

BELT CONVEYOR STANDARDISATION AN AID TO MINE PLANNING

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ABSTRACT

In this paper the development of underground belt conveyor systems transporting minerals and personnel from the face to surface are discussed and special consideration is given to the belt conveyor standardisation as an aid to mine planning.

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1. INTRODUCTION

Tremendous progress and capital investment has been made in recent years in the development of coal production equipment for both longwall and room and pillar installations. This progress has inevitably resulted in considerable increase in mine outputs. In many instances, this improvement in efficiency in the production area, has highlighted the inefficiency of outbye belt conveyor systems.

As a result of these improvements, the requirements of the mining industry have been reviewed and schemes to suit the demands of increased productivity have been developed. Within these developments, particular attention has been devoted to the standardisation of equipment.

Many papers have been written on the subject of the transportation of materials and equipment and therefore, the author is confining this study to the following subjects relating to the transportation of minerals and personnel by belt conveyor.

- a) Conventional Belt Conveying equipment
- b) Extensible Belt Conveyors
- c) Man-riding Conveyors
- d) Booster Conveyors
- e) High Powered Conveyors

2. CONVENTIONAL CONVEYING EQUIPMENT

2.1. Drive Equipment

The need to improve the design and increase the power range of the drive equipment to meet the developing requirements of the coal industry, the following main criteria are found important.

- a) Maximum efficiency
- b) Minimum maintenance
- c) Economical
- d) Dimensionally compact
- e) Safe in operation
- f) Compact standardisation

These parameters culminated in the design of drive equipment with power ratings in the 48-560 KW range.

The drive heads are 'slimline' design to suit the limitations of narrow roadways and are modular construction for ease of underground transportation and assembly. The complete unit comprises individual drum units, power units and reduction gearboxes. Each module is machine faced or spigot mounted for ease of assembly and in the unlikely event of breakdown, the drive pulleys can be withdrawn through the side of the pulley unit without disturbing the drive structure.

The spigot mounted gearbox is standard to the total range of the drive equipment and this feature also applies in many cases to the drive pulleys and pulley units, which within certain power ranges, are interchangeable.

The power units can be fitted with either foot or flange-mounted motors and a variety of couplings, brakes, or backstops is available to suit customer requirements.

Facilities are also available to monitor the condition of the bearings, the temperature of gearbox oil, the wear of brake linings, etc.

A comprehensive range of delivery ends is available for all types of discharge which include adjustable delivery pulleys and suitable belt scrapers.

One of the major problems associated with belt conveying systems is that of cleaning the dirt and moisture from the return belt to avoid 'build-up' at each pulley and return idler location. To solve this problem a dirt disposal conveyor fitted to the underside of the delivery end has been innovated. This unit, together with the incorporation of multiple belt scrapers, has proved invaluable in improving the performance of conveyor systems.

2.2. Belt Tensioning & Storage Equipment

In order to ensure that adequate tension is applied to return strand of the conveyor belt, to maintain suitable driving tension, a tensioning unit is normally installed at the rear of the drive head. Several types of units are available for this purpose, each being capable of storing a nominal quantity of belt, the length of the unit naturally varying with the length of the conveyor installation.

The various types of the belt tensioning equipment are as follows.

The Hand Winch Type is the commonest form of unit, being the most economical, the tension being manually applied by means of hand operated winches which are rope coupled to the mobile tension carriage.

The Gravity Type is a more effective unit incorporating structure as the hand winch type, but with the tension carriage ropes coupled to a 'floating' weight frame within a tower which is located adjacent to the rear section. The weights automatically control the elastic stretch of the conveyor belt and as permanent stretch occurs, the hand winches are used to adjust the position of the weight frame within the tower.

The Automatic Type is a more sophisticated system with the same type of structure as the above units, but with an electric winch replacing the hand winches. The winch is bolted onto the rear loop structure and is rope coupled through the mobile tension carriage to a dynamometer. The dynamometer is 'set' to suit the requisite belt tension and control the tension by means of switches within the dynamometer which actuate intermediate control relays, which in turn, operate a forward or reserve contactor controlling

the electric winch motor. This action has the effect of releasing belt when in a state of overtension and 'reeling in' belt when slack occurs

The Hydraulic Unit is a patented design, which automatically maintains the required conveyor driving tension with a similar response to that of a gravity system.

