MODIFICATIONS AND INNOVATIONS TO REDUCE SUGAR SPILLAGE SUBSTANTIALLY AND OPTIMISE CONVEYOR LOADING AT THE SUGAR TERMINAL

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Abstract

The purpose of this paper is to describe some of the modifications and innovations carried out at the Sugar Terminal during the past eighteen months in order to reduce sugar spillage to negligible levels. This work has resulted in a considerable saving of labour. It has optimised the loading of conveyors, which will facilitate an increase in the shiploading rate from 800 to 1000 tons per hour at low cost, while retaining existing belt speeds.

Introduction

Sugar spillage, associated with conveyors, has always been a problem at the Sugar Terminal, amplified by the large quantity of sugar handled each year and by the rather high loading rates of 800 tons per hour.

Since commissioning the plant, the quantity of spillage occurring was systematically reduced over a period of time by means of various types of equipment, such as belt scrapers, rotary brushes, various types of seals at hoppers and water sprays. Also, a good deal of vigilance was maintained to ensure that the devices were maintained in good order. Eventually, a stage was reached, where the total spillage that occurred was about 0,1% of the sugar handled.

This was considered to be economically acceptable. However, when considered in terms of loading an average cargo of say 14 000 tons, the sugar spillage to be recovered after loading was 14 tons. The cleaning operation was labour intensive and included operations such as scraping, shovelling and sweeping throughout the shiploading conveyor systems and molasses mixing plant. The sugar intake plant had similar shortcomings which were aggravated because it was required to operate continuously, so cleaning often had to be carried out on overtime rates.

During 1982, the author visited some Australian sugar terminals, to see at first hand, recent developments in the field of spillage control. It was found that there was almost no sugar spillage in these terminals. There are six sugar terminals in Queensland so the competition is fierce. They also have the benefits resulting from combined experience.

The work done at the Durban Sugar Terminal since 1982 to reduce sugar spillage substantially is described.

Sugar Spillage

The phenomenon referred to as sugar spillage can be divided into four distinct categories and will be discussed as follows:

(1) Spillage over the edges or sides of the conveyor belts.
(2) Spillage due to carry-over on the return belt.
(3) Sugar build-up in hoppers and on skirt boards etc.
(4) Spillage related to dusty VHP sugar.

(1) *Spillage over the edges or sides of the conveyor belts*

Spillage of this nature arises from two causes:–

- uncontrolled feed-on from transfer hoppers, and
- flooding, when re-starting the conveyor system, after having stopped with a full load of sugar.

Uncontrolled feed-on from transfer hoppers: to achieve control of the sugar at feed-on, the following observations are relevant:–

- The vertical component of velocity of the falling sugar must be reduced to zero.
- The sugar deposited on to the receiving conveyor must be accelerated to belt velocity in as short a distance as possible.
- The sugar must be heaped up along the centre line of the belt, leaving adequate free space at both edges.

If these requirements are not effectively achieved, spillage over the edges of conveyor belts will be inevitable, regardless of any expedient measures taken to prevent it.

Therefore, when considering the existing transfer hoppers at the Sugar Terminal in terms of the above observations, it became obvious that major modifications were necessary to achieve the required control and accuracy of sugar flow during transition from one conveyor to the next.

Each transfer hopper, together with associated conveyor plant, was redesigned and modified, within the constraints of existing parameters such as space and relative situation of conveyor plant. In some situations, a degree of compromise was unavoidable.

