SPILLAGE CONTROL ON BELT CONVEYOR SYSTEMS

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INTRODUCTION

In the next hour or so, I shall be taking a look at spillage control and considering how best to tackle one of the most fundamental problems which face any plant operator responsible for bulk materials handling.

We should not attempt to carry materials in sieves. Why? Because they leak. Yet in spite of that fact that materials handling plants leak just like sieves, we continue to use them because we don't have an alternative. A painful reminder of this fact is the lesson we learn daily that spillage, once on the floor, is difficult to pick up again.

A useful exercise at the beginning of any analysis is an examination of what we don't know about a particular topic. What might we not know about spillage? For a start, we probably don't know how much it costs to make a mess in the first place. We probably don't know how much will it will cost to clean it up. We probably don't know how we will clean it up. Most important of all, however, we probably don't know what we could have done to prevent it happening in the first place.

What's the point of all this? Most materials handling plants are designed, installed and maintained without giving much attention to spillage prevention. Although my talk is entitled "Spillage Control", it might more accurately have been called "Spillage Prevention".

In the UK there have not been many new materials handling projects commenced recently but there are a great number of plants in operation. Whilst it is desirable to ensure that new plants don't spill, I'll leave that topic until later. The problems on existing plants pose the most extensive and difficult tasks to improve on spillage control/ prevention.

I shall now proceed to highlight a few relevant issues: -

1. Regulations
   COSHH and the Environmental Protection Legislation
2. The Nature of the Problem on bulk handling conveyor systems
   a) At the load point
   b) At the discharge point and
   c) Along the conveyor run.
3. Task of improving existing plants
   Importance of (i) maintenance and (ii) working in partnership
4. New Concepts
5. The Way forward
   Establishing true costs
   Working in partnership
   Value for money for operating company.

REGULATIONS

These days, when every politician seems to be offering the electorate more and more choice, it comes as a sobering shock to realise that, as of November, 1990, those of us in the materials

handling industry in the UK had only a very stark choice: - either a £20,000 fine in a Magistrate's court or the possibility of 2 years' imprisonment and an unlimited fine in a County Court, if found in contravention of the new environmental protection legislation. And if that's the good news, the bad news is that we are presumed guilty until proven innocent.

The Legislative Climate

The UK Environmental Protection Act received Royal assent in November, 1990. It is a far-reaching and powerful piece of legislation which will affect all companies in some way or another. The Act comprises nine parts and sixteen schedules, but the most important parts of the Act, as far as the materials handling industry is concerned, is Parts I.

Part I outlines how the larger/more polluting "Part A" prescribed processes will be controlled and enforced by Her Majesty's Inspectorate of Pollution (HMIP) and, where relevant, the National Rivers Authority (NRA) and the Waste Regulatory Authorities (WRA). The smaller/less polluting "Part B" processes will fall under local authority air pollution control and waste will be controlled separately. Companies must cheek if they operate a prescribed process.

Part I means that all prescribed process operators need to apply for authorisation to begin or continue that process. Charges for authorisation will be costed for the application, or any variation, and there will be an annual charge. All processes will have to use Best Available Techniques not Entailing Excessive Cost (BATNEEC) and ensure that, where appropriate, they are using the Best Practicable Environmental Option (BPEO).

In summary, Part I will introduce:-

1. New/tighter emission limits/quality objectives
2. Public access to information
3. Higher penalties (Magistrates Court £20,000. Crown Court 2 years' imprisonment and unlimited fine)
4. Implied condition of "guilty until proven innocent"
5. Risk of personal liability
6. Variation and prohibition notices.

Under Part II - Waste on Land - the main provisions include a Duty of Care requiring holders of waste to take reasonable care that it is not managed or disposed of illegally. It introduces new waste management licences for the disposal companies and separates waste disposal operations from the WRAS. It also introduces higher standards of waste regulation - and extensive penalties are available to the courts.

Part II came into force in January, 1991. It concerns emissions which may be prejudicial to health or a nuisance, and could involve smoke, fumes, dust, smells or noise.

A local Authority can serve an Abatement Notice to stop or restrict the situation. An individual can also apply to a Magistrates Court for an Abatement Order. Penalties of up to £20,000 are available in a Magistrates Court.

