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GENERAL PROBLEMS IN THE MODERNIZATION OF MINE CONVEYANCE

OPŠTI PROBLEMI PRI MODERNIZACIJI RUDNIČKOG TRANSPORTA

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Abstract: *The conveyance of mineral raw materials is one of the most important technological stages in the operation of a mine. In the course of time, conveyance equipment is worn out, technologies become obsolete, accidents happen etc. In such occasions it is necessary to modernize the equipment in terms of introducing new technologies and equipment. In introducing new conveyance technologies certain problems may occur. This paper deals with general issues that are present when introducing new technologies in the modernization of ore conveyance.*

Key words: *mine conveyance, modernization, problems*

Apstrakt: *Transport mineralnih sirovina je jedna od najvažnijih tehnoloških faza u radu rudnika. Vremenom dolazi do istrošenosti opreme za transport, zastarelosti tehnologija, havarija i sl. Tada je potrebno izvršiti njegovu modernizaciju u smislu uvođenja novih tehnologija i opreme. Prilikom uvođenja novih tehnologija transporta javljaju se određeni problemi. U ovom radu se razmatraju opšti problemi koji su prisutni pri uvođenju novih tehnologija pri modernizaciji transporta mineralnih sirovina.*

Ključne reči: *rudnički transport, modernizacija, problemi*

1 INTRODUCTION

Considering the requirements of a modern society, the production of mineral raw materials has to be cost-effective, safe, reliable and with a high environmental protection. In order to realize this, it is necessary to tend towards an optimal solution in each technological stage.

The conveyance of mineral raw materials falls into a group of the most significant technological stages of the mine exploitation. However, it is a common observation that there is not enough attention given to the mine haulage and hoisting, that is, they do not have an adequate treatment, in conformity with their role. There are certain

1 UVOD

S obzirom na zahteve savremenog društva neophodno je da proizvodnja mineralnih sirovina bude ekonomična, sigurna, pouzdana i da ima visok stepen zaštite životne sredine.Da bi se to ostvarilo potrebno je da se u svakoj tehnološkoj fazi teži optimalnom rešenju.

Transport mineralnih sirovina spada u najvažnije tehnološke faze rudničke eksploatacije. Međutim, opšta je konstatacija da se rudničkom transportu i izvozu ne posvećuje dovoljna pažnja, odnosno da nema adekvatan tretman, shodno ulozi koju ima. Za to postoje objektivni, ali i subjektivni,

impartial, but also subjective reasons for that, which hold back the application of new conveyance technologies. This is especially typical for the Serbian mining industry.

The objective of this paper is to point out to problems arising when introducing new technologies of the conveyance of mineral raw materials. Thereat the limitation is made only to common issues and to the categorization of problems, because otherwise much more space and time would be needed.

razlozi koji usporavaju primenu novih tehnologija transporta. Ovo je naročito karakteristično za rudarstvo Srbije.

Cilj ovog rada je da ukaže na probleme koji nastaju prilikom uvođenja novih tehnologija transporta mineralnih sirovina. Pri tome se vrši ograničenje samo na opšte pojave i grupisanje problema, jer u suprotnom bi bilo potrebno mnogo više prostora i vremena.

2 THE MOST SIGNIFICANT PROBLEMS IN THE MODERNIZATION OF CONVEYANCE TECHNOLOGIES

The condition of the conveyance in most of mines, regardless if mineral raw materials are extracted via underground or surface mining, is such that it requires urgent interventions. In some cases, it refers to minor system reconstructions, sometimes a comprehensive revitalization is required, with replacements of some parts of the system, and in most cases it is necessary to introduce new conveyance technologies.

Obsolete conveyance technologies, especially in mines with longer prospects of exploitation, hold back the development, having increased costs. Conveyance technologies generally are to be modernized after the expiry of the amortization term, that is, during the replacement of amortized means it is advisable to introduce new conveyance technologies along with the adequate equipment. This is inevitable, especially for new stationary conveyance systems, of which the useful life exceeds 10 years and which in this period have to meet all of the requirements in regard to cost-effectiveness, reliability, safety and environmental protection.

