BELT CONVEYORS AND MECHANIZATION OF STORAGE PROCESS IN POLISH SURFACE MINING

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ABSTRACT

Highly efficient belt conveyors are widely utilized to transport bulk materials, In this paper the characteristics of belt conveyors applied to transport materials having granulation to 400 mm and bulk density to 3 t/rn^ are presented. Belt width is to 2.5 m, speed to 5.3 m/s, length to 6 km and capacity 22.000 t/h.

The technological system of the opencast mine Belchatow being under construction has been described including the latest construction of the belt conveyors applied there as well as assemblies and elements.

Highly efficient belt conveyors designed and produced in Poland applied at ports, steel plants and at coal handling system of power stations especially taking into account export of the belt conveyors have been discussed.

Modern storage devices have been presented, particularly two functional stacker-reclaimers.

ÖZET

Yüksek kapasiteli bant taşıyıcılar parça malzeme nakliyatı için yaygın bir biçimde kullanılmaktadır. Bu makalede parça büyüklüğü 400 mm ve yoğunluğu 3 t/m³e kadar olan malzemelerin nakliyatı için kullanılan bant taşıyıcıların özellikleri sunulmaktadır.

Belchatov açık işletmesinde yapımı devam eden teknolojik sistemler hu bölgedeki bant taşıyıcıların son durumu ile birlikte tanıtılmaktadır.

Polonya'da uretilen yüksek kapasiteli bant taşıyıcıların limanlarda, çelik endüstrisinde ve enerji santrallerine kömür naklinde kullanımları tartışılmıştır. Ayrıca, gelişmiş depolama üniteleri sunulmuştur.

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1. INTRODUCTION

The belt conveyors assure the most economical continuous transport of bulk materials (solid fuels, other minerals, building materials, earth etc)'in surface mining ,at earth works, at sea and river ports, at storage yards in building industry, at metallurgy, chemistry, power industry and at other branches of industry.

For thirty years Poltegor has been specializing in research and desing of techonoligacl lines and excavating, transporting, loading dumping plants and other similiar machines operating continuously. In this range designing of highly efficient belt conveyors takes significant place as well as designing of technologically and economically optimal systems adopted to various functions and operating conditions.

The total lenght of belt conveyors designed so far amounts to about 600 km. They operate in East Germany, Jugoslavia, Bulgaria, Turkey, Czechoslovakia, Hungary, India besides Poland.

Belt conveyors produced in Poland are characterized by the following parameters.

— granulation of material 400 mm,
— bulk density of material to 3 t/m^1,
— belt width to 2.500 mm,
— belt speed to 6.3 m/s,
— lenght of a single belt conveyor to 6000 m,
— capacity to 22000 t/h.

To meet special requirements belt conveyors of different operating characteristics are designed.

Basing on wide range of designed elements and assemblies belt conveyors adopted to required functions and operating functions and operating conditions as well as type of material are constructed. Here are mentioned:

belt conveyors for transport of loose and coarse grained materials.

— belt conveyors on foundations and bridge constructions with stationary or drawing out discharge pulley,
— Shiftable conveyors on steel sleeperers with mobile or shiftable stations.
— specially designed belt converys — mobile or reversible conveyors separating, loading etc.

2. TECHNOLOGICAL SYSTEMS IN SURFACE MINING

Stationary, mobile belt conveyors and of special construction allow to build techonological lines adopted to different geological and minning conditions.

The choice of technological system depends on: size of output, deposition of strata, depth of surface mining, kind of everburden, distance of opencast mine from receiver

In Polish lignite surface mining to remove overburden the system excavator — belt conveyor (or line of belt conveyors) — stacker is usually applied, i.e. the overburden is removed by excavators, transported by belt conveyors and dumped by stacker. However, in smaller pist where excavators having capacity to 6000 mVday two excavators feed material on one belt conveyor line and one stacker. While in bigger open pits where excavators of 100.000 mVday capacity are used one excavator feeds one belt conveyor line and one stacker. As it implies from the above mentioned facts in bigger minos monoblock system are employed.

