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DEVELOPMENT AND TEST OF WEAR RESISTANT AND ENERGY-OPTIMIZED CONVEYOR BELTS

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Abstract:
The article deals with the problem of development and test of wear resistant and energy-optimized conveyor belts.

1. Introduction

For the transport of a large mass flow belt conveyors are frequently the optimal solution regarding technical as well as economic and ecologic considerations. Particular care must be employed in the design of a conveyor belt according to the given circumstances as the belt is the most important and cost-relevant element of the belt conveyor. Investment and operating cost of a belt conveyor can already be influenced significantly in the planning stage by the technological properties of the chosen belt [1], [2].

A choice of a carry side cover plate compound suitable for the given operationalparameters based on material characteristics determined in laboratory tests is merely possible to a certain extent. Extensive investigations have shown that more than 50 % of all belt damages are caused by cutting. Size and appearance of the damage greatly depends on the material properties of the conveyor belt as well asthe configuration of the loading station [3], [4]. Based on this fact a test method was developed in cooperation with the Leibniz Universität Hannover, which closely simulates real life circumstances, in order to evaluate conveyor belt cover plate compounds regarding cut resistance. The optimization of the pulley side cover plate compound also requests special test methods that closely simulate real life conditions. The energy consumption of horizontal belt conveyors is primarily determined by the visco-elastic properties of this cover plate. In order to measure the subsequent indentation rolling resistance a test rig was designed and built. With this test rig the indentation rolling resistance of conveyor belts can be measured with operational parameters quite close to real life and with variations of vertical load, belt speed, idler diameter and ambient temperature. Therefore it is possible to evaluate the conveyor belts regarding expected energy consumption in the practical application.

2. Experimental Measurements of Cut Resistance of Conveyor Belts

In order to determine the cut resistance a test rig was used which is based on a pendulum impact testing machine. With this test rig cutting tests were performed with 12 different carry side cover plate compounds with defined and reproducible parameters. In Fig. 1 a sketch of the test rig can be seen which was employed forthis investigation.

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Fig. 1 *Pendulum Impact Testing Machine*

At the end of the rotating pendulum arm a sensor head is positioned which has on its bottom side a cutting tool which cuts into the conveyor belt. The belt samples are fixed in a clamp and can be regulated in height. The energy of the pendulum can be adjusted by four different heights from which the pendulum falls down and also by adding additional weight to increase the mass of the sensor head. Apart from the measured value of maximum cutting force the length of the cut can be used to evaluate the cutting resistance of the belt samples.