Part III covers Statutory Nuisance and Clean Air. These will be controlled by local Authorities.

So what do companies have to do in order to comply with the Act?

1. They must ascertain whether they are a prescribed process or not.
2. If this is the case, they should look at the methodology for authorisation.
3. They should consider what emissions the processes causes and monitor where appropriate.
4. They need to decide what is BATNEEC for their industry sector
5. They should look at their handling, storage and disposal of waste.
6. They should assess any possible statutory nuisance.

THE SCOPE OF THE PROBLEM

Without spillage control, belt conveyors work with impaired efficiency, increasing cleaning-up costs and putting plant availability and continuity of production at risk.

Containment of the materials being conveyed can be considered in three stages:

1. Loading point containment
2. Preventing the escape of material from the run of conveyor
3. Managing the discharge of the materials being conveyed.

Load Point Spillage Containment

The most obvious way to avoid spillage problems is to eliminate spillage at source. Nowhere is this more important than at transfer points where maintaining a tight seal to contain materials prone to become airborne is of paramount importance.

Load Point spillage containment depends predominantly on the maintenance of an efficient seal between fixed skirting and the moving conveyor belt. Dust extraction is also of importance, as is belt support and maintenance.

If the conveyor is troughed at the load point, well-designed skirt rubbers should ensure that material is contained. The key to success, however, depends on the accuracy with which the seal can be maintained. One way, for example, in which this can be impaired is when the impact of the failing material frequently causes the belt to sag, so allowing material to escape.

To create an effective seal requires close-tolerances to be maintained. This is only made possible with the use of load or impact bars set between troughing roller sets in order to absorb the impact of material being deposited from the loading chute, to provide a trough-shaped, low-friction support platform for the conveyor belt and to prevent the skirt rubber seals from gaping at the point of impact.

By supporting the conveyor belt on a fixed plane, the high-durability impact bars enable skirt rubbers to be close-sealed at the loading section, thereby reducing spillage and the air-borne escape of more fluid materials frequently encountered at transfer points. They can also be used to form a slide bed, where conveyors are loaded over an extensive length - filter cake conveyors beneath plate presses, for example.

A system such as the one which I have just described will only remain effective, however, for as long as it is properly maintained.

All components are subject to wear but skirt rubbers are in the front line. It is vital, therefore, to fit clamps which permit quick and easy readjustment for wear. It is also essential to ensure that there is easy, but safe access to the clamps to enable the adjustments to be made in as cost-effective a manner as possible.

The Role of Hywall Conveyors

There are applications, however, where troughed conveyors cannot be used. A case in point was a recent installation which ACE completed on the south bank of the Thames.

Spillage problems had been experienced at transfer points on four inclined, troughed conveyors which transport cement from silos, below ground level, to storage hoppers which link directly with ships or lighters tied up alongside the plant.

There was unacceptable "fall-back" of material, too, on the conveyors which were up to capacity. The company' needed to increase handled volume, to maintain throughput and satisfy market demand. The belt speed could not be increased; nor could the gantry be modified. ACE had to resolve these conflicting requirements and also install effective belt cleaning.

ACE recommended a switch to cleated Hywall belt, for three reasons: -

Firstly, they would enable the belt to carry increased loads at reduced belt speed, so minimising load point emissions. It also obviated the necessity to modify the conveyor structure or the gantry, both of which would have been too costly.

Secondly, the lateral cleats on the belt would prevent the "fall-back" of product on the inclined belt sections and also enhance the carrying capacity of the belt - again, whilst allowing a reduction in belt speed. Speed is always important since it not only leads to increased component wear but also generates dust and spillage when highly fluid materials are being conveyed.

Thirdly, and most importantly, the Hywall belt would help prevent transfer point spillage at the loading point, because effective, tight sealing is possible with this kind of belt.

Labyrinth Seals

ACE devised, manufactured and installed a labyrinth seal arrangement for the new load point. It involved a seal which created a tortuous path, effectively eliminating the air-borne spillage previously encountered.

