New energy-saving conveyor belts being standardized

Belt conveyors are the most economical and energy-efficient means for conveying bulk materials such as coal over moderate to long distances.

In an article published in the May/June 2011 issue of CoalAsia, innovations in conveyor belt design allowing for lower tension steel cord belts with high dynamic efficiency as per German standard DIN 22110, were described. Based on the belt breaking strength design as per DIN 22101-2011, lower belt ratings, hence lighter belts, can be selected.

The benefits derived in addition to reduced power consumption are the overall reduced costs in other conveyor components such as motors, gearboxes, pulleys, idlers and structural requirements.

Another very important factor in further reducing costs along with environmental impact is the development of energy efficient conveyor belts, also known as EOB. This new compound development can reduce energy requirements by as much as 20 percent.

An example of an average application may demonstrate the monetary savings by using an EOB conveyor belt. A 10 km long conveyor with a 1200 mm wide belt conveying 2500 tons of coal per hour at a speed of 6 m/s, with conventional cover grades, operating all year, would annually consume 21 million kWh. At an electricity price of 0.15 USD/kWh, this would mean spending of 3.15 million USD. If using an EOB conveyor belt, the energy consumption would be 17 million kWh. Multiplied by 0.15 USD/kWh, the spending would be 2.55 million USD. Hence, the use of a modern EOB belt would save 600,000 USD every year.

The power requirements to bring a mass from one location to another cannot be changed. Only the motion resistances such as bearing resistances in idlers and pulleys, flexure resistance of the conveyed material, scraper friction and some other parameters, can be modified and the belt's indentation rolling resistance.

The belt's indentation rolling resistance is by far the most critical factor by representing more than 60 percent of the resistance forces. This means that when the indentation rolling resistance of the conveyor belt is reduced by say 25 percent, the required power is reduced by at least 15 percent.

This resistance is caused by the deformation of the belt as it runs over the idlers, creating a bulge in the belt as it comes in contact with the idlers. The larger the bulge, the larger the power demand just as underinflated tires on a car will consume more energy than properly inflated tires.

The highest resistance forces are found in the top run of the conveyor, where the material is conveyed. This is, by the way, the reason why long conveyors have a tail drive (at the material discharge) in order to pull the belt. It is the belt's bottom cover that is in contact with the conveyor idlers, and is therefore affected by the belts deformation, energy consuming forces.

How can this bulge be reduced?
Apart from other design belt parameters such as cover thickness or integration of transverse reinforcement, or external influences such as temperature,
the primary reduction in indentation rolling resistance is attributed to the composition of the belt’s cover compound.

Designing the optimal compound with the proper viscoelastic characteristics is the result of extensive research and development utilizing finite element analysis, involving extensive in-house and field testing. PHOENIX Conveyor Belt Systems along with German coal mines and the German Institute of Transport and Automation Technology (ITA), initiated this process decades ago.

These intensive studies were further refined to include practical testing equipment developed with ITA, to further measure indentation rolling resistance.

There the indentation rolling resistance is measured on a two-pulley test rig. The test equipment utilized allows for adjustments in load, idler diameter, belt speed and ambient temperature, to facilitate operating conditions under a vast range of environments.

The standardized test rig used in measuring indentation rolling resistance has a centre distance of 3900 mm, two pulleys with a diameter of 800 mm and a direct current 36 kW motor, with speeds up to 8 m/s. The measuring device is located in the middle of the rig with a measuring idler, the diameter and length of which can individually be determined in accordance with the real operation. The idler is pressed into the belt with a defined force. Below this idler, under the belt, is a pulley with a diameter of 400 mm. Usually, the final bottom cover of the endless belt is outside, towards the measuring idler. The test rig is located within a temperature controlled chamber that can be adjusted from -50 to +60 degrees C. A video animation of this test can be viewed at www.conveyorbeltguide.com/
energysavingbelts.html.

In order to have a reliable basis for determining the energy saving properties of a conveyor belt, DIN standard 22123-2012, Conveyor belt - Indentation rolling resistances of conveyor belts related to belt width - Requirements, testing was published in October 2012, establishing formal requirements. Now belt users, designers and manufacturers can rely on exact binding data that define energy-saving properties of conveyor belts. This provides a platform that allows for all parties to test product supplied and confirm whether it meets the specific criteria.

The results of this test can be translated into the belt breaking strength calculation as per DIN 22101-2011 (Continuous conveyors - Belt conveyors for loose bulk materials - Basis for calculation and dimensioning) or other design tools, by adjusting the friction coefficient f. Exact algorithms will be defined shortly by another new DIN standard.

It is worthwhile to state that the rubber cover hardness, given as a degrees Shore A figure, is not suitable for determining energy consumption as this static test cannot define the cover’s dynamic behavior.

The development of the EOB compound has significantly advanced conveyor belt technology to allow for more economical, cost effective, energy efficient and environmentally friendly conveyors. Likewise, belt performance and durability must be on a similar high level. Therefore, PHOENIX is keeping all other belt characteristics such as abrasion resistance, tear resistance, elongation at break at the highest possible level. This means that the belt top resp. carrying cover compound is designed to withstand the strains that it is subjected to in practice.

Coal mines planning long distance conveying systems of 1 km length or more should select steel cord conveyor belts with EOB bottom covers. The little higher investment will shortly be amortized.
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