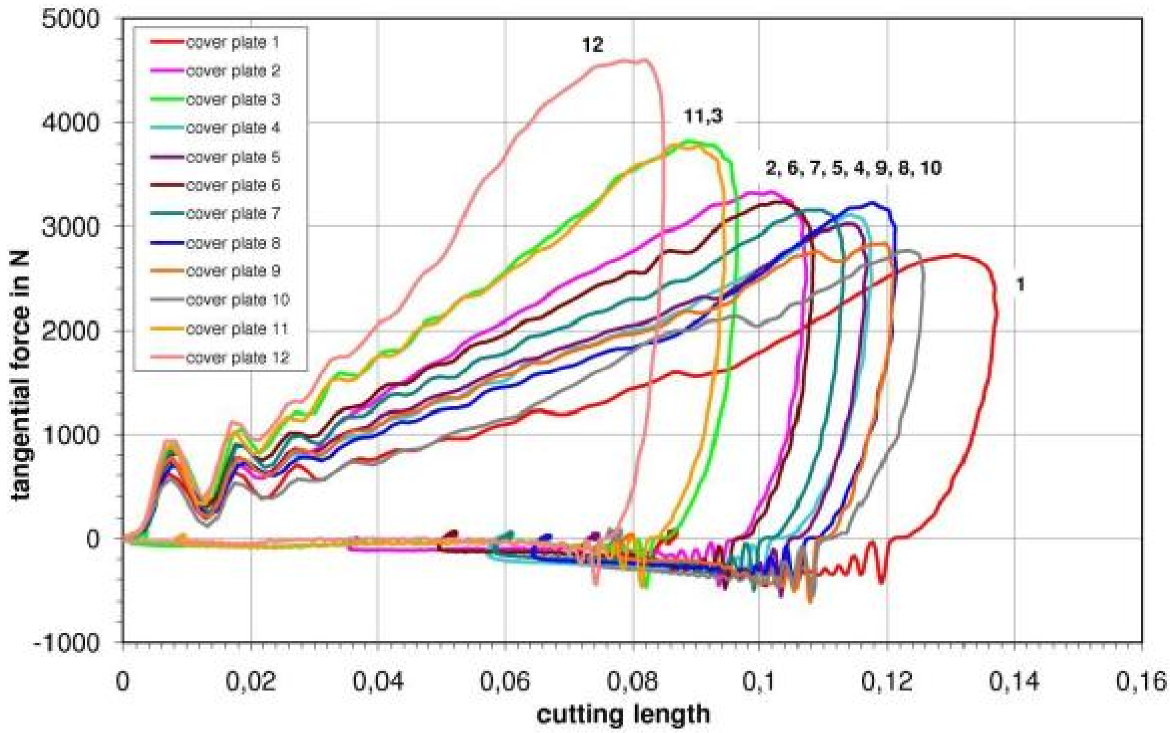

Fig. 2 *Tangential force against cutting length*

Examples of test results can be seen in Fig. 2. Cover plate compounds with a low cut resistance are characterized by low tangential forces and large values of cutting length. Compounds with a high cut resistance show high tangential forces and small cutting lengths. The test results could be confirmed by measurements from field tests. In these field tests the conveyor belts are subjected to extreme cutting exposure due to sharp edges and large particle size of the bulk material and also due to a large transfer height at the loading station. In figure 3 it can be seen that the standard cover plate compound suffers significant damages after merely short running time and this leads to a short life time of the belts.

Fig. 3 *Cover plate damages in field tests*

In the course of the investigation an optimized cover compound No. 3 was developed. The good results of the measurements in the test rig could be confirmed in the field measurements. After comparable running time no cover plate damages are to be seen. Therefore a significantly longer life time of the belts and subsequently a significant reduction of cost for the customer are achieved.

Experimental Investigations of Indentation Rolling Resistance of Conveyor Belts The measurements of indentation rolling resistance were performed with a specially equipped test rig at the Institut für Transport- und Automatisierungstechnik. The test rig (shown in Fig. 4) consists of a drive pulley and a return pulley, both with a diameter of 800 mm. The distance center-to-center measures approximately 4000 mm. The drive is a direct current motor with 36 kW. The belt speed can be adjusted up to 8 m/s. The complete test rig is placed in a climate chamber with cooling and heating aggregates which allow measurements in temperatures in a range from – 35° C up to 40° C.

A special measuring device is positioned in the top run. Here an idler is pressed onto the belt running below it with a defined vertical force by means of pneumatic cylinders. From below the belt is held by a finished idler with a diameter of 400 mm.The measuring idler is on the outside of the belt. Therefore the endless belt must be inverted prior to the test, so that the running side cover plate is on the outside**.**

For the measurement of indentation rolling resistance idlers of varying diameter and length are used which are fixed in an adjustable frame. The bearing of the frame is constructed in a manner that reactive forces which could influence the measuring results are avoided. The fixing points of the frame are equipped with force gauges.With these all forces acting on the frame can be precisely determined.