Naturally, such tight sealing arrangements required close tolerances in the manufacture of the belt and we were able to control quality because we hot-vulcanises both cleats and sidewall on the belt at our Doncaster factory. The seal arrangements, too, demanded precise belt tracking control - which is even more critical than on a standard Hywall installation.

Tracking Aids

A troughed belt conveyor is assisted in its tracking by the fact that the belt is troughed in the first place. The idler set has a lead angle which helps to centralise the belt as it is fed into it. A flat roller, however, has a minimal influence on tracking.

Link-type vertical rollers were installed, therefore, on the Hywall belt, near the loading point, in order to minimise the possibility of belt wander. This was crucial in order to maintain the tight seals on the delivery chute.

Support Bars

For sections of belt which are not subject to loading impact but where positive sealing is still required, ACE has support bars which are equally effective in preventing vertical displacement of the belt between roller sets, thus promoting a good seal between the belt and the skirt rubbers.

For applications utilising troughed belts, options include retaining the central roller, using the impact bars in place of the troughing rollers; using conventional troughing set rollers with impact bars to support the belt in between; or replacing whole troughing set with impact bars.

Importance of Skirt Rubber Adjustment

Whichever configuration is most appropriate, we recommend that the impact bars are used in conjunction with our quick-release, skirt rubber clamps. The clamps permit easy and fast adjustment of skirt rubbers, enabling spillage-free transfer to be maintained with minimal downtime. After all, there is little point in saving man- hours on cleaning up, only to deploy the same personnel on skirt rubber adjustment duties which are inefficient.

Skirt Rubber Clamps

The improved design of the well-known ACE/JB quick-release skirt rubber clamp makes for even more secure spillage control at transfer points in conveying systems.

Simplicity itself in use, the ACE/JB clamps are designed for use with skirts from 8mm - 20mm, the clamps can be adjusted and re-secured with a clamping force of 52.5 kgs, simply by pushing the torsion arm forward, tapping the rubber down and releasing the torsion arm to re-clamp the skirt in its new position.

Under normal conditions, the clamps are welded to the skirt boards at approximately 600mm spacings, although this spacing may be varied, according to severity of duty.

The serrated gripper strip, which prevents riding up and also prevents the skirt rubber from being dragged along in the direction of belt travel is now fixed to the clamp for even easier adjustment.

There are no bolts to undo or tighten and the fixing method dispenses with the need for bolt heads inside the skirt boards or holes in the boards, rubbers or clamping strips.

There are no wearing or metal-on-metal moving parts to rust and the standard version of the clamp is fully galvanised to offer protection against corrosion in most operating environments.

Discharge Points

At discharge points, belt cleaning is a major preoccupation. Primary, torsion arm scrapers, blade types and materials, wet fines removal and the return of spillage to the conveying strand are issues which nearly always have to be addressed, along with belt washing, to cope with really difficult residues.

Belt Scrapers

The classic ACE range of belt cleaning equipment includes scrapers, V-return ploughs, washers, chute linings, skirts and quick-release clamps.

Scrapers include primary and newly up-rated torsion-arm types and options include single/segmented blades which can be in a variety of materials to suit individual applications. These options include wear-resistant polyurethane, stainless steel, high-carbon steel, ceramic & tungsten carbide. Often both types of blade are fitted with shrouds which divert spillage away from the blade mechanism, enhancing still further the effectiveness of the design.

The ACE/FR removes not only wet fines and slurry but also dry, granular residues which are dislodged as the belt passes through the roller mechanism. Simple to install or retrofit, the device is also easy to maintain and repair.

The Ace/RE Rotary Fines Elevator, eliminates the unpopular and sometimes dangerous job of spillage clearance by providing an effective mechanised method of returning fines to the carrying strand of a belt conveyor.
Available as original equipment or as a retrofit after the head chute, the drum-like rotary elevator is fitted round the conveyor at a suitable belt cleaning position, typically as part of the tertiary stage of the cleaning system.
Material is scraped from the belt return strand into the inside of a drum which rotates slowly, thereby returning spillage to the carrying side of the conveyor belt.
This means that there is less need for cleaning up, that less conveyor maintenance is required and that airborne dust is substantially reduced.
When residues prove unmanageable by other means, there is often little alternative to "wet" cleaning and ACE markets a pressure jet washing system which then needs to be followed up with belt scrapers which remove the softened residues and then squeegee the excess water from the belt.
In the materials handling example which I cited earlier - the one which employed cleated Hywall belt, the cleaning system employs two beater rollers, or rappers, at the top of the conveyor, adjacent to the head chute. These rappers beat the belt such that any material which has not discharged up to that point is dislodged from the carrying strand and fails into a hopper, at the bottom of which is a screw conveyor, directing the fines back into the main discharge hopper.
This neat and effective belt-cleaning station utilises self-powered rappers driven by shaft-mounted drive units and also incorporates dust extraction equipment.