Depending on distance between a pit and a receiver excavated coal is transported directly by belt conveyors to receiver — power station or by belt conveyors from excavator to rail wagon loading station and then by wagons.

To give an example the technological line of opencast mine Belchatow is presented. Its annual output amounts to 38 milion ton and overburden about 110 milion m^3.

Overburden and coal are mined by multi buckel excavators, To obtain high degree of works concentraiton three bucket wheel excavators (BWE) — two SchRs 4600 and one SchRs 4000 of theoretical capacity 9350 nvVh and 11.000 m^3/h are applied to remove overburden. To win coal 5 excavators S.Rs 2000 having theoretical capacity 6000 m^3/h and two bucket chain excavators (BCE) BBS 710 of theoretical capacity 1700 m^3/h. On outer dump on five levels 4 stackers AzRsB 12.500 and one AzRsB 15.400 operate. Obtaining of such high concentration and output continuity at Belchatow opencast mine is only possible due to the application of belt conveyor transport.

The designed structure of the technological system is maximally simplified and at the same time sufficiently elastic.

Several groups of belt convevors are applied in transport system as below mentioned:

1. overburden transport lines at mine with belt conveyors of belt width 2250 mm which consist of shiftable belt conveyors at the levels of excavators RchRs 4600 and SchRs 100 and of stationary belt conveyors at transport levels and chutes as well as of belt conveyors at separation station on the surface;
2. overburden-coal transport lines at pit with belt conveyors of belt width 1800 mm — from excavators SRs 2000 to separation station.
3. stacker transport lines to stackers with belt conveyor's having belt width 2250 mm,

4. coal transport lines from seperaticn station at pit to power station which include coal storage yard and loading on wagons.

In such technological lines first of all belt conveyors of belt width 1800 mm are employed. But at the coal storage yards belt conveyors which have belt width equal 2250 mm are applied.

2.1. Belt Conveyors

For the Betchatow opencast mine belt conveyors characterized by especialy high degree of standardization of assemblies and construction elements were designed.

Steel cord belts type St 3150 in carrying run are supported by articulated three idlers units having deflecting angle of side idlers 45°, at the point of taking of material handled are suported by articulated five idlers units and at return by articulated two idlers units having deflection of side idlers 10°.

The routes are built of the repeatable members of 6 m modules, set up on hollow steel sleepers. The members of stationary and mobile belt conveyors are identical but sleepers are different.

Characteristics of belt conveyors having belt width 2250 mm.

belt speed	—	5.24 m/s,
theoretical capacity	—	125 000 mVh,
power of main drives .	—	4x1000 kW,
belt type	—	St 3150,
maximal length	—	2300 m,
diameter of driving drums	—	1600 mm,
diameter of non-drivmg drums	—	1250 mm,
maximal force on belt at driving station	—	1200 kN,
construction of station	—	plate girder
weight of bench belt conveyor station	—	560 t,

Stationary founded stations are on sleepers and adjusted to shift by special transport or on foundations. Shiftable stations with crawler have own driving mechanism

Belt conveyors are equipped with loading tables underslug to excavator construction and travelling and support tripper with travelling mechanism on rail-tracks or with crawlers.

Belt conveyor having belt width 1800 mm have following characteristics:

belt speed	—	5 24 m/s,
theoretical capacity	—	8000 mVh,
power of main drives	—	(1-6) x 630 kW,
belt type	—	St 3150,
maximal length	—	4600 m
diameter of driving drums	—	1400 mm
diameter of non-driving drums	—	1000 mm,
maximal force on belt	—	900 kN,
construction of station	—	plate girder,
weight of bench belt conveyor station	—	263 t