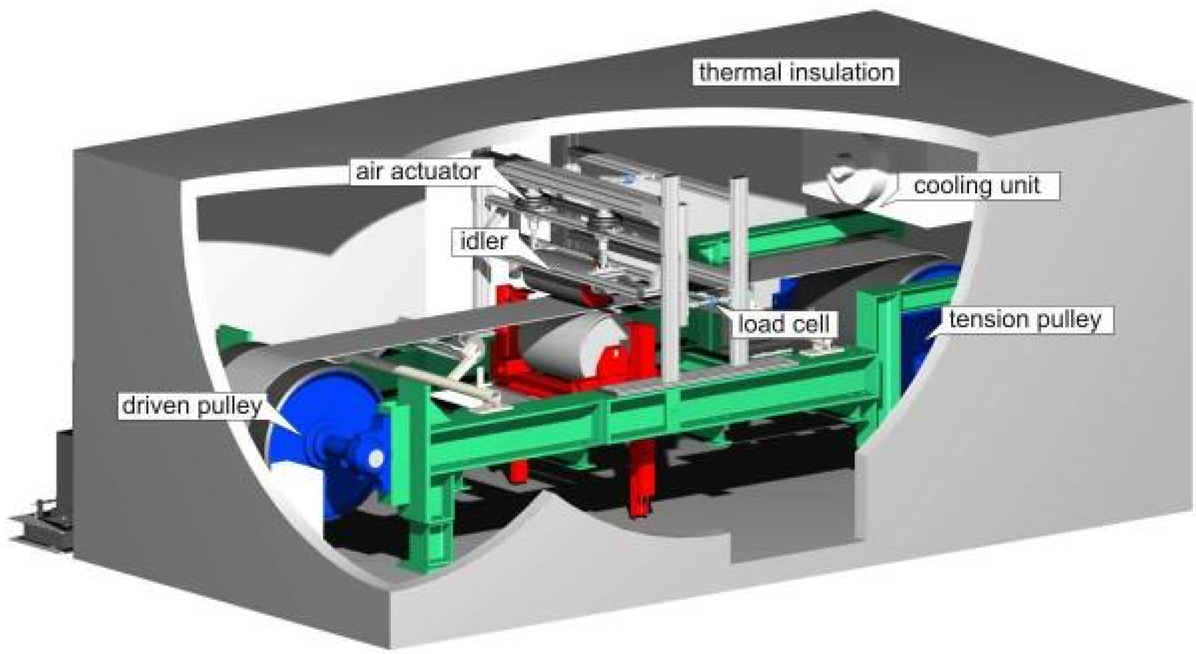

Fig. 4 *Test rig to measure the indentation rolling resistance*

An example of the results of indentation rolling resistance measurements can be seen in Fig. 5. Here the indentation rolling resistance was measured for several cover plate compounds hich were glued to a steel band functioning as tensile carrier.

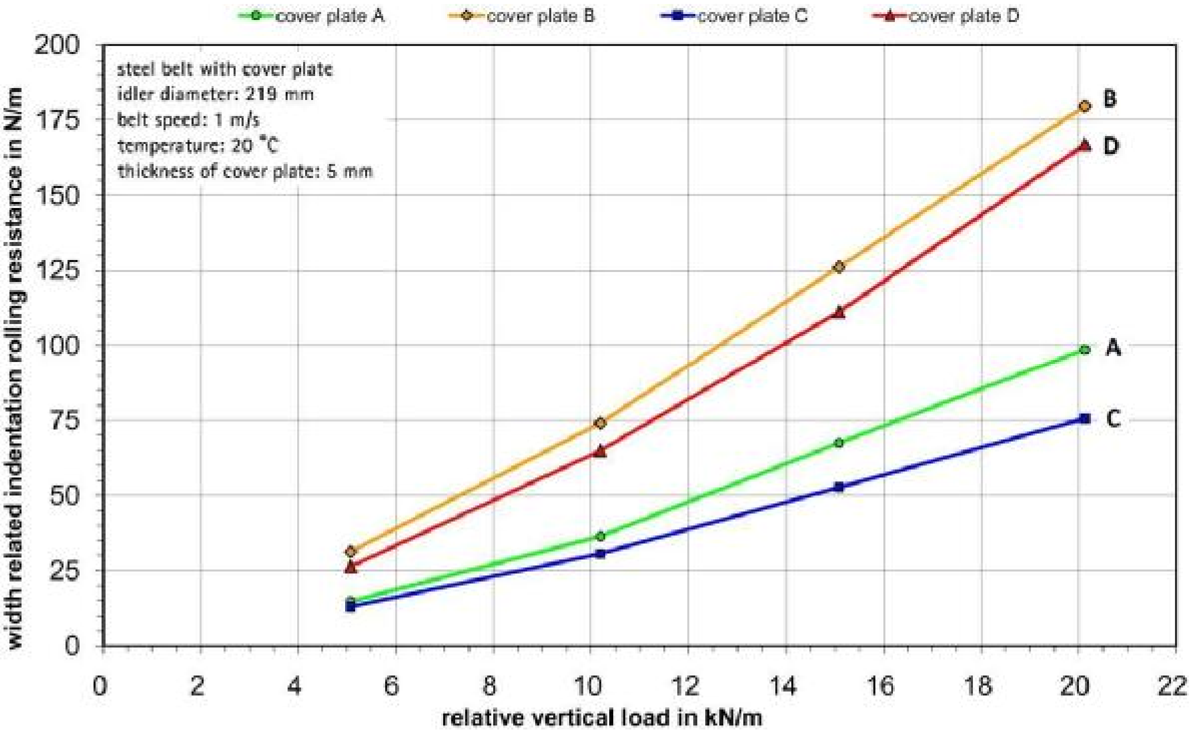

Fig. 5 *Measured indentation rolling resistance in dependence of the vertical load*

