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ENERGY REQUIREMENTS AND OPTIMIZATION THE TRANSPORT ROUTE OF BELT CONVEYORS

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Abstract: *Bulk material transportation requirements have continued to press the belt conveyor industry to carry higher tonnages over longer distances and more diverse routes. In order keep up, significant technology advances have been required in the field of system design, analysis and numerical simulation. The application of traditional components in non-traditional applications requiring horizontal curves and intermediate drives have changed and expanded belt conveyor possibilities.[3]*

Key words: *energy consumption, route optimization, belt conveyor*

1 INTRODUCTION

Belt conveyor is used in all kinds of industry fields, such as electric power, coal mine, metallurgy, chemical industry, port, and architecture and food supplies. It is one of the most important devices to transport bulk material of long distance. Long distance, high speed, large capacity, high power and multi drive is the main trend. [1][2] Study on conveyor system is helpful to improve the efficiency and productivity of conveyor, guarantee safe, reliable and stable running. To choose appropriate type of conveyor is characteristic consider particularly energy requirements. Selection and location right drive and optimization the transport route of belt conveyor is important because of efficiency transporting the material in economy way and the time aspect.

2 ENERGY CONSUMPTION

Minimizing overall power consumption is a critical aspect of any project and belt conveyors are no different. Although belt conveyors have always been an efficient means of transporting large tonnages as compared to other transport methods, there are still various methods to reduce power requirements on overland conveyors. The main resistances of a belt conveyor are made up of:[3]

-Idler resistance

-Rubber indentation due to idler support
-Belt flexure due to sag being idlers

These aspects and more secondary resistances, force to negotiate the gravity, increase energy requirements needed for transport the material. In a typical in plant conveyor of 400 m length, power might be broken into this components (Chyba! Nenašiel sa žiaden zdroj odkazov.) where the largest part is lift making up.

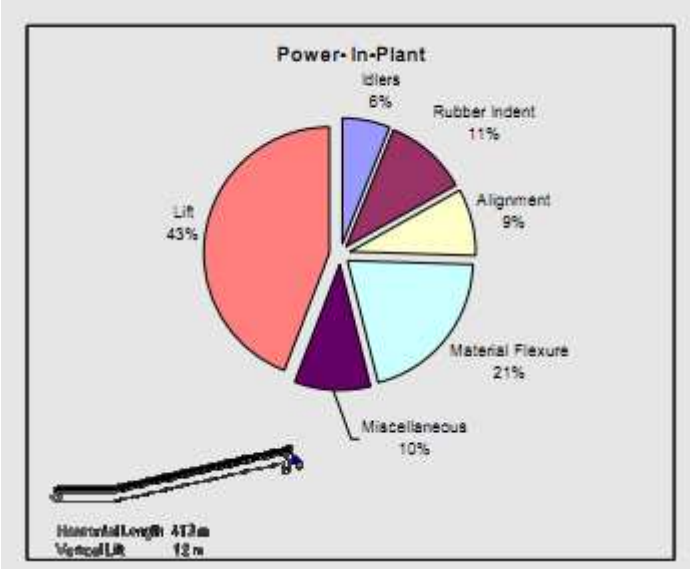


Fig. 1 *Energy consumption 1*

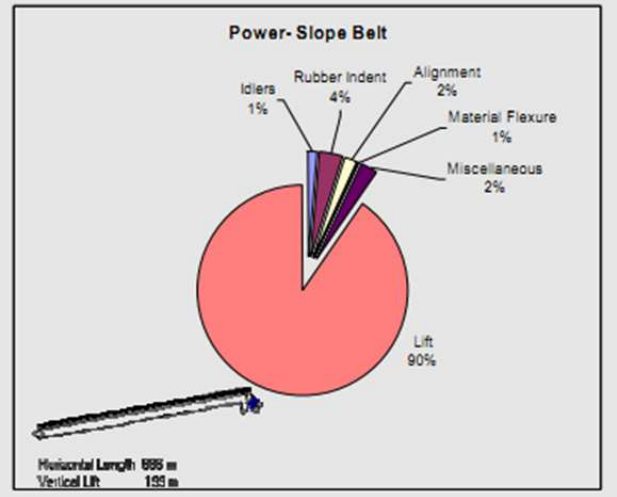


Fig. 2 *Energy consumption 2*

In a high incline conveyor, where the belt negotiates hill, the energy is divided as is shown in (Chyba! Nenašiel sa žiaden zdroj odkazov.). Since there is no way to reduce gravity forces, negotiating high incline is the main part of energy consumption. [3]