Stationary driving station and shiftable driving station are founded on sleepers and adopted to shifting by means of crawler transport of typp TUR 500 Stationary stations on coal storage yards are founded on foundations Bench conveyors are equipped with loading tables with crawlers and own driving mechanism Separation station of coal and overburden is situated on the surface of the Betchatow open pit Its construction allows to connect each line with other and control the separation of material handled

Material mined at each bench is delivered to seperation station by eight conveyor lines situated on ramp and directed by dispatcher on appropriate receiver lines At septration station overburden io directed on dumping lines of stackers and coal on three coal lines to power station Each belt conveyor at seperation station has sliding drum head which enables to throw transported material on one of five belt conveyors Taking into account the complicated construction of seperation station and Us many yeais planned operation the area under station was covered with concrete plates

Location of belt conveyor permits bulldozers to operate without difficulty under hoppers when removing spillage and directing it to conveyors situated in tunne's

Coal route to power station cınsısts of three transport lines where belt conveyors having total length 4300 m have been applied The belts of three conveyors are reversed what portects the route to be polluted On coal route the storage yard was designed to

— assure maximal coal blending

— assure storage of coal about 500 000 ton

Near the storage yard loading station was foreseen to load wa gons with coal or other material occuring together with coal

Belt conveyors are eqcuipped with electric control system of pro tection and control as follow

— devices for measurement of force on belt,

— devices for control of belt slip on driving drums,

— switches of belt drifting and control of lubrication as well as gear temperature,
— sensors of overspillage.

Belt conveyors system will be equipped with computer control system with special regard to control and record of technilogical system states and control of coal blending.

3. ELEMENTS AND ASSEMBLIES OF BELT CONVEYORS

Basing on 30 years, experiences the majority of elements and assemblies which constitute belt conveyor have been typified. The greatest degree of repeatability the most frequent and most numerous elements and assemblies have achieved. Hre is to mentiond:

— upper idler sets,
— impact idler sets,
— return idler sets,
— members of carrying construction,
— driving drums,
— non-driving drums,
— driving sets.

3.1. Upper Idler Sets

Upper Idler Set guides belt in upper run. Articulated connection of idler set protects belt from distructive dynamic effect of lumps of transportt ed material. Construction of idlers and sealing of bearing joints enable its operation under the most difficult conditions without extra maintenance works and lubrications.

3.2. Impact Idler Sets

Five idlers articulated connected and deep trough of belt assures highly elastic set and protects efficiently from spilling of transported material at a feed points. Depending on kind of transported material impact idler may be smooth or disc (with rubber discs). At each solution special attention is paid to increase belt life.

3.3. Return Idler Sets

Double return idler sets articulated with disc idlers 10° or 15° assure rectilinear belt run. The rubber discs protect from coating of idlers by transported material that is especially important in low temperature.

3.4. Members of Carrying Constructian

Repeatable members with suspended idler sets in articulated way constitute the essential carrying element of belt conveyors. They are made of steel having increased strength with rolled sections which create closed box what assures lightweight. Depending on purpose members may be set on foundations or on steel sleepers, which allow to shift periodically.

3.5. Driving and. Non-driving Drums

Driving drums are adjusted to cooperate with one or two driving sets having apporopriate power and are mounted directly on the drum shaft.

Special grooving rubber sealing on the drum jacket assures high coeficient of friction independent of atmospheric conditions and level of pollution, The drum constuction consisting of steel jacket and cast steel bottoms connected with shoft by clamping rings assures taking of overloading caused by forces on belt which are greater than 100 t. Rolling bearing of shaft assures minimal resistance.

3.6. Driving Sets

Depending on required power of belt conveyor the appropriate number and size of set is selected. The set constitutes compact assembly of electric motor having power of 55 to 1000 kW, transmission of appropriate power and of ratio from 8-25 connected by flexible clutch with two-shoe brake.

The whole is mounted on the frame. Transmission is equipped with splash or forced lubrication system. The set is mounted on the side of transmission on the end of drum driving shaft by clamping rings at the side of motor is supported on articulated support.

