ARPN Journal of Engineering and Applied Sciences

www.arpnjournals.com

THE EFFICIENCY IMPROVEMENT OF BELT CONVEYOR INTERMEDIATE DRIVE TRACTION EFFORT

Trufanova I. S. and Lavrenko S. A.
National Mineral Resources University (Mining University), Russia
E-Mail: sergey18.09.89@mail.ru

ABSTRACT

This article describes the options for increasing traction of the belt conveyor intermediate drive. The functioning principle of intermediate linear drive with pressure rollers has been described, formulas for calculating the values of traction effort have been provided, also comparative graphs, which shows the efficiency of using intermediate drive in various conditions, have been given.

Keywords: belt conveyor, linear drive, traction effort, pressure.

INTRODUCTION

The tractive effort is transferred through a conveyor belt by the friction forces generated on the frictional contact surfaces. The frictional surface of the drive pulley is the surface of the pulley, as for linear drive, the frictional surface is the contact area of the conveyor belt with the intermediate drive. Transmitted tractive effort should be sufficient for overcoming resistant forces; however it shouldn't cause slipping underneath the conveyor belt.

Belt conveyor with an intermediate drive is a closed loop load-carrying belt, in which there are one or more intermediate linear drives in the form of short belt conveyors, and the upper branch of their belt is in force frictional contact with the load-carrying conveyor belt. Each intermediate drive overcomes the resistance of only its own interval section.

MAIN PART

As a result the belt tension diagram for conveyor with intermediate drive (Figure-1, b) significantly changes, characterized by a decrease in the maximum belt tension, compared with tension diagram for one head drive conveyor (Figure-1, a). This is clearly seen in Figure-1, c.

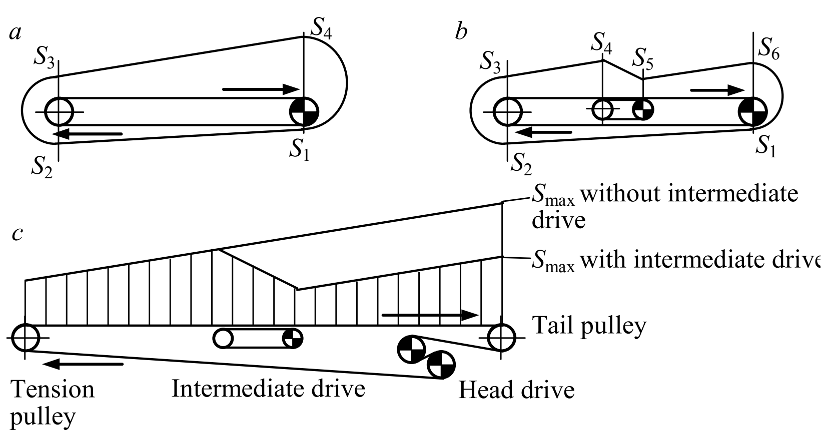

Figure-1. Belt tension diagram.
(a) for belt conveyor with one head drive; (b) for joint work of head drive and intermediate linear drive; (c) comparative diagram of maximum belt tension for joint work of head drive and intermediate linear drive.

Figure-2 shows relative efficiency of the intermediate linear drive depending on the angle of the conveyor and its load occupancy.

VOL. 11, NO. 7, APRIL 2016 ISSN 1819-6608
ARPN Journal of Engineering and Applied Sciences

www.arpnjournals.com

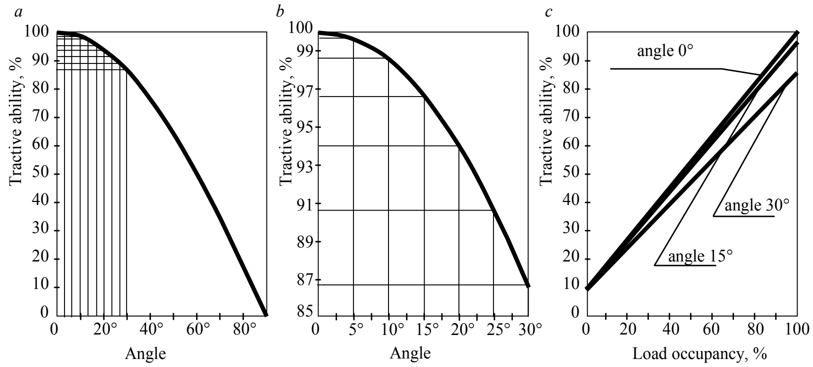

Figure-2. The efficiency of transferring traction effort of intermediate drive depending on the angle of conveyor inclination (a, b) and the load occupancy (c):
(a) theoretical, throughout the whole range of angles; (b) at significant range of angles of conveyor inclination; (c) depending on the intermediate drive load occupancy.