RUN OF CONVEYOR

On the run of conveyor, the inspection and maintenance of the belt itself is of vital importance, if the belt is to be kept in serviceable condition.
I cannot recommend too highly the use of vulcanised joints, wherever practicable. Flexible joints in a rubber belt also keep dust to a minimum, particularly when materials which easily become air-borne are being conveyed; the smoother the progress of the belt around drums and over rollers, the fewer are the opportunities for such materials to cause dust.
Where the use of such joints is not practicable - or where the material conveyed is exceptionally light - dust-encapsulating covers can be employed to contain the escape of air-borne material.
Mechanical fasteners have the disadvantage of allowing spillage through the gaps which develop and also lead to advanced wear on other moving parts. Clip joints also need more frequent attention.
Belt tracking is also important to ensure that the belt runs straight and true and does not wander off, spilling its product.
The use of the belt turning technique on long-centre conveyors can also be beneficial. Here, the belt is turned through 180 degrees, just after discharge points. This has the effect of loosening some of the material which adheres to the belt surface at this section but any that remains is on the upper side and does not fall off. Naturally, the belt has to be twisted back to its proper operating mode at the tail end.
While the belt is twisted, rappers - the vibrating cleaning devices I mentioned earlier - and brush mechanisms - both rotating and non-rotating - can also be used to dislodge adhering material from the belt. Such material can then be returned to the conveying strand by very simple means.
In the conveyor run, there is frequently a need to consider a means of duct encapsulation. Frequently this means putting covers onto the conveyor in order to minimise the effect of wind loss, where the wind blows material from the belt. Sometimes, wind deflectors are required to prevent not only product but, in extreme situations, the troughed belt itself from being blown off the conveyor.

THE IMPORTANCE OF MAINTENANCE

So far, I have touched on a wide variety of devices which can be used successfully to combat spillage. They will only remain successful at their job, however, if they are maintained in peak operating condition. This is why maintenance is so vital.
It is traditional for companies to purchase equipment and carry out their own maintenance. What they fail to appreciate is the skill and detailed knowledge relating to the apparently straightforward equipment. Knowing how to set it up and install it to make it effective. This lack of interest in getting things just right can have a tremendous effect on the performance of the equipment.

Unless the issue of proper maintenance is accepted, it is all too easy for companies to switch between suppliers of cleaning equipment such that they end up with a variety of devices from a number of suppliers, none of which is correctly maintained and none of which is fully understood by the maintenance crew. Supplier companies not interested in maintaining the equipment, partly because the customer has demonstrated that he has no loyalty and principally because it is not cost-effective to visit the plant simply to maintain one or two devices.

BRING IN THE CONTRACTORS

Materials containment depends of such factors as drop heights, belt speeds, belt widths and the type of conveyor belt, including whether it is profiled or not. They are essentially practical considerations - not highly theoretical ones. What is important is experience and customers would do well to employ a contractor who can demonstrate the breadth of experience required to handle the application under consideration.

By way of example, if product is highly abrasive, scrapers will need high contact pressure and large contact areas. In these circumstances, the power requirements may be significantly greater than the nominal figure suggested by theory. A smooth surface and a product with a low coefficient of friction which is not too wet, may well have a power requirement which is lower than theory would suggest. Cleaning systems, however, often require more than one cleaning device and the contractor's experience is invaluable in assessing to what extent power requirements might be a problem.

Providing adequate power, however, is not the only point at issue. We may also have to consider how the power will be dissipated. If it is through heat, it can then have a knock-on effect on the choice of blade material for scrapers. Some types cannot be successfully deployed in high-temperature environments.

