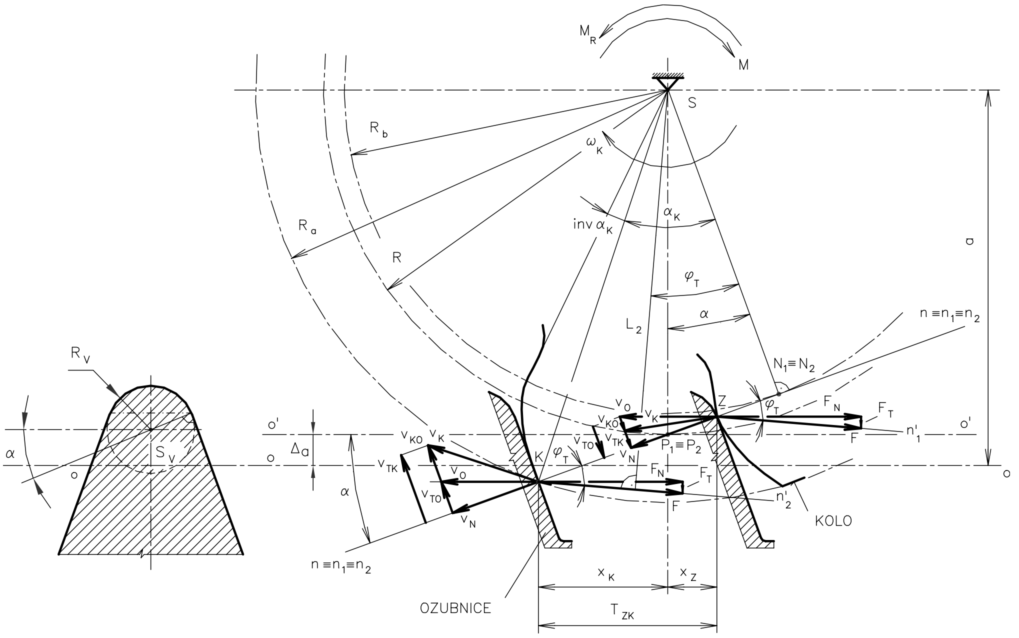

Fig 4 Combined teeth profile.
Obr. 4 Kombinovaný profil ozubení.

This ineligible phenomenon can be eliminated by rack bar design so-called basic profile (Figure 3). From knack we know, that basic profile is used to matching of evolvent cog-wheel, when teeth of this profile makes cog-wheel by rectilinear back cutting motions. We know, that we have radius of spacing circle which is lead up to infinity, evolvent gearing melted to cog axis and evolvent cog cheek melted to straight line bowed from cog axis by catch angle a. Big advantage catch of idler wheel with so designed rack bar would be relatively stepless motion with smallish cog cheek wear or rack bar wear.

Other advantage is biggish insensitive to abaxial of together catching parts, because common normal of sequential catch simply shift together with idler wheel by a distance.

It has big problem. When come to bigger push out then is definite boundary, can come to clash rack bar with idler wheel. It can't happen at circle cross section of rack bar teeth.

This problem I solve by combined profile of rack bar like is showed at Figure 4. It is coalescence advantages of basic profile (Figure 3.) and roller profile of rack bar. It has advantage, owing to basic profile herein, that upon push out of definite boundary of together catching parts will not come to clack rack bar with idler wheel. Other advantage of this profile is cylindrical parts of tooth head profile. While it, when longwall shearer go down with idler wheel, toward to foot-wall, root of teeth are "settled" to mentioned roller profile of rack bar. Thereby forces are fixed and translated by mangers of face conveyor to foot-wall. While it we crossover this critical mine locality and at the same time with generating of two cylindrical surface comp by rolling friction, which is definitely most favourable, relate to wear, than shear friction.

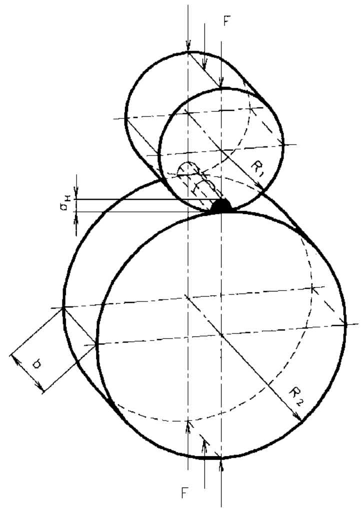

Fig. 5 Hertz´s pressure.
Obr. 5 Hertzovy tlaky.

Pressure between together catching teeth

Transfer of twisting moment by gearing and his forces contact between teeth is went together with tension concentration at contact place of together catching parts (Figure 5). Dimension of this parameter has direct effect to gearing lifetime, scilicet from point of view wear and fatigue wear teeth working surfaces - pitting.