It is assumed here that the weight of the load is 91% of the distributed load, and the belt weight is 9% of the distributed load*. The calculation formula is as follows $F = (q_{load} \cdot k_{load} + q_{belt})\cos\alpha$, where q_{load} and q_{belt} – linear load weight and linear belt weight, respectively, kg/m, k_{rp} – the load occupancy ratio of the intermediate drive length; α – angle of conveyor inclination.

Figure-2 shows that the efficiency of intermediate drive is reduced linearly depending on the degree of load occupancy, and the dependence on the angle of inclination is sinusoidal. At an angle of inclination of 18° efficiency loss is 5%, and at the double angle of inclination of 30° efficiency loss three times greater - 13%. That is a non-linear dependence.

Engineering companies increase the length of the intermediate drives to compensate for the loss of efficiency.

Figure-3 shows the required length of the intermediate drive, which is needed to sustain 100% of the traction ability of the intermediate drive relative to a reference (which runs at an inclination of 0 °).

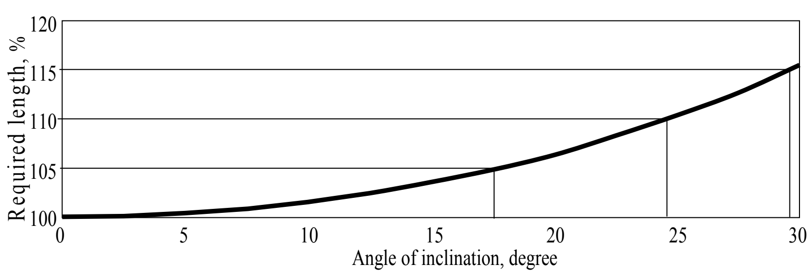

Figure-3. The required length of the intermediate drive to sustain traction ability depending on the angle of inclination of the conveyor.

Figure-3 shows that at angles less than 5°, you can ignore the drop in traction ability and at angles above 15° drop in efficiency is becoming more prominent. However, at the maximum angle of the belt conveyor inclination of 18° drop in efficiency is about 7%, to compensate which conveyor should be extended the at the same 7%, while costs of lengthening intermediate drive represent only consumption of belt (2 × 7% = 14%) without affecting the other parameters (power, the number of engines, power consumption, etc.).

Figure-2, c shows how the traction capacity of the intermediate drive drops to 10% when there is no load on it, and this means that the intermediate drive is not able to transmit tractive effort in case the main conveyor belt is not properly pressed to the intermediate drive belt. Intermediate linear drive with pressure rollers for belt conveyor has been developed to eliminate this disadvantage (patents of the Russian Federation № 2487071, №2456570, №2476851).

Tractive effort of intermediate linear drive transferred to the belt is provided not only by the frictional force of the normal components of the transported load and belt weight, but also due to an additional pressure conveyor and drive belts to each other using the pressure rollers. The required effort of conveyor and drive belts pressure is provided by bolts with packing nuts.

ARPN Journal of Engineering and Applied Sciences

The additional tractive effort transferred to the conveyor belt by the proposed intermediate linear drive is determined by the formula:

$$P = 2\, p{\cdot}n{\cdot}b{\cdot}f \cdot 2(h\, D - h^2\,)^{0,5}, \tag{1}$$

where P – additional tractive effort, kN; p – maximum usable pressure between the pressure rollers, kPa; n – the total number of rows of the pair of pressure rollers; b – the width of the pressure rollers, m; f – the friction coefficient between the conveyor and drive belts; h – the deformation size of the rollers elastic rim, m; D – the outer diameter of the pressure rollers, m.