When introducing new technologies, in mines under Serbian conditions, but also under conditions of most of South-East European countries, certain problems may arise that is sometimes very difficult to overcome. These problems may be, in general, classified into three categories:

- Finance-related problems,
- Problems resulted from natural and technical conditions and
- Subjective problems.

2 NAJVAŽNIJI PROBLEMI PRI MODERNIZACIJI TEHNOLOGIJA TRANSPORTA

Stanje transporta u većini rudnika, bez obzira na to da li se mineralne sirovine eksploatišu podzemnim ili površinskim putem, je takvo da zahteva hitne intervencije. U nekim slučajevima se to odnosi na manje rekonstrukcije sistema, nekad je neophodna temeljna revitalizacija, sa izmenama pojedinih delova sistema, a u dosta slučajeva je potrebno uvesti nove tehnologije transporta.

Zastarele tehnologije transporta, naročito kod rudnika sa dužom perspektivom eksploatacije predstavljaju kočnicu razvoja, uz povećane troškove. Tehnologije transporta, po pravilu, treba modernizovati nakon isteka veka amortizacije, odnosno, pri zameni amortizovanih sredstava poželjno je uvoditi nove tehnologije transporta uz odgovarajuću opremu. Ovo je neminovnost, posebno za nove stacionarne transportne sisteme, čiji vek trajanja prelazi 10 i više godina i koji mora u tom periodu da zadovolji sve zahteve u pogledu ekonomičnosti, pouzdanosti, sigurnosti i zaštite životne sredine.

Prilikom uvođenja novih tehnologija u srpskim uslovima, ali i u uslovima većine zemalja u jugpistočnoj Evropi, javljaju se određeni problemi koje je ponekad veoma teško savladati. Ovi problemi se mogu svrstati, generalno, u tri grupe:

- problemi finansijske prirode,
- problemi usled prirodnih i tehničkih uslova i
- subjektivni problemi.

In each of these categories there are a number of problems. In order to solve or moderate these problems it is crucial to be aware of them.

Financial problems. The Golden Age of the European mining industry has obviously gone and the focus of ore exploitation is moved to African and South-American countries, together with the expansion of the Australian mining industry. Investments in the exploitation of mineral deposits in Europe made by powerful financial companies are increasingly rare. Large oscillations in prices of metallic mineral raw materials and the Global Financial Crisis additionally aggravate the current situation. Mine conveyance shares the destiny of the overall mining industry, and in many cases it is at the bottom of the priority list of mining companies.

Financial problems arise in all segments related to new haulage and hoisting technologies in mines, namely:

- At the stage of finding new solutions,
- At the stage of producing new means and devices,
- At the stage of applying new conveyance technologies in mines.

The lack of financial assets considerably reflects on reducing the search for new solutions. Most of specialized science-research institutions, engaged in finding new solutions in the field of mining mechanization and thereby conveyance, have reduced their activities, and some of them almost discontinued their operations. A certain number of researches are still being made by large equipment manufacturers, and new modern technology solutions are, in most cases, the result of the work of development departments of these companies.

Equipment manufacturers also rarely opt for conquering new products, at the stage of production, due to uncertain sale conditions and prospects of large-scale use of such products. It is interesting that the primacy of Europe in producing modern technology equipment is endangered by non-European countries, even countries which were only few decades ago unknown in the mining equipment market.

The biggest financial problems arise at the stage of applying new conveyance technologies. Mines chronically have problems with investments which are consequently minimized. To this end,

U svakoj od ovih grupa se javlja više problema čije je poznavanje presudno za njihovo otklanjanje ili ublažavanje.

Finansijski problemi. Zlatno doba evropskog rudarstva je evidentno prošlo i težište eksploatacije mineralnih sirovina se premešta u afričke i južno-američke zemlje, uz ekspanziju australijskog rudarstva. Ulaganja u eksploataciju ležišta mineralnih sirovina u Evropi, od strane moćnih finansijskih kompanija, postaju sve ređa. Velike oscilacije cena metaličnih mineralnih sirovina i svetska finansijska kriza, dodatno pogoršavaju dosadašnje stanje. Rudnički transport deli sudbinu celokupnog rudarstva, a u dosta slučajeva nalazi se pri dnu liste prioriteta u rudarskim preduzećima.