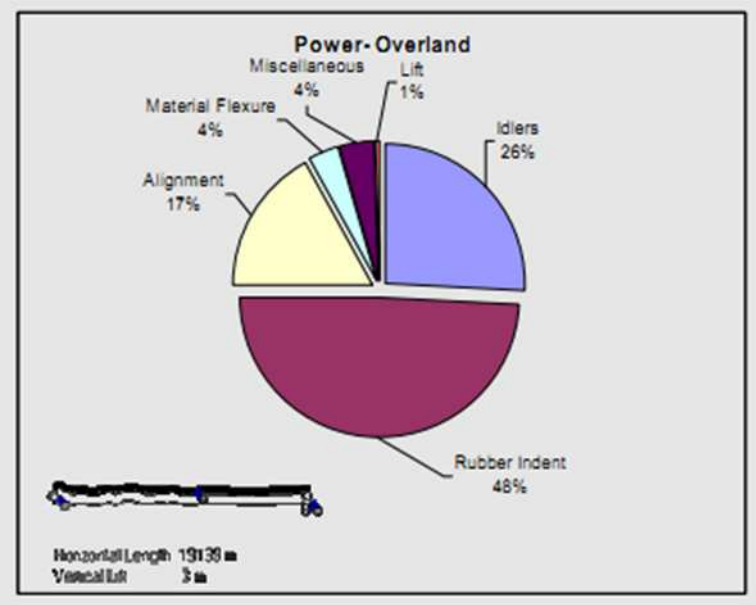
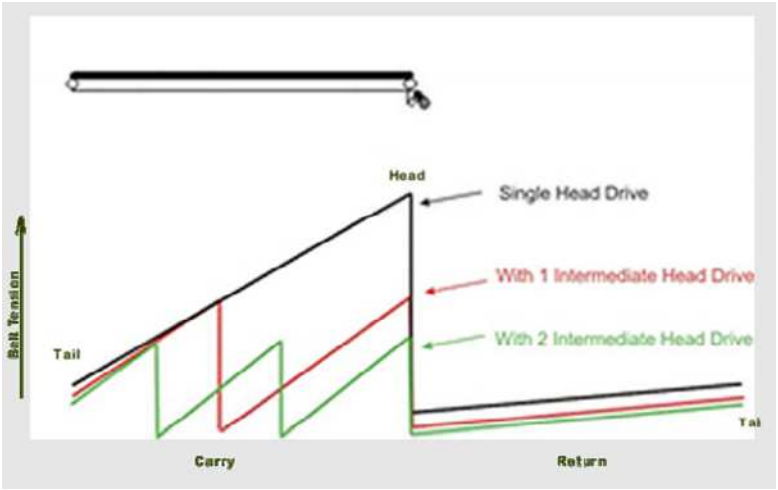


Fig. 3 *Energy consumption 3*

In a long overland conveyor, incline is insignificant. Power components will look much more like (Chyba! Nenašiel sa žiaden zdroj odkazov.) Frictional components making up almost all the power. In this case, attention to the main resistances is essential.

3 ENERGY DISTRIBUTIONS

One of the most interesting developments in technology in the recent past has been the distribution of power along the conveyor path. Is has not been uncommon to see drives positioned at the head and tail ends of long conveyors. But now that idea has expanded to allow designers to position drive power wherever it is most needed. The first application in the USA was installed at Kaiser *Coal* in 1974. [3] Mining equipment efficiencies and capabilities were improving dramatically. The tension diagram in (Chyba! Nenašiel sa žiaden zdroj odkazov.) shows the simple principal and most significant benefit of intermediate belt conveyor drives.



This flat, head driven conveyor has a simple belt tension distribution as shown in black. By splitting the power into two locations (red line), the maximum belt tension is educed by almost 40% while the total power requirement remains virtually the same. To extend the example further, a second intermediate drive is added (green line) and the peak belt tension drops further. [3]

Fig. 4 *The tension diagram*

4 ROUTE OPTIMIZATION

Commercial belt conveyor can not negotiate requirement curves of the belt in horizontal direction, and vertical direction neither. Under these conditions, we use special conveyors, for instance the pipe conveyor. Idlers, which keep the belt in pipe shape, allow curve the belt in any direction.(Chyba! Nenašiel sa žiaden zdroj odkazov.) [3]

Fig. 5 *The belt of the pipe conveyor*

Horizontal adaptability

The most efficient way to transport material from one point to the next is as directly as possible. But as we continue to transport longer distances by conveyor, the possibility of conveying in a straight line is less and less likely as many natural and man-made obstacles exist. To prevent building up more transfer points, the first horizontally curved conveyors being installed. Nowadays it seems just about every overland conveyor being installed has at least one horizontal change in direction. And today´s technology allows designers to accommodate these curves relatively easily.

(Chyba! Nenašiel sa žiaden zdroj odkazov.) shows an overland conveyor transporting material from stockpile to unload place to another processing. It is an example of creating necessary horizontally curves, because of natural obstacles.