The total tractive effort (N), which is realized by linear drive, could be determined by one of the following formulas, respectively, for a given linear drive length (L) or a given number of rows of pressure rollers (n):

$$W = L \times f \times [g \times (\, k \times q + q_{\text{belt}}\,) \times \cos\beta + 2 \times b \times l^{-1} \times \Delta \times p], \tag{2}$$

$$W = n \times f \times [\, g \times l \times (\, k \times q + q_{\text{belt}}\,) \times \cos\beta + 2 \times b \times \Delta \times p], \tag{3}$$

where L – length of intermediate drive, m; Δ – length of the base of the pressure rollers deformed elastic rims in the areas of contact with the sides of the conveyor belt load-carrying branches, m; q – linear load weight, kg/m; q_{belt} – linear belt weight, kg/m; β – angle of conveyor inclination; l – idlers and pressure rollers spacing on the load-carrying conveyor belt branch, m; k – coefficient taking into account the operating mode of the conveyor, which determines the degree of the belt load occupancy along the conveyor ($0 \le k \le 1$).

Figure-4 shows the relative efficiency of such a drive in dependence on the angle of the conveyor inclination and its load occupancy. The effectiveness of the intermediate drive without pressing elements has been shown for comparison (Figure-4, a).

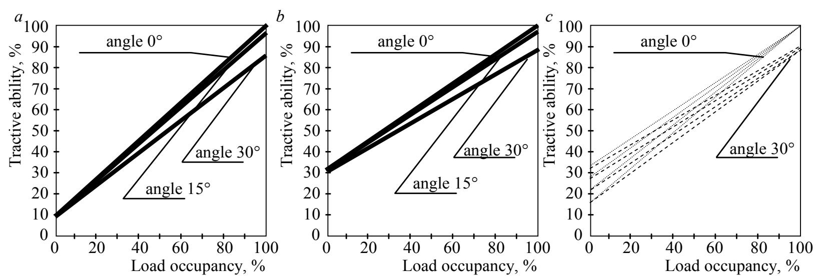

Figure-4. The efficiency of transferring traction effort of intermediate drive depending on the angle of conveyor inclination and the load occupancy: (a) basic linear drive; (b) with an additional pressure depending on the load occupancy; (c) depending on the angle of inclination, with the pressure in amount of 1:1, 2:1, 3:1, 4:1

The efficiency of transferring traction effort by this type of drive doesn't depend on the angle of conveyor inclination or load occupancy of the conveyor section with intermediate linear drive. In relative terms, this kind of intermediate drive always provides a constant tractive ability at its maximum level.

CONCLUSIONS

Increasing drives tractive ability, independence of the conveyor angle of inclination, reducing thus their length significantly improves technical and economical performance and extend the field of multidrive belt conveyor application, therefore work on improving the design of intermediate drives continue to be carried out not only in Russia but also worldwide.

REFERENCES

[1] Trufanova I. S. 2014. Intermediate drive as a means of improving the belt conveyor. Mining Equipment and Electromechanics. (6): 13-16.

[2] Tarasov, Yu.D. and Trufanova, I.S. Patent 2456570 Russian Federation, MPK G01M 17/00, B65G15/00. Stand for investigation of the parameters of the belt conveyor with the placement of belt conveyor lower run with the possibility of interaction with the idlers of load-carrying.

[3] Tarasov Yu.D. and Trufanova I.S. Patent 2476851 Russian Federation, MPK G01M 17/00. Stand for investigation of the parameters of the intermediate linear drive of the belt conveyor.

[4] Tarasov Yu.D. and Trufanova I.S. Patent 2487071 Russian Federation, MPK B65G 23/04. Intermediate linear drive of the belt conveyor.

[5] Vasilyev K.A., Nikolaev A.K. and Sazonov, K.G. Transportation machinery and lifting equipment enrichment plants. SPb: Science. p. 359.

[6] Finaev V., Kobersy I., Beloglazov D., Shapovalov I., Kosenko E. and Soloviev V. 2015. Design of the neuro-like learning control system for a vehicle. WSEAS Transactions on Systems and Control. 10: 328-334.

[7] Shkurkin D., Novikov V., Kobersy I., Kobersy I. and Borisova A. 2015. Investigation of the scope of intellectual services in the aspect of virtualization and information economy of modern Russia. Mediterranean Journal of Social Sciences. 6(5S3): 217-224.

[8] Kobersy I.S., Karyagina A.V., Karyagina O.V. and Shkurkin D. 2015. Law as a social regulator of advertisement and advertising activity in the modern Russian information space. Mediterranean Journal of Social Sciences. 6(3S4): 9-16.