In operation, belt tension is maintained by the charge in the accumulators which discharge to the actuator when the conveyor is started and slack belt develops. The process is reversed when the conveyor is stopped, when the return belt tension tends to increase.

2.3. Belt Conveyor Structure

Belt conveyor structures are so variant in design and type that they are too numerous to discuss effectively.

It can be stated, however, that the most popular is the tubular boltless type due to its ease of assembly and is less prone to fines 'build-up' than other conventional structures.

The same reference can be made to loading sections and return end units. In this instance the most popular is the modular construction type which can be fitted with a variety of impact idlers and includes a fines drawer to facilitate the removal of fines from the return pulley frame. The idler rollers are of a standard design.

3. EXTENSIBLE CONVEYORS

In all mining operations, the main objective is to achieve maximum output in the minimum period. To achieve this ideal, mining should be a continuous operation, but regrettably, is unattainable. The introduction of extensible belt conveying systems has contributed to an improvement in the loading cycle.

The conventional method of extending conveyors is by the addition of conveyor sections at the return end and the insertion of an appropriate length of belt.

Although this is a relatively simple operation, it is time consuming and adding multiples of belt has its obvious disadvantages.

An alternative method is to apply an overlapping conveyor, generally a stage loader. With this system a degree of continuity is attained, but when the overlap is exhausted, the return end must be pulled back prior to adding sections and belt.

The preferred system comprises a long skid mounted return end which forms the track for either a Stage Loader or Bridge Conveyor Support Trolley. The trolley is fitted with a horizontal and vertical articulated frame to accommodate deviations in the road-header or continuous miner operation. The system operates in conjunction with an automatic storage type loop take-up unit. As the 'getting' machine advances, the trolley,

including the mobile receiving section moves towards the rear of the return end. When the length of travel is taken up, the return end is retreated until the trolley is situated at the front of the track. The action of retreating the return end creates overtension in the belt. The overtension reaction is detected by the dynamometer in the extensible loop take-up. The dynamometer then actuates the electric winch which allows belt to be released from the storage area. On completion of the cycle, the dynamometer detects the slack belt condition and dictates that the winches 'reels in', to ensure that the correct drive tension is maintained. The storage loop is capable of storing up to 100 metres of belt, ensuring that the operation can be continuous for a lengthy period.

Further developments within this area include the introduction of an Angle Station which permits the belt to negotiate angular turns without misalignment.

4. MAN-RIDING CONVEYORS

Due to improvements in modern mining techniques and the associated increase in the rate of advance of mechanised faces, it follows that the distance to the coal face is also increasing. This situation introduces the problem of transporting personnel to their place of work as quickly as possible, to ensure that they arrive in a fit condition and that the maximum time will be available for output during the shift.

In relation to the rapid face advance referred to, longer trunk and gate belt conveyors are being installed and consequently, the practice of riding personnel on conveyor belt is increasing. Although the use of belts for man-riding was formerly forbidden by the Mines Inspectorate because of the hazards involved, the practice is now completely legalised as a result of the introduction of the necessary safety equipment. Details of the Codes and Rules of Practice are available in booklet form from the UK's National Coal Board's Production Department. This deals with all aspects of safety, details of relevant clearances and equipment, including boarding and alighting platforms, safety gates, emergency trip wire systems, etc.

Conveyor man-riding has significant advantages over other conventional systems;

a) There is no waiting time at the beginning or end of the working shift, being a continuous operation.

b) Where conveyors are already installed for mineral transport, these can be easily adapted for man-riding, with the addition of boarding and alighting platforms, safety gates and signalling equipment, which in many instances, is already fitted to the conveyor structure.

The practice of man-riding was initially confined to riding on the top belt, but double-decked structure for top and bottom belt man-riding is now commonplace. Statistics are available showing the substantial time saving due to the introduction of man-riding on belt conveyors.

The development of these systems is constantly being reviewed, particularly with respect to safety and increased speeds. It is noteworthy that when belt man-riding was officially introduced in the late 60's, the maximum allowable speed was 1.88 m/second, whereas the current speed is 2.66 m/second.