Finansijski problemi se javljaju u svim segmentima vezanim za nove tehnologije transporta i izvoza u rudnicima i to:

- u fazi istraživanja novih rešenja,
- u fazi izrade novih sredstava i uređaja,
- u fazi primene novih tehnologija transporta u rudnicima.

Nedostatak finansijskih sredstava u znatnoj meri se odražava i na redukciju istraživanja novih rešenja. Većina specijalizovanih naučno-istraživačkih institucija, koje se bave traženjem novih rešenja u oblasti u oblasti rudničke mehanizacije a samim tim i transporta, smanjile su aktivnosti, a neke su skoro i prestale sa radom. Određeni broj istraživanja se radi još kod većih proizvođača opreme, a nova savremena rešenja tehnologije, su u većini slučajeva posledica rada u razvojnim sektorima tih kompanija.

Proizvođači opreme se takođe u fazi proizvodnje ređe odlučuju za osvajanje novih proizvoda zbog neizvesnih uslova prodaje i perspektiva šire primene tih proizvoda. Karakteristično je da je primat Evrope u proizvodnji opreme za savremene tehnologije ugrožen od strane vanevropskih zemalja, pa čak i zemalja koje su do pre neku deceniju bile nepoznate na tržištu rudarske opreme.

Najveći finansijski problemi nastaju u fazi primene novih tehnologija transporta. Rudnici hronično imaju problema sa investicijama i svode ulaganja na najmanju moguću meru. U tom

they usually search for solutions requiring minimum investments, regardless of increased specific costs. Generally, new technologies represent more expensive solutions and this additionally complicates their application. Under such conditions, mines opt for older technologies with minor investments or for the rehabilitation of the existing systems. In Serbian mining industry, the most attention is traditionally given to the mining technology, where objectively the problems are the largest, and therefore the investments are mostly directed there. This is another reason why investing in new technologies of mine haulage and hoisting is falling behind.

Problems resulted from natural and technical conditions. Starting from the fact that every deposit is specific and that, virtually, two mines are never the same, we can identify problems in applying certain defined technologies. Most of the current new technologies are taken from other industries and developed for the conveyance of mineral raw materials. The development of these technologies, regardless of adjustments to new loads and conditions, cannot completely include all the influencing factors. The problems from this category may arise:

- Due to natural conditions,
- Due to an inadequate mine infrastructure,
- Due to incompatible neighbouring systems etc.

Natural conditions, related to a deposit or to the environment, define considerably a conveyance technology. The biggest mistake that a decision-maker (investor or designer) can make is to place the best and the state-of-the-art technology into inadequate natural conditions. Many years' exploitation of mineral raw materials led to that the majority of high-quality deposits were already depleted, that we can expect mining of increasingly deep and poor deposits, and this aggravates the conditions under which the broken ground is to be transported.

In addition to geological conditions (quality, depth, deposit dip, rock strength, content of gas, hydro-geological circumstances etc.), geographic, weather and other circumstances also influence on the application of new technologies. Altitude, geographic position, climate etc., restrain the application of conveyance technologies which, under some other conditions, proved to be optimal. The same conveyance technology and

smislu, obično se traže rešenja koja zahtevaju najmanja ulaganja, bez obzira na povećane specifične troškove. Po pravilu, nove tehnologije predstavljaju skuplja rešenja i to dodatno otežava njihovu primenu. U takvim uslovima rudnici se opredeljuju za starije tehnologije sa manjim ulaganjima ili revitalizovanje postojećih sistema. U rudarstvu Srbije najviše pažnje se tradicionalno posvećuje tehnologiji otkopavanja, gde objektivno i postoje najveći problemi, pa se i ulaganja usmeravaju uglavnom tamo. To je još jedan razlog zaostajanja investiranja u nove tehnologije rudničkog transporta i izvoza.

Problemi usled prirodnih i tehničkih uslova. Polazeći od činjenice da je svako ležište specifično i da, praktično, ne postoje dva ista rudnika, mogu se konstatovati problemi kod primene određenih definisanih tehnologija. Većina sadašnjih novih tehnologija je preuzeta iz drugih grana privrede i razvijena za transport mineralnih sirovina. Razvoj ovih tehnologija, bez obzira na adaptaciju za nove terete i uslove, ne može u potpunosti obuhvatiti sve uticajne faktore. Problemi iz ove grupe mogu nastati:

- usled prirodnih uslova,
- usled neadekvatne infrastrukture rudnika,
- usled nekompatibilnih susednih sistema i dr.