[9] Finaev Valery, I., Kobersy Iskandar, S., Kosenko Evgeny, Y., Solovyev Viktor, V. & Zargaryan Yuri, A. 2015. Hybrid algorithm for the control of technical objects. ARPN Journal of Engineering and Applied Sciences, vol. 10, no. 6, pp. 2335-2339.

[10] Kobersi I.S., Finaev V.I., Almasani S.A. and Abdo K.W.A. 2013. Control of the heating system with fuzzy logic. World Applied Sciences Journal. 23(11): 1441-1447.

[11] Baronti F., Roncella R., Saletti R., Pede G. and Vellucci F. 2015. Smart LiFePO4 battery modules in a fast charge application for local public transportation. 2014 AEIT Annual Conference - From Research to Industry: The Need for a More Effective Technology Transfer, AEIT 2014.

[12] Hossain A., Rahman A. and Mohiuddin A.K.M. 2011. Fuzzy expert system for controlling swamp terrain intelligent air-cushion tracked vehicle. International Journal of Automotive Technology. 12(5): 745-753.

[13] Kobersy Iskandar S., Ignatev Vladimir V., Finaev Valery I. and Denisova Galina V. 2014. Automatic optimization of the route on the screen of the car driver. ARPN Journal of Engineering and Applied Sciences. 9(7): 1164-1169.

[14] Beloglazov Denis A., Finaev Valery I., Zargarjan Jury A., Soloviev Victor V., Kosenko Evgeny Y. and Kobersy Iskandar S. 2015. Efficiency of genetic algorithms in intelligent hybrid control systems. ARPN Journal of Engineering and Applied Sciences. 10(6): 2488-2495.

[15] Kobersy, I.S., Ignatev, V.V., Beloglazov, D.A. and Kramarenko, E.R. 2014. An intelligent navigator with the control of the car technical condition. ARPN Journal of Engineering and Applied Sciences. 9(7): 1094-1098.

[16] Liudvinavičius L., Lingaitis L.P., Dailydka S. and Jastremskas V. 2009. The aspect of vector control using the asynchronous traction motor in locomotives. Transport. doi:10.3846/1648-4142.2009.24.318-324. 24(4): 318-324.

[17] Morrow T.H. 1974. Improved methods for construction and maintenance of runway pavement surfaces. SAE Technical Papers.

[18] Finaev Valery I., Beloglazov Denis A., Shapovalov Igor O., Kosenko Evgeny Y. and Kobersy Iskandar S. 2015. Evolutionary algorithm for intelligent hybrid system training. ARPN Journal of Engineering and Applied Sciences, vol. 10, no. 6, pp. 2386-2391.

[19] Kobersy Iskandar S., Finaev Valery I., Zargarjan Jury A., Beloglazov Denis A. and Shadrina Valentina, V. 2015. Model of the controller for output stream concentration in the mixer of a steam unit. ARPN Journal of Engineering and Applied Sciences. 10(4): 1637-1641.

[20] Mentges M.I., Reichert J.M., da Rosa D.P., Vieira D.A., da Rosa V.T. and Reinert D.J. 2010. Soil physicohydric properties and chisel energy demand in a compacted Alfisol. Pesquisa Agropecuaria Brasileira. 45(3): 315-321.

[21] Kobersy Iskandar S., Ignatev Vladimir V., Finaev Valery I. and Denisova Galina V. 2014, Automatic optimization of the route on the screen of the car driver, ARPN Journal of Engineering and Applied Sciences. 9(7): 1164-1169.

[22] Liu Y., Wang K. and Shen D. 2015. Visual Tracking Based on Dynamic Coupled Conditional Random Field Model. IEEE Transactions on Intelligent Transportation Systems.

[23] Zhou Y., Zhang Y., Ge Y., Xue Z., Fu Y., Guo D., Shao J., Zhu T., Wang X. and Li J. 2015. An efficient data processing framework for mining the massive

ARPN Journal of Engineering and Applied Sciences

trajectory of moving objects. Computers, Environment and Urban Systems.

[24] Liu Z., Wang F. and Zhang Y. 2015. Adaptive Visual Tracking Control for Manipulator with Actuator Fuzzy Dead-Zone Constraint and Unmodeled Dynamic. IEEE Transactions on Systems, Man, and Cybernetics: Systems. 45(10): 1301-1312.