We can make parameter k_H (1) which is ratio between Hertz's pressure of used rack bar and same pressure of new type (combined) rack bar, upon same condition of teeth mash. It says, how much times is pressure in contact points of used gearing biger then pressure in contact points of combined gearing.

$$k_H = \frac{\sigma_{Hc}}{\sigma_{He}} = \frac{\sqrt{\dfrac{\dfrac{F}{b}\cdot\left(\dfrac{1}{R_{1c}}+\dfrac{1}{R_{2c}}\right)}{\pi\cdot\left(\dfrac{1-\mu_{1c}^2}{E_{1c}}+\dfrac{1-\mu_{2c}^2}{E_{2c}}\right)}}}{\sqrt{\dfrac{\dfrac{F}{b}\cdot\left(\dfrac{1}{R_{1e}}+\dfrac{1}{R_{2e}}\right)}{\pi\cdot\left(\dfrac{1-\mu_{1e}^2}{E_{1e}}+\dfrac{1-\mu_{2e}^2}{E_{2e}}\right)}}} = \frac{k\cdot\sqrt{\left(\dfrac{1}{R_{1c}}+\dfrac{1}{R_{2c}}\right)}}{k\cdot\sqrt{\left(\dfrac{1}{R_{1e}}+\dfrac{1}{R_{2e}}\right)}} = \sqrt{\frac{R}{R_{1c}}+1} \tag{1}$$

It is logical, that mentioned formula is acceptable upon conditions same materials constants and same constructional and force parameters aboard both type of teeth (constant k in the formula). Radius of kog-rail tooth infinitively large $R_{1e} \Rightarrow \infty$, which results from its constructional, and radius of tooth profile of idler wheel is taken for constant (R in the figure) together. From the figure we can see, if tooth radius of rack bar decrease, pressure between together matching teeth increase (parameter k_H increase). While it increase wear in the gearing. For example, concrete for this time used teeth of rack bar with radius $R_{1e} = 25\text{mm}$ and immediate radius of idler wheel evolvent profile $R = 50$ (this is tooth profile curve at heel areas, where are maximal pressures) we get:

$$k_H = \sqrt{\frac{R}{R_{1c}}+1} = \sqrt{\frac{50}{25}+1} = \sqrt{3} = 1{,}73 \tag{2}$$

We can say, that at this location is contact pressure of used rack bar 1,73 times bigger then contact pressure of new type – combined rack bar. For it, new rack bar will be has smallish wear of together matching parts.

Effect of shearer sumping

We can use any profile of rack bar profile, but when shearer will not be goes on direct face conveyor, it is no very good. Upon now used sumping, shearer goes on curve conveyor. Therefore is angle between together matching teeth (figure 6). This condition is not very good for pressure and wear of the teeth.

We have to use other – new type of shearer sumping. For example "drilling" - type of shearer sumping not used at our area (Figure 7) (Syd S.P., 1994). When we use this type of shearer sumping, shearer will be goes on curve less face conveyor.

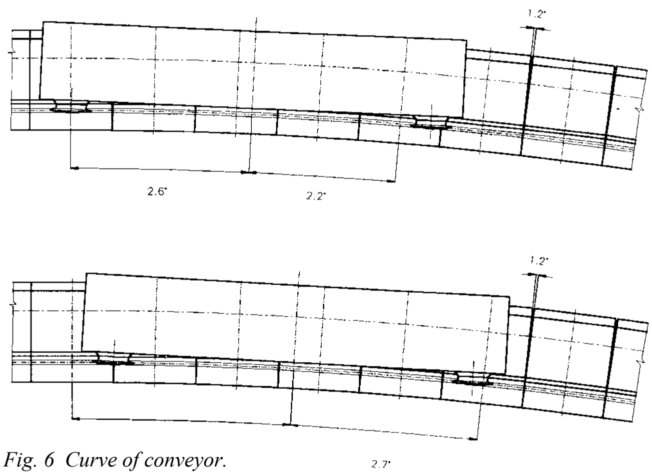

Fig. 6 Curve of conveyor.
Obr. 6 Zakřivení dopravníku.

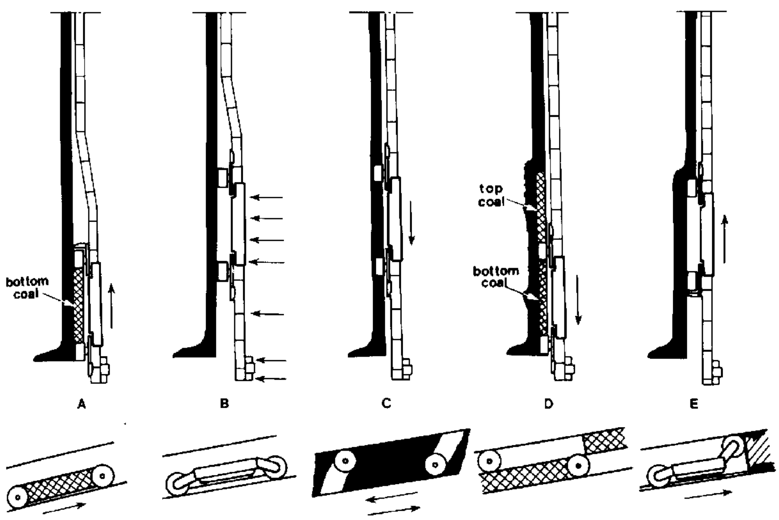

Fig. 7 Drilling – sumping of longwall shearer.
Obr. 7 Zabrázdění - zavrtávání kombajnu.

Conclusion

This article is only brief foretoken of problems, which are now solved by mining engineers. It is difficulty to say, what mentioned problem is greater, bat we know that stopped face no extract coal, decrease work productivity, no standing to plane and worsening finance relations at coal deep mine. While it, we have to work heavily on these problems, and solve it successful.

Special computing software will help us at it. I think, that advisable software and practical, theoretic and constructional accomplishment at any branch lead to technical progress.

Literature

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