Prirodni uslovi, bilo da su vezani za ležište, bilo za okruženje, u značajnoj meri određuju tehnologiju trensporta. Najveću grešku može napraviti donosilac odluke (investitor ili projektant) koji pokuša da najbolju i najsavremeniju tehnologiju transporta smesti u neadekvatne prirodne uslove. Dugogodišnja eksploatacija mineralnih sirovina dovela je do toga da je većina kvalitetnijih ležišta, već iscrpljena, da predstoje otkopavanja sve dubljih i sve siromašnijih ležišta, što pogoršava uslove u kojima treba transportovati iskopinu.

Pored geoloških uslova (kvalitet, dubina, pad ležišta, čvrstoća stena, gasonosnost, hidrogeološke prilike i sl.) na primenu novih tehnologija transporta utiču i geografske, klimatske i druge prilike. Nadmorska visina, geografski položaj, klima i sl. ograničavaju primenu tehnologija transporta koje su se u nekim drugim uslovima pokazale kao optimalne. Ne mogu se ista tehnologija transporta i oprema

equipment cannot be applied in open-pit mines of Jakutija with the same success as in those of Zambia.

An inadequate mine infrastructure is a result of various stages in a mine development, as well as the lack of synchronization in the development of the mine and its environment. A typical example for that are underground coal mines in Serbia, where a series of short inadequate tunnels, with frequent changes in directions under sharp angle, leads to the face. In open-pit coal mines, mines of metallic and non-metallic raw materials too, due to different development levels and the non-existence of a unique concept of opening and mining, the built-up infrastructure represents a restrictive factor. It is not rare to build a completely new infrastructure when introducing new conveyance technologies.

Haulage and hoisting technologically rely on surrounding systems like exploitation and dumping, that is, the preparation and treatment of mineral raw materials. Introducing new conveyance technologies makes sense only if advantages arisen from them can be followed by surrounding technological systems. Even the most efficient conveyance system becomes pointless if the mining technology is obsolete and the utilization of the conveyance, caused by delays of mining systems, is minimal. This issue of adjusting mining and conveyance is a very complex one and it is dealt by many research teams, especially for the needs of open-pit mines of metallic and non-metallic mineral raw materials.

Subjective problems. A large portion of difficulties when introducing new conveyance technologies also pertains to so-called subjective problems. This category of problems is mostly related to the management of mines and mining exploitation companies and they are the following:

- Problems related to the traditionalism,
- Resistance due to the unprofessionalism and the lack of information,
- Problems due to personal interests etc.

The traditionalism represents one of big advantages in mining industry but, in some cases, it is a disadvantage. In regard to introducing new conveyance technologies it is not rare that the resistance arises from conscious or unconscious tendency of the management to keep the existing conveyance methods, and eventually replace

sa istim uspehom primeniti na površinskim kopovima Jakutije i Zambije.

Neadekvatna infrastruktura rudnika je posledica različitih faza u razvoju rudnika, kao i nedostatak sinhronizacije u razvoju rudnika i okruženja. Tipičan primer za to su podzemni rudnici uglja u Srbiji, kod kojih do otkopa vodi niz kratkih neadekvatnih podzemnih prostorija sa čestim promenama pravca pod oštrim uglovima. Na površinskim kopovima uglja, metaličnih i nemetaličnih mineralnih sirovina, takođe, zbog različitih stepena razvoja i nepostojanja jedinstvene koncepcije otvaranja i eksploatacije, izgrađena infrastruktura predstavlja ograničavajući faktor. Nije redak slučaj da se pri uvođenju novih tehnologija transporta izgradi i potpuno nova infrastruktura.