4. CONVEYOR BELT

Belts are produced in Poland in wide range depending on needs and purpose of application.

Textile-rubber belts with polyamide plies (3 to 6 plies) strength of plies 200, 250 and 420 kb/cm of ply width. These belts are foreseen to transport loose materials in temperature range from —25°C to + 60°C.

Steel cord belts having to 2500 mm can operate in temperature from —30°C to +60°C. Their strength is from 1000 to 4000 kb/cm of belt width.

To connect and repair belt devices projected and produced in Poland are applied. For cold vulcanization drawbench, grinder for rasping vibrators, heating pands, heating assemblies, screw clamps, tables to preparation and repairing works are applied. For hot vulcanization vulcanizing presses are used to connect and repair belt. They are made if light alloy In press heating panels are pressed down by hydraulic servo-motor sets. Besides devices for field repairs where work centers for connecting and repairing of belts are foreseen works centers for regeneration of belts are designed The program of activities for such works may include production of various rubber elements

5. CHIFTERS FOR BELT CONVEYORS

To shift a belt conveyor a special set of devices is foreseen. Conveyors routes are shifted by shifters ı e a tractor of appropriate power equipped with special heads. Device for shifting is installed on crawler tractors having 200 - 350 kW power It consists of steel frame, boom set in articulated way on frame structure, hydraulic system for driving and control of each mechanism, line system, head for shifting and counter weight.

The shifter PP12 is adjusted to shift belt conveyors routes having width 2250 mm and has lifting capacity 120 kN horizontal force 110 kN shifting stroke 1500 mm, shifting speed from 2-10 km/h. The weight of device amounts to 8000 kg.

The heavy driving station of shiftable conveyors are moved on crawler or by means of special crawler troop-carriers At "Poltegor" the crawler troop-carrier TUR 500 was designed to shift station being mounted or operating. When the troop-carrier aproaches from the driving station its platform is jamed on the station structure and together with it lifted hydraulically. In such a way station may bo shifted in both longitudinal and transverse directions due to the possibility of rotation of platform in relation to crawlers The troop carrier h.i'. its own I.C engine connected with generator Nominal carrying capaticty is equal 500 t, speed 8 m/minute, total weight 250 t

6. HIGHLY EFFICIENT BELT CONVEYORS AT PORTS, AT METALLURGICAL WORKS, AT AGGREGATE WORKS AND AT POWER STATIONS

At sea and river ports speedy and efficient unloading and loading of great amount of loose meterials should be provided. In mechamz ation of such works highly efficient belt conveyors have been applied as well as special devices - stacker reclaimer.

Basing on specialistic assumptions of desing offices for port building "Poltegor" elaborated projects of mechanization of works in number of ports in Poland and abroad

Such devices operate in ports: in Szczecin-Swinoujscie, Gdansk, Lcvosice (CSRS) In metallurgy in Steel Plant Katowice, ore reloading station in Stawkow, coking plant Zieszowice. Enormous storage yards of ore and its concentrate, coke, floxes are equipped with conveyors designed by "Poltegor". Which have capacity in range from 1000 to 3000 t/h and belt width to 1400 mm and power of drive from 55 kW to 2x400 kW.

In opencast mine Morawica neai Kielce where year output amounts to 5 million ton of aggregate belt transport has been applied to transport from mine to processing work.

In this mine mobile crushing plant with crawler operates. Crushing plant moves along front and feeds crushed material on conveyor lines. The crushing plant is equipped with loading hopper and plate conveyor. Maximal capacity of installed hammer crusher is equal 800 t/h, size of lumps of material to 1400 mm, weight 500 t

Highly efficient belt conveyors are applied sucessfully at big power plants. Designed at "Poltegor" conveyors are used at the "Belchatov" Power Station having power 12x360 MW. The conveyors applied there have belt width 1800 mm, capacity 3000 t/h and maximal power to 2x630 kW.