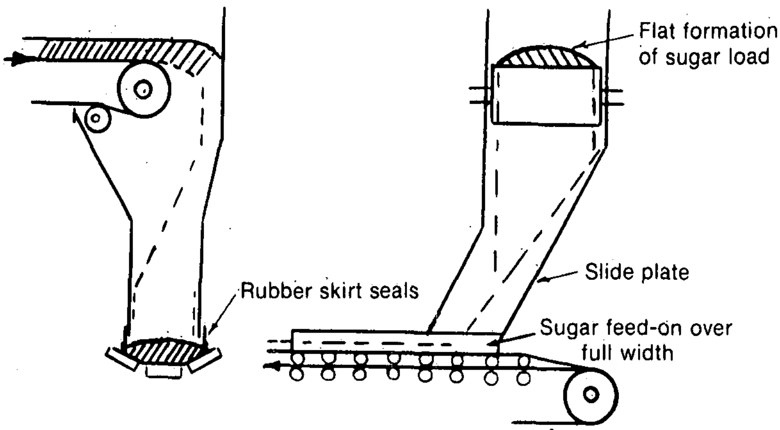


FIGURE 1 Typical transfer hopper before modification

The basic design features of the transfer hoppers before modification are illustrated in Figure 1. The important features are:–

- Sugar flowing into the transfer hopper, falls onto the sloping 'slide-plate' which directs it onto the receiving conveyor in the general direction of travel.
- Feed-on occurs over the full width between skirt boards and acceleration takes place from the back of the transfer hopper. However, friction at the surface of the skirt-boards retards this acceleration, causing turbulence.
- Spillage over the edges of the conveyor is contained by the rubber skirt seals which are, at best, moderately effective.

This type of transfer hopper arrangement has the following disadvantages:

- The loading of the conveyors cannot be optimised, because of the vertical component of velocity of the falling sugar and the wide feed-on. This results in a flat formation of the sugar load, occupying the full width of the conveyor. Any attempt to increase loading, will result in spillage of sugar over the edges, which is not acceptable.

- Sugar build-up within the hopper is excessive, and soon results in an unbalanced flow of sugar at feed-on, causing difficulty with belt tracking, which aggravates the spillage problem.
- The rubber skirt seals cause rapid belt wear.

An outline of the modifications carried out to the transfer hoppers and conveyor plant, are shown in Figure 2 and are described briefly as follows:

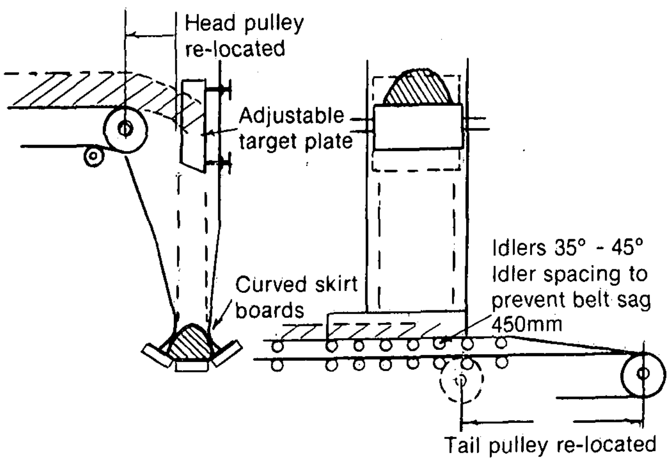


FIGURE 2 Transfer hopper and conveyors after modification

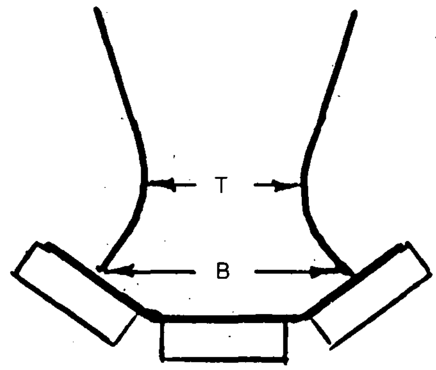
- The head pulley and associated bar pulley have been moved.
- The bar pulley is no longer situated within the hopper, thus avoiding build-up caused by dusty sugar.
- A suitably designed target-plate has been positioned, relative to the centre line of the receiving conveyor and parallel to its line of travel. Target-plates are adjustable and easily cleaned.
- The tail-pulley of the receiving conveyor has been moved backwards in order to accomodate the modified transfer hopper, together with deep-trough 35°–45° idlers at feed-on.
- Idler spacing at feed-on is at 450 mm centres in order to prevent sagging of the belt.
- Curved skirt-boards are installed, as shown in Figure 3 allowing a clearance from the belt of about 4 mm. Rubber skirt seals are not fitted.