Equally for all cover plate compounds the indentation rolling resistance increases with increasing vertical load. The increase is slightly over-proportional. The standard cover plate compounds B and D have a significantly higher indentation rolling resistance than the energy optimized compounds A and C.

The low indentation rolling resistance of compound C could be confirmed in field tests at RWE Power AG. Fig. 6 shows that a conveyor belt manufactured with compound B has a significantly higher indentation rolling resistance than a belt with compound C.

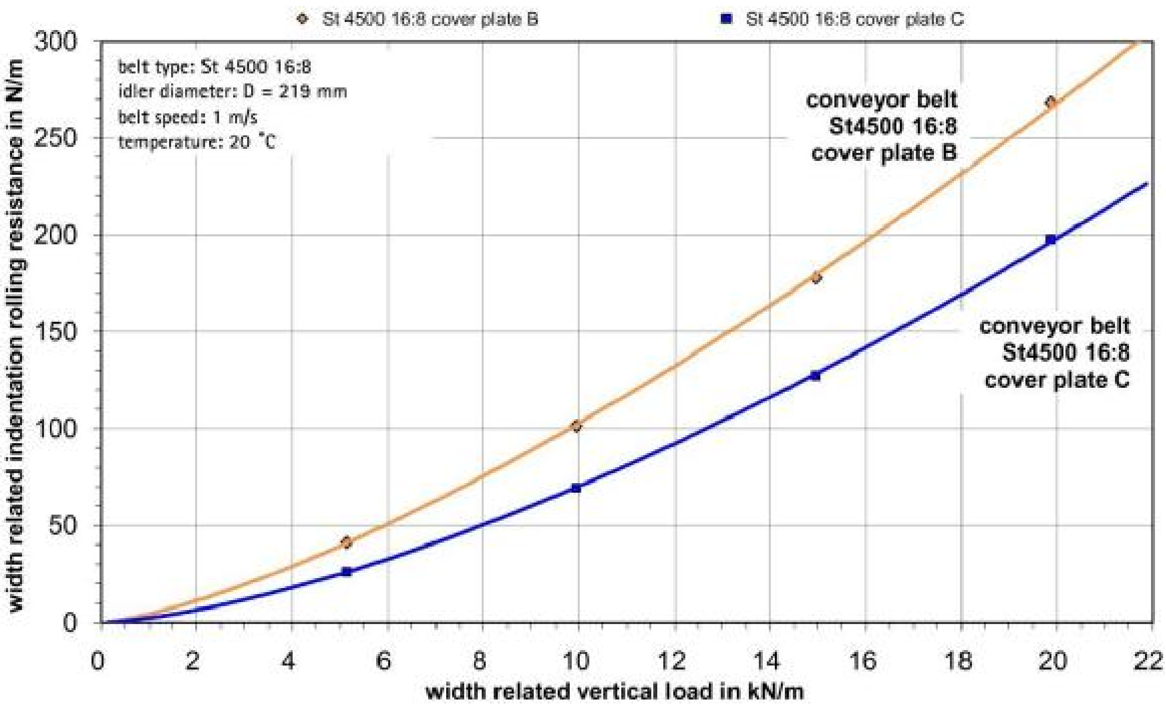

Fig. 6 *Field test measurement of indentation rolling resistance in dependence of the mass flow*

The optimization of the pulley side cover plate leads to significantly lower energy consumption of the belt conveyor and thus generates an important advantage for the operator of the conveyor.

3. Summary

Cover plate compounds for conveyor belts which are optimized regarding the operational parameters can decisively improve durability and energy efficiency of the conveyor belt. Current research enabled the development of optimized cover plate compounds. Characteristic values determined in laboratory measurements were confirmed in field test measurements.

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