Load bars, fitted in a short section at point of impact, exert insignificant frictional drag on a belt moving over a fixed plane but if the belt speed is high and the contact pressures are also high, the friction could generate sufficient heat to affect the belt surface and wear away the impact bars more rapidly. Such effects are usually non- linear and the longer the section converted to impact bars, the greater the effect of heat build-up and other frictional effects.

We have encountered installations where conveyors have been modified from roller- based systems to slide-bed-based types which were incapable of being driven because the power requirement has been far in excess of that provided by the available motor. In such a case, motors and gearboxes have to be changed - which, in turn, may have knock-on effect on the end drums and gravity take-up units. Higher tensile belts might be required, as might up-graded roller bearings - even the conveyor structure itself!

HOW DO WE DEFINE BEST PRACTICE?

Best practice starts with unit selection and extends, through ease of installation to inspection and maintenance. There is a need to design plant which is accessible for inspection and, more importantly, for maintenance to be carried out.

More fundamental still is the selection of components in a conveyor system on the basis of their modest requirement for maintenance - frequency and scope of the attention required; the blade life, in the case of a scraper; in a belt, the thickness of its covers, bearing in mind the exponential relationship between thickness and rate of wear.

Existing installations pose a disproportionate number of maintenance problems, usually because of the poor design of the original plant. We regularly encounter conveyor without walkways, or shrouding and safety cages which actually impede inspection and maintenance because they have not been designed for easy removal.

OPEN PARTNERSHIP ESSENTIAL TO ACHIEVE RESULTS

To be successful in combating spillage on materials handling plant, an open partnership has to be created between the user, the equipment supplier and maintenance provider of certain key components, such as belt cleaning equipment, skirting systems or dust extraction equipment.

One of the persistent problems in the past has been the fact that initial improvements which have been achieved through the expenditure of capital and the provision of new equipment has not been sustained because maintenance has not been carried out sufficiently well or regularly to allow the equipment to continue to function as it did when it was first installed.

There is a need for this partnership to be created and there should be open accounting where the true costs of the previous or less effective method of handling the product are duly

acknowledged. Only when the costs of previous ways of working have been fully and correctly acknowledged can savings be measured with any confidence. And confidence is vital as a basis for contracts.

Normally, potential or existing customers can't or won't disclose the true cost of coping with poor materials containment in terms of wear and tear on the equipment, the cost of clearing up, the loss of materials and also of production because breakdowns are more frequent.

Comprehensive answers are never available. If companies do know, they may not want anyone else to know. And yet in order to measure improvements, there has to be a readiness to acknowledge what the costs are. Only then can improvements be monitored and the benefits evaluated.

If companies will not acknowledge what it is costing them to operate badly, they will never value the good practice which they could be enjoying. If costs are not identified, there is no perceived gain.

If we get to the point where we can measure the true costs of poor performance on materials handling plant then we may get the stage where we can operate plant performance contracts. But it does depend on accurate identification of true costs and savings. This could be beneficial to all concerned but, at present, there is little confidence in the data.

If contracts were to be drawn up with penalties for contractors who failed to deliver the promised savings, contractors would have to be confident that they are not being misled into subsidising on-going bad-practice.

Equally, plant operators would need to be reassured that they are not being persuaded to part with large sums of money for unsuitable equipment and/or unnecessary maintenance.

NEW CONCEPTS

Recognising the limitations of the traditional troughed belt design, where the product is open to the environment, alternative ways have been sought the better to contain material: -