Transport i izvoz se tehnološki oslanjaju na susedne sisteme kao što su otkopavanje i deponovanje, odnosno priprema i prerada mineralnih sirovina. Uvođenje novih tehnologija transporta ima smisla samo ako prednosti, koje pri tome nastaju, mogu da otprate i susedni tehnološki sistemi. Najefikasniji transportni sistem postaje bespredmetan ako je tehnologija otkopavanja zastarela i iskorišćenje transporta, usled zastoja otkopnih sistema, bude minimalno. Ovaj problem usklađivanja otkopavanja i transporta je veoma kompleksan i njime se bave čitave ekipe istraživača, naročito za potrebe površinskih kopova metaličnih i nemetaličnih mineralnih sirovina.

Subjektivni problemi. Znatan udeo u teškoćama pri uvođenju novih tehnologija transporta čine i tzv. subjektivni problemi. Ova grupa problema vezana je uglavnom za menadžment rudnika i kompanija koje se bave rudarskom eksploatacijom i sastoji se od:

- problema vezanih za tradicionalizam,
- otpora usled nestručnosti i neobaveštenosti,
- problema usled ličnih interesa i dr.

Tradicionalizam spada u velike prednosti u rudarstvu, ali u nekim slučajevima to je i nedostatak. U pogledu uvođenja novih tehnologija transporta nije redak slučaj da se otpori javljaju usled svesne, ili nesvesne, težnje rukovodstva da se zadrže postojeći načini transporta, uz eventualnu zamenu amortizovane

amortized equipment with the same or similar types. The reasons for that are allegedly in the practice and training of managers, lower maintenance costs, short trial period etc. The real reasons often lie in "going with the flow" and in the fear of unknown new technologies. The psychological moment is not either negligible, because the managerial structures, as young engineers, "grew up" with these technologies and are emotionally attached to them.

In certain mine managerial structures, sometimes positions are held by persons who are not sufficiently qualified or competent for. This is aggravated, to a large extent, by some laid down rules of hierarchical advancement, so in conveyance-related positions there are experts who are specialized for other fields. It is typical, but not very rare that, for the purchase of one conveyor, a team of sales specialists travels abroad, but without a conveyance expert.

It is frequent that mining experts are not very informed about new achievements in mining industry An analysis has shown that Serbian mines obtained les than 2% and design bureaus about 5% of relevant professional journals dealing with mining mechanization and conveyance issues. One of ten engineers in the operative unit follows new achievements in mining engineering. There are some extreme cases, but still present, that some engineers vaunted of that they had not read a single professional publication in the past 20 years. The lack of information about development trends in the field of new technologies and equipment represents a serious problem in Yugoslav mining industry.

In such cases, where the replacement of old equipment or adoption of a conveyance technology and equipment for new systems become necessary, the final word is given to equipment manufacturers. They are often reputable manufacturers warranting the quality of their products. However, interests of equipment manufacturers and users are not always the same. A manufacturer generally wants to make a good sale of the old technology, offering favourable financial conditions, loans, guarantee periods etc. It is hard to resist such attitude and offers if decision-makers are not completely and professionally prepared and informed.

opreme istim ili sličnim tipovima. Razlozi za to se traže i nalaze u uhodanosti i obučenosti rukovodilaca, nižim troškovima održavanja, skraćenom probnom radu i sl. Stvarni razlozi često leže u liniji manjeg otpora i u strahu od nepoznatih novih tehnologija. Tu nije zanemarljiv ni psihološki momenat, jer su rukovodeće strukture, kao mladi inženjeri, stasavali uz te tehnologije i emotivno su vezani za nih.

U određenim strukturama rukovodstva rudnika ponekad su prisutne i pojave obavljanja poslova za koje nisu dovoljno osposobljeni ili stručni. Tome, u znatnoj meri, doprinose uvrežena pravila hijerarhijskog napredovanja, pa se na poslovima vezanim za transport nađu i stručnjaci koji su se specijalizovali za druge oblasti. Karakterističan je, ali ne tako redak primer, da za kupovinu jednog transportera u inostranstvo putuje tim komercijalista, ali bez stručnjaka za transport.