It must be emphasised that at no time has the safety of personnel been sacrificed for the desired increase in speed. This fact is substantiated by statistics which indicate that in UK Mines, accidents relating to belt man-riding is much less than any other form of underground transport. The highest rate is attributed to men walking the roadways.

5. BOOSTER CONVEYORS

During recent years, the demands on mineral transport systems have increased, due to improvements in production rates and extending lengths of conveyor systems. This is particularly appropriate to longwall developments. The requirements associated with these improvements have been identified and as the development of belting technology has enabled higher tensile ratings to be available, the necessary belt conveying equipment to meet these demands have also been developed.

Situations can arise, however, where it is uneconomical to introduce new equipment and belting for a variety of reasons. It was because of these factors the application of the concept of adding increased power into a belt conveyor at an intermediate point/s were investigated and developed. This system has become universally known as the booster drive.

The booster drive has been designed so that it can be installed at a suitable selected point between the delivery and return pulleys, of an existing belt conveyor installation.

In contrast to the conventional mode of power transference to the conveyor belt, by wrapping the belt around a single or series of driving pulleys, the booster drive transmits the tractive force linearly, by frictional contact with the main belt. The power transmitting element is an endless driving belt, which is in contact with the underside of the carrying strand running on the idlers of the main carrying belt.

The pressure to transmit the force results from a combination of the weight of the belt and the material being transported. Although the unit pressure is much less than that achieved by the conventional method, the required force is attained by an extended length of engagement between the belts.

This simple method of power transfer, enables the principle of intermediate boosting to be applied to any belt conveyor system and offers the following advantages;

- a) The belt tension is reduced, therefore, a lower tensile strength belt can be used at a substantially reduced capital cost.
- b) Individual conveyor lengths can be increased.
- c) In-line transfer points can be eliminated thus reducing degradation of mineral and the hazards associated with airborne dust.
- d) The physical size of the equipment is reduced thereby obviating the need for costly excavations.
- e) Common components can be utilised thus reducing spares holdings and associated maintenance.

f) Where belt man-riding is practiced, the frequency of boarding and alighting is reduced, which improves overall efficiency

g) The handling capacity of the conveyor can be increased.

h) In the event of a transmission failure on a drive unit, the system could still operate, although at a reduced capacity.

The application of booster drives fall into four main categories;

a) To increase the carrying of an existing conveyor system. This particularly applies in the mining industry where production rates are being improved due to increased mechanisation and the increasing use of equipment to higher technological standards.

b) To increase the length of an existing conveyor system. Again applicable to underground mining situations where the distance between the point of mineral extraction and the point of egress from the mine is continually increasing.

c) To eliminate intermediate transfer points in an existing series of in-line conveyors, by converting some of the existing drives into intermediate booster drives.

d) In any new belt conveyor scheme where site conditions and other considerations such as standardisation of equipment, standardisation of grade of belt, capital costs of equipment, belt and spares, running costs and maintenance costs indicate that a booster system would be the most beneficial arrangement.

Details are available showing the varying conditions to which "boosters" are applied, which once again, demonstrates the high degree of standardisation of equipment involved.

6. HIGH POWERED BELT CONVEYORS

There has been considerable development in recent years relating to the application of high powered belt conveyors. The principal factor has been in the continual improvement in the tensile capability of both fabric and steel cord conveyor belting.

These improvements now enable conveyor designers to develop very long centre, single flight conveyors, involving high vertical lifts. This feature has led to the introduction of single slope conveyors capable of dealing with the total output of the mine in preference to shaft winding systems.

With this type of application, it becomes increasingly difficult to utilise standard equipment. However, there are many installations in the UK and overseas, where the systems have been designed to include standard major components. This applies particularly to gearboxes, pulleys and main bearings. It is understandable that the associated drive supporting structure varies considerably with each application.

7. CONCLUSION

It is difficult to deal adequately with the subject of standardisation benefits for face to surface equipment in the limited space and time available. To refer to the original comment, the development of coal production equipment has revolutionised the industry. We must, therefore, ensure that the outbye systems are capable of accommodating the resultant increased output.

In developing these systems, management must be increasingly aware of the need, wherever possible, to give serious consideration to "Conveyor Standardisation — an Aid to Mine Planning".