The function of the curved skirt boards can be described as follows: (See Figure 3)

A choking action is achieved across the throat between the skirt boards, thus decelerating the falling stream of sugar. The sugar then expands through the increasing size of the throat, as it is accelerated by the belt conveyor on to which it is being fed. Sugar is thus heaped high in the centre of the belt. The required lengths of the skirt boards and the throat sizes were found by experimentation and are described in Figure 3. All conveyor belts are 1 050 mm wide and the belt speed 2,67 metres per second.

These modifications have produced a situation, where sugar feeding from one conveyor to the next is completely under control. This has resulted in the symmetrical loading of conveyors, heaping sugar up along the centre leaving a clear section of belt at both sides of about 130–180 mm. Belt tracking is excellent and sugar spillage over the edges of belts has been eliminated.

Flooding when re-starting the conveyor system after having stopped with a full load of sugar: flooding will occur under these conditions when re-starting the conveyor system, because transfer hoppers will contain an accumulation of sugar in transit. This problem was overcome by means of pneumatically operated control gates fitted at the exit from the transfer hoppers (See Figure 4).



	Length of Board	Throat T	Belt B
Horizontal conveyors	1200	320	600
Inclined conveyors	1800	440	690

FIGURE 3 Dimensions for setting skirt boards

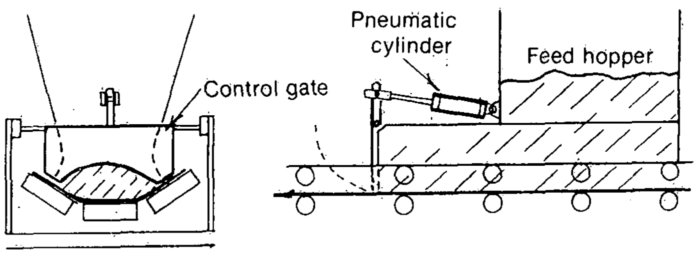


FIGURE 4 Pneumatically operated control gate

When the conveyor system is stopped, the gates close automatically. However, they will not re-open until a predetermined time has elapsed after start-up, thus allowing the accumulated sugar in the hopper sufficient time to run off. The gates incorporate a suitably sized opening which restricts the rate of flow of sugar from the hopper, thus preventing spillage over the edges of the belt. This equipment is most effective and is an essential part of the conveyor installation.

(2) *Spillage due to carry-over on the return belt*

This is a longstanding and well known problem, especially in hot, humid climates. It was the cause of more than half of the total spillage at the Sugar Terminal i.e. 0,05% of the sugar handled or 7 tons of spillage in a cargo of 14 000 tons. This spillage was distributed on the floor, along the entire length of the conveyor system, and recovery of the sugar was costly and time consuming.

Carry-over also results in a build-up of sugar on idlers and pulleys which in turn causes belts to run out of line, resulting in spillage over the edges and damage. It is a primary cause of rapid belt wear due to scuffing. To overcome the problem of carry-over, a belt scraper was designed and developed at the Sugar Terminal (See Figures 5 and 6).