Hronična pojava je da su stručnjaci u rudarskoj privredi veoma malo obavešteni o novim dostignućima u rudarstvu. Jednom analizom je utvrđeno da u srpske rudnike dolazi manje od 2% a u projektantske organizacije oko 5% relevantnih stručnih časopisa koji obrađuju problematiku rudničke mehanizacije i transporta. Svaki deseti inženjer u operativi prati nova dostignuća u rudarskoj tehnici. Ekstremni su slučajevi, ali i prisutni, da se pojedini inženjeri hvale kako poslednjih 20 godina nisu pročitali ni jednu stručnu knjigu. Neobaveštenost o trendovima razvoja novih tehnologija i opreme predstavlja ozbiljan problem u jugoslovenskom rudarstvu.

U takvim slučajevima, kada dođe do neophodnosti zamene stare opreme ili usvajanja tehnologije transporta i opreme za nove sisteme, glavna reč se prepušta proizvođačima opreme. To su često renomirani proizvođači koji garantuju kvalitet svojih proizvoda. Međutim, interesi proizvođača i korisnika opreme ne poklapaju se uvek. Proizvođač, po pravilu, želi da dobro proda stariju tehnologiju, nudeći povoljnije finansijske uslove, kredite, garantne rokove i sl. Ovakvim nastupima i ponudama se teško može suprostaviti ako donosioci odluke nisu u potpunosti stručno pripremljeni i obavešteni.

Personal interests have also an important role when purchasing conveyance equipment. This issue is sometimes overrated, and often underrated, but it cannot be neglected. Every decision-maker, when selecting a new technology or equipment, is exposed to a little or big pressure of manufacturers or sellers of such equipment. In these cases certain conveniences are offered, like visiting other mines and facilities, getting introduced with similar technologies and equipment, or even personal favours. There are no exact data on the degree of influence of personal interests on a decision-maker, but they must not be underrated. Some solutions in selecting technologies and equipment, in not so distant past, indicate this.

Problems arising when introducing new conveyance technologies and equipment cannot be solved in a short period of time. Their elimination should be a constant ongoing process, and measures to be taken are various and depend on the cause of the problem. In any case, measures for problem elimination should be directed to the creation of an environment for the objective problems to be eliminated or mitigated and for the influence of subjective problems to be minimized.

Lični interesi pri nabavci opreme za transport imaju takođe važnu ulogu. Ponekad se to pitanje precenjuje, a često i potcenjuje, ali se ne može zanemariti. Svaki donosilac odluke u fazi rada na izboru nove tehnologije ili opreme izložen je manjem ili većem pritisku proizvođača ili prodavca te opreme. U takvim slučajevima nude se određene pogodnosti, od poseta drugim rudnicima i objektima, upoznavanja sa sličnim tehnologijama i opremom, do ličnih usluga. Ne postoje egzaktni podaci o stepenu uticaja ličnih interesa donosioca odluke, ali se oni ne smeju potceniti. Neka rešenja pri izboru tehnologija i opreme, u ne tako dalekoj prošlosti, ukazuju upravo na to.

Problemi koji se javljaju pri uvođenju novih tehnologija i opreme za transport ne mogu se rešiti u kratkom periodu. Njihovo otklanjanje treba da bude proces koji se stalno odvija a mere koje treba preduzeti su različite i zavise od uzroka problema. U svakom slučaju, mere za otklanjanje problema treba usmeriti na stvaranje ambijenta da se otklone ili ublaže objektivni problemi i da se maksimalno smanji uticaj subjektivnih problema.

3 CONCLUSION

The conveyance of mineral raw materials, as one of the most significant stages in mining industry, requires constant improvement. Problems arising when introducing new technologies must be identified and measures for their elimination must be taken. The elimination of problems, or their reduction, needs a certain period of time and the mining profession and science must permanently work on these issues. In this way, the path to a successful and cost-effective exploitation of mineral deposits can be shortened.

3 ZAKLJUČAK

Transport mineralnih sirovina, kao jedna od najvažnijih faza u rudarstvu, zahteva stalno osavremenjavanje. Problemi koji se javljaju pri uvođenju novih tehnologija moraju biti definisani i preduzete mere za njihovo uklanjanje. Eliminisanje problema, ili njihovo smanjenje, zahtevaju određeni vremenski period i na tome rudarska struka i nauka moraju permanentno raditi. Na taj način se može skratiti put do uspešne I ekonomične eksploatacije ležišta mineralnih sirovina.

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