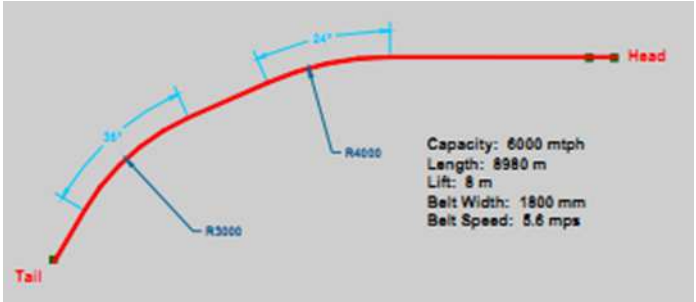


Fig. 6 *Route of conveyor 1*

Conveyors in tunnels

In a case, that conveyor can´t negotiate horizontal curve in landscape, there is option to make a tunnel, in which we can use overland conveyor in that way, and we can use acceptable horizontal curving. For example we can see (Chyba! Nenašiel sa žiaden zdroj odkazov.), there is conveyor leads in tunnel in Spain is the development of a 10.9m diameter under Barcelona. Continental Conveyor Ltd. installed the first 4.7km conveyor. The route of belt conveyor is made up with necessary horizontal curves. [3]

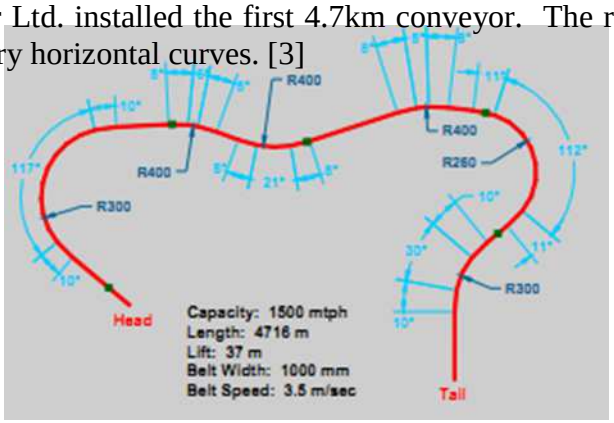


Fig. 7 *Route of conveyor 2*

Pipe conveyors

And if conventional conveyors cannot negotiate the required radii, other variations of belt conveyor such as the Pipe Conveyor might be used. [3] The pipe conveyor consists of rubber belt rolled into a pipe shape with idler rolls. These rolls are usually arranged into groups in hexagon form. The fundamental different between pipe conveyor and commercial conveyor is that the transported material is totally enclosed by the belt, which directly creates all the advantages. From bold decreasing the environment pollution, through no spillage or lost the material, to possibilities increase incline the transport route in any direction, horizontal, vertical. (**Fig. 8**) [3]

Fig. 8 *The pipe conveyor*

Vertical adaptability

Sometimes material needs to be raised or lowered and the conventional conveyor is limited to incline angles around 16-18 degrees. But again non-traditional variations of belt conveyors have been quite successful at increased angles as well as straight up.

"Sandwich" conveyor

It is the conveyor with two belts between them there is the transported material. Aid a special rolls is the second belt pressed on the material, so there is no spillage and we also can transport the material in higher inclines of the transport route. (**Fig. 9**) **Chyba! Nenašiel sa žiaden zdroj odkazov.**

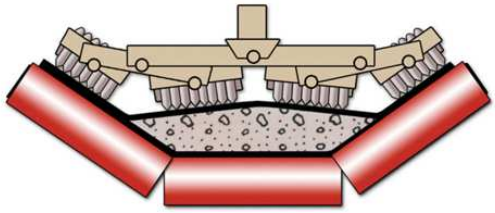


Fig. 9 *Sandwich conveyor*

5 CONSLUSION

Increase energy requirements depend on the length of conveyor, its type, difference in height, which it is necessary to negotiate, also a type the transported material. Optimization the route and appropriate location drive is possibly making whole transport process more efficiency. The big potential is in a pipe conveyor, which thanks rolled belt brings many advantages opposite the commercial belt conveyor.

References

[1] PU, X.L. - WANG, G.Q. - YUE, Y.J.: Summarization on Foreign Dynamic Analysis Software for Belt Conveyor. Mining & Processing Equipment 11 (2007)

[2] DONG, D.Q.: Research on Dynamics Behavior of Large Scale Belt Conveyor and its Appli-cation. North China Electric Power University (2008)

[3] ALSPAUGH, M. A.: Latest Developments in Belt Conveyor Technology: Presented at MINExpo 2004, Las Vegas, NV, USA ,September 27, 2004

[4] Belt Conveyors for Bulk Materials", Conveyor Equipment Manufacturers Association, 5th Edition, 1997

[5] High Angle Conveyor: [online], 2012 P&H Mining Equipment Inc: [cit 2012-3-5] <http://www.phmining.com/en/PHMining/Mining-Equipment/Continental-Conveyors/High-Angle.htm>

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