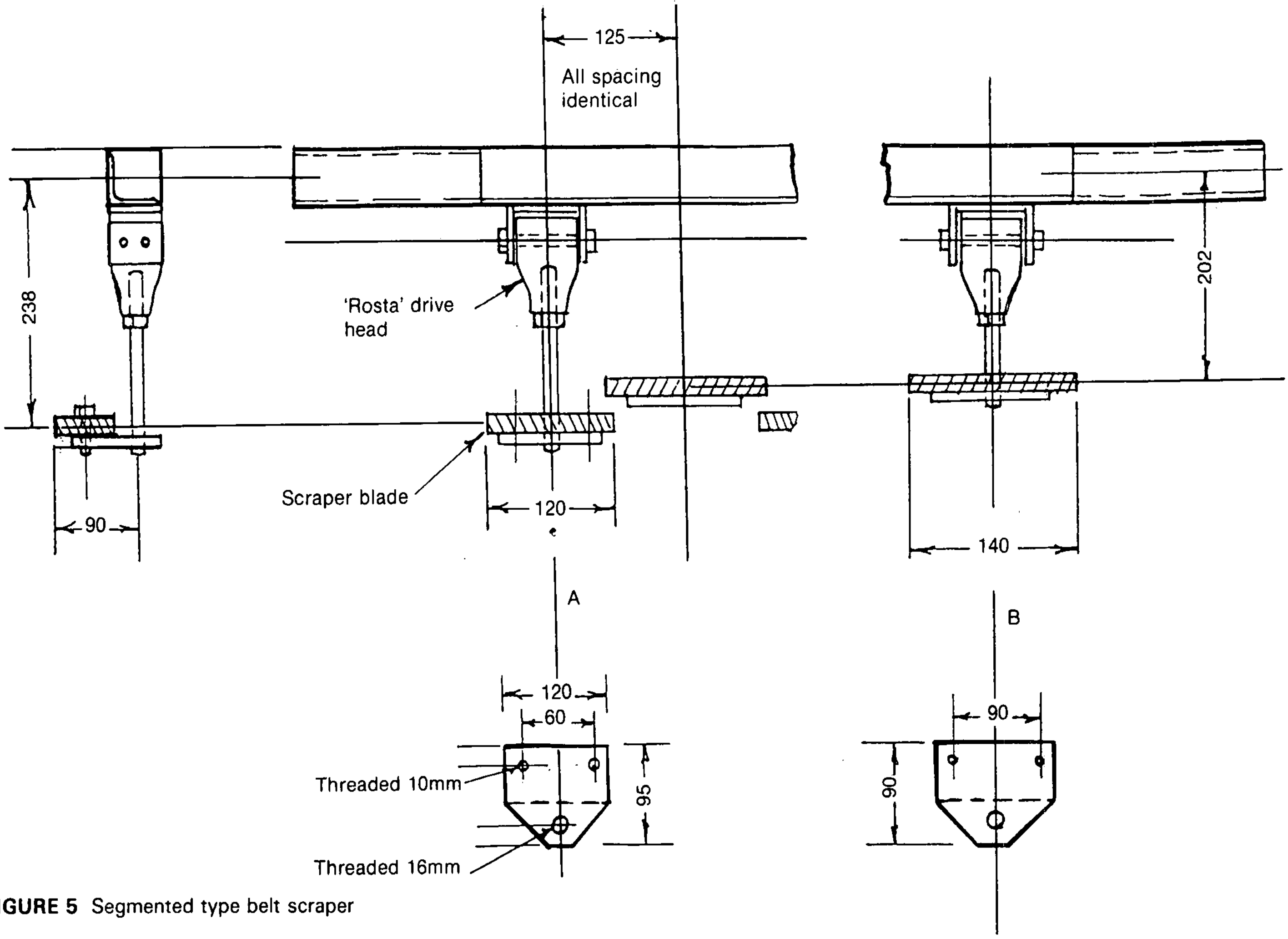


FIGURE 5 Segmented type belt scraper

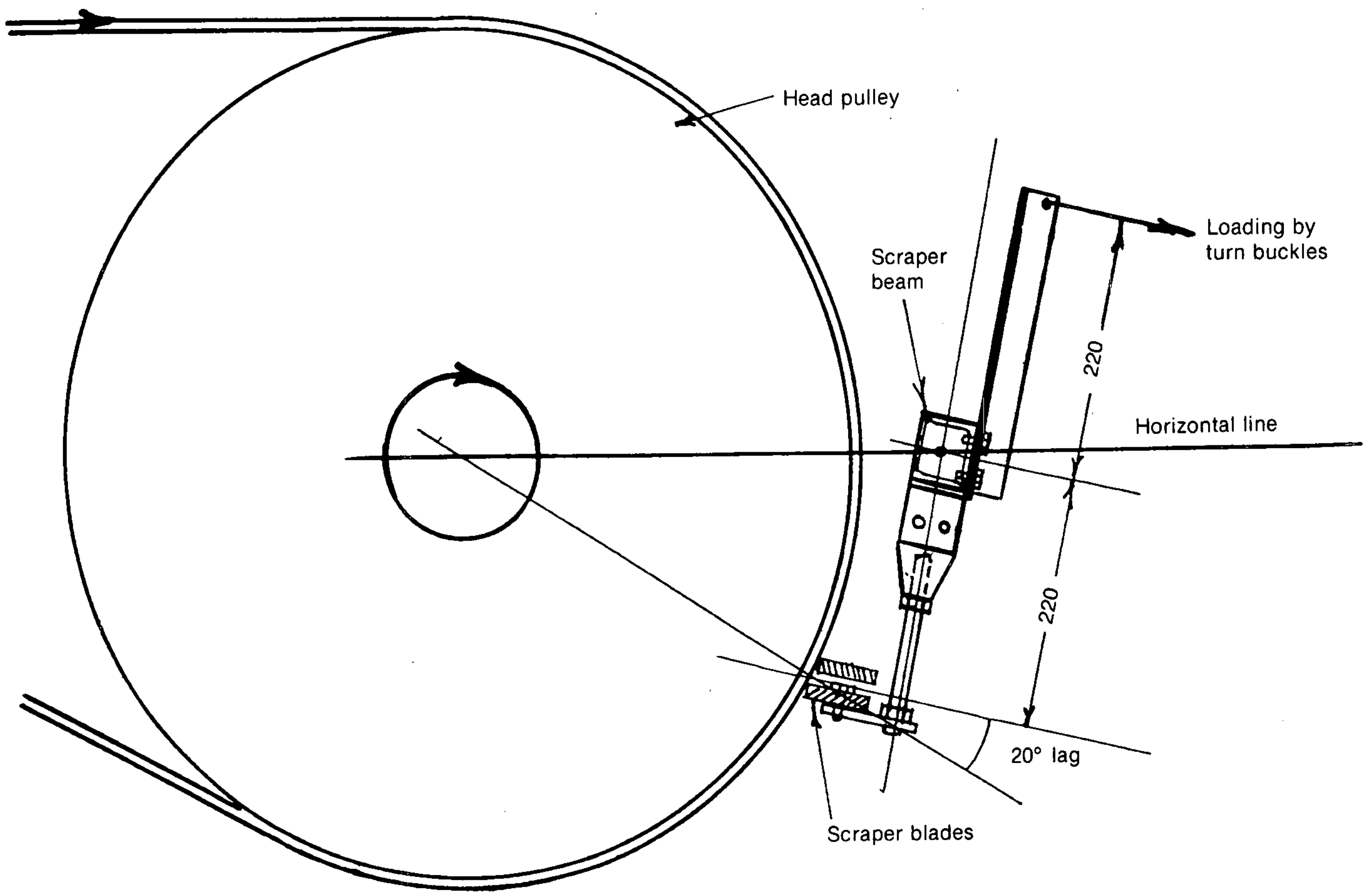


FIGURE 6 Mounting of belt scraper

The scraper is of the segmented type, based on 'Rosta' drive heads which are commercially available. The drive heads produce the pressure required by the scraper blades. This type of scraper has been in use at the Sugar Terminal for more than a year. It is successful and has reduced carry-over of sugar to negligible levels. It is effective when handling VHP or coated sugar. However, when handling coated sugar, the scraper is used in conjunction with a water spray system which wets the surface of the belt just before coated sugar is loaded onto it.

The scraper is mounted at the head pulley at about 4 o'clock to the vertical. It is accessible for maintenance and can readily be observed in operation. The scraper unit consists primarily of a transverse beam, made up from a 50 × 50 mm steel angle section, boxed at both ends to form a square section. The beam is mounted through the sides of the transfer hopper ahead of the pulley, using standard pipe flanges as bearing guides, since it will not rotate after initial tensioning. 'Rosta' drive heads are bolted to the beam side by side, depending on the width of the conveyor. (Eight are used at the Sugar Terminal).