7. MODERN DEVICES AT STORAGE YARDS

Number of experiences on surface mining basing on modern highly efficient devices for excavating, transport and dumping enable desing of the whole group of machines as loaders, stackers, and stack er - reclaimer which may meet requirements of modern and big storage yards of loose materials. The advantages of devices working in continuous mode over those operating periodically is greater capacity, uniform feeding of material, less differences in loads of mechanical and electric devices and significantly advantageous ratio of transported material to pay load of device and in relation to this fact less coefficient of energy consumption.

Development of such devices has taken place in Poland as well for several years

A wide range of machines made in Poland enables solution of so far complicated problem of economic technology of feeding, transport and dumping of loose materials at storage yards.

Range of machines for storage yards comprises besides mobile conveyors with crawlers and stationary belt conveyors together with

necessary auxiliary devices as travelling and loading trippers etc. as well following devices:

— belt stackers on rail-track or crawler undercarriage,

— bucket wheel reclaimer.

Two functional devices-stacker-reclaimer on rail-track under-carriage.

8. STACKING AND RECLAIMING DEVICES

Applying of combine device which calls stacker - reclaimer is the most economic solution in great many cases. Devices of this type are two functional what allows to reclaim material from storage yard and stack it.

Stacker - reclaimer is in general loader with reversible conveyor on boorn with extra travelling tripper and feeding carriage. When dumping material from travelling tripper and feeding carriage is directed by hopper embadied on belt conveyor on boom on slewing axis. In this case bucket wheel is inmobilized and rear wall of chute of bucket wheel is opened what enables throwing of material on storage yard.

When loading rear wall of chute is closed and material taken by bucket wheel is fed on conveyor which belt moves in reversive direction. In the middle of machine material goes through central hopper on conveyor at storage yard. All stacker - reclaimer driving units are fed by rubber-coated cable which is wound on drum on feeding truck

Each machanism is controled from control cab by means of press bottons on the board. The cab is equipped with connection system which enables contact with central dispatcher room at storage yard. Stacker - reclaimer modernity is obtained mainly by application of: hydraulic - elements for both luffing of bucket wheel boom and its drive. Smooth change of bucket wheel rotation is achieved by hydraulic drive what allows optimal use of rotation depending on properties oh handled material and enables adjustment of machine capacity and protection against overloading.

By means of stacker - reclaimer with regard to type of storage the following operation variants are possible:

— for passage storage yard,

— schemes on drawing included in folders.

i — dumping

ii — loading

iii — transport of material direlty to receiver omitting storage yard and machine

iv — transport of material directly to receiver omitting storage yard but also extra loading by taking from the storage yard
v — division of material on two stream, one is directed to receiver the other dumping on storage yard

— for lateral storage yard
— schemes on drawing included in folders
i — dumping
11 — loading
iii — transport on dumping area omitting machine in case of two machines on one rail-tract
iv — transport of material immediately to receiver omitting machine and extra loadin gat storage yard
v — transport omitting machines in case of two machines on one rail track

Independent of mentioned above possibilities stacker-reclaimers have special undercarriages by means of which it is possible to shift the machine in the perpendicular direction. It enables machine travel on other parallel rail-track on the storage yard without necessity of building expensive rail-tracks having appropriate curvature and oc cupying a lot of space, or travel of shifter

This constructional feature permits as well to reduce the number of machines in case when few types of materials are on the storage yard wchih are not taken simultanously.

Mentioned before multi-variants stacker-reclaimer operatin possibility allow to homogenize loose materials what is of great sig nificante at power stations, blast furnace process, cement plant ana other industry works

A number of examples of stacker-reclaimer application in Poland in each case indicate significant decrease of capital expenditure in range from 15 to 25 % and operation cost from 20 to 35 %. It results from high elasticity (capability of machine adjustment to changing situation), few servicing personnel, considerable utilization of storage yard space, relatively small height and dimensions in comparison with capacities obtained and high level of mechanization and automation of reclaiming and storage process