The scraper blades are made from polyurethane of 90° Shore hardness and are 20 mm thick. They are mounted on steel backing plates and are reversible for reasons of economy. The backing plates are attached to the drive heads by means of threaded steel bar. Scraper blades are staggered alternately to achieve an overlap of about 10 mm. An important aspect of the design is that alternate blades are different widths, to achieve uniform blade pressure at the belt surface.

To avoid blade-chatter, the scraper beam must be positioned so that the angle of contact between the blades and a line drawn diametrically through the head pulley centre is not less than 20° lag.

The scraper is finally loaded by means of turnbuckles fixed to lever arms, mounted at both ends of the scraper beam, outside of the hopper. The loading is measured by means of an ordinary spring balance. Pressure is kept to a minimum and will be found in practice by trial and error. The loading that was found to be adequate at the Sugar Terminal was 140 kg total.

No evidence of belt cover wear resulting from use of the scrapers has been found. Scraper blade wear is minimal. It is possible that the scraper does not allow any sugar to penetrate between the blade and belt, thus preventing any 'grinding' or 'scuffing' effects.

(3) *Sugar build-up in hoppers and on skirt boards etc.*

This problem has largely been resolved since the transfer hoppers were modified because the flow of sugar is now confined to the target plates and curved skirt boards, which are the only areas requiring regular scraping and washing. The transfer hoppers serve primarily to contain sugar dust and to cater for surges of sugar during emergency stops on full load, when hoppers will function as surge bins. Hoppers have been painted inside with a smooth white epoxy to reduce sugar build-up and facilitate rapid cleaning.

(4) *Spillage related to dusty VHP sugar*

In the past, this problem arose mainly at transfer hoppers, where clouds of dust would blow out from the bottom of the hopper. However, it has been noted that the incidence of dust clouds emanating from transfer hoppers has decreased dramatically since the above modifications were carried out. A possible explanation for this improvement is that the sugar in transit through the hoppers no longer flows haphazardly from one side to the other, driving clouds of dusty air ahead of it. However, spillage arising from dusty sugar is still a problem at the Sugar Terminal particularly at the bottom-dump intake station and within the storage silos.

Conclusion

The recent modifications and innovations carried out at the Sugar Terminal, have resulted in a dramatic reduction in sugar spillage, to levels which can be considered as negligible.

Sugar spillage over the edges of conveyor belts is no longer a problem. Belt tracking is very good and is completely predictable, thus reducing the possibility of damage to the edges of the belts.

Wear and tear of the top covers of belts is substantially reduced because rubber skirt-seals are no longer required at the feed-on hoppers and because of the elimination of carry-over on the return belt which causes scuffing.

Sugar build-up in transfer hoppers has been greatly reduced because of the introduction of target-plates. The plant can now operate for much longer periods between cleaning operations.

Spillage resulting from dusty sugar is significantly reduced because of controlled sugar flow through the transfer hoppers. However, dusty sugar in the bottom-dump intake station and also in the storage silos is still a cause of concern.

In areas where modifications have been completed, the standard observed in the Australian sugar terminals has been achieved. However, work is progressing with the remaining areas of the plant.

The best results are obtained when the plant is operated with a constant feed rate that is close to full load. When the feed is erratic, spillage occurs at the feed-on from hoppers, spilling through the gap between the curved skirt-board and the belt. A load indicator to facilitate rapid adjustment of the sugar feed when shiploading has been installed at the silo reclaim conveyor. Also, the existing profile-type feed controllers are being replaced by a double clamshell system to facilitate rapid control and good belt loading.

It is of interest that the modifications and innovations carried out to reduce sugar spillage have resulted in an optimum loading of the conveyors. This, in turn, has presented an opportunity to increase the loading of the conveyors. It is therefore anticipated, that the shiploading rate will be increased in the near future, from 800 to 1 000 tons per hour, at very low cost, while retaining existing belt speeds.

Future savings resulting from the modifications will be substantial.

Acknowledgements

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