1. The Conveyor tube - product is conveyed in a moving tube to be opened up at load and discharge points. It is returned as a tube, too. This idea has definite advantages as far as containment is concerned, although there are operational problems with controlling the tracking of the tube which can twist, open and so spill the contents.
2. The Sicon conveyor. This runs on a monorail which holds the edges of the belt together. Again the belt has to be opened up for loading and discharge.
3. Standard troughed belt in curved conveyor configuration to minimise number of transfer points.
4. The Blanket Conveyor. In this instance, a second belt is laid over a troughed conveyor and maintains a seal. Problems may arise in the amount of space taken by returning the top belt. Tracking is difficult and speed differentials when the angle of incline is changed can cause problems. There can also be associated abrasion problems.
5. Traditional sidewall belt eliminates spillage at transfer points in vertical plane. There can, however, be problems cleaning the belt, because of the profiles which are often fitted in inclined conveying applications.
6. Solitude. This is another tube design which is held in place with spring steel clips and driven by large-sized Vee belts cantilevered out from the sides. This design contains materials effectively but has problems when a change of direction is required.
   The radii of curvature of the seal and drive belts are different, because of the difference in path length when the conveyor negotiates a bend. This causes the seal to open slightly, so there is a risk of spillage. The other problem is keeping the Vee belts synchronised. Even slight variations of relative speed causes an asynchronous waveform to develop along the sealing edge, thus causing the seal to gape at anti-nodes.
7. Labyrinth Belt. This idea employs two belts driven one on top of the other. Both have sidewalls. The system works well on a straight run but the difference in angular speed between the two belts when negotiating vertical angle changes produces slip and the concept has failed in these applications.
8. Zipper Belt was tried some years ago but the closure proved unreliable, resulting in dramatic and expensive failure.

The limitation of all these systems, cleated Hywall excluded, is their small carrying capacity. At present, they mainly handle only low-tonnage, small-sized material. They all suffer from the disadvantages of being easily damaged if foreign bodies are trapped inside them.
There is a lot still to be said for the troughed belt conveyor but it is weak on environmental containment of the product.

POINTERS FOR THE FUTURE

By now it should be clear that spillage and belt cleaning cannot be treated in isolation. The problems need to be seen in the context of the materials handling application as a whole.
That is why the greatest development in the future will be in the area of attitude, rather than conventional R & D. Many of the UK's major companies are now entrusting conveyor maintenance to third-party specialist contractors. Not only do they have the breadth of expertise necessary to achieve high operating standards; they also allow non-specialist maintenance staff to be re-deployed elsewhere on the plant.
It is user attitudes which keep the industry going. Ironically, plant managers who try to make false economies in maintenance and cleaning usually pay more, in the long term, both in environmental and cash terms, to cope with cleaning and spillage control on their plant.
My message today is that customers must investigate what it is costing, in total terms, to operate in the way in which they operate at present. They must be willing to measure the improvements in financial terms. In our experience, many of the better schemes with which we have been involved, have been killed by senior managers and accountants when they started to monitor the costs of operating the maintenance schedule. What they fail to realise is that they had spent a good deal of money on capital equipment which was then being thrown away, because they were not maintaining the equipment in optimum condition.
Admitting total costs, monitoring the cost of spillage control, identifying the savings - these are the tasks which must be undertaken as part of a joint venture between customer and contractor.
Contracting spillage control out helps customers identify the true costs of the plant's inefficiency in that it has to quantify what needs to be done to eliminate problems and attaches a cost to the remedial action.
Spillage control is best treated as a joint exercise. It does not work if it is left to the operating company, the people who own the plant. It does not when spillage control is contracted out totally, when in-house personnel have no interest in operating the plant cleanly.
If a truly collaborative approach were embarked upon, benchmarks could be identified within a contract based on the period of time over which improvements would become apparent. Some items, such as reduced cleaning-up time, would show an immediate improvement while others, such as replacement costs on rollers, belts and other wearing components, would only be discernable over a two to four-year period.
It is in the long-term interest of suppliers to support the aims of their customers in being more efficient manufacturers if only for the reason that those which are inefficient tend to go out of business!
The inefficiency betokened by their attitude to conveyor belts may frequently be reflected in other areas of the business and they may not be a reliable company with which to trade.
Equally, companies which appear to be big spenders, which don't enquire to closely into pricing and which simply want instant problem-solving in a crisis, tend to have maintenance/repair budgets which spiral out of control. Their costs are out of order, their product time is down, delivery times extend, they may let customers down and suddenly they don't have a business any more. Their attitude, too, can be bad news for a contractor.
There is also the question of incentive in the third-party contractor. It is not easy for an untrained fitter to install a belt scraper properly - at exactly the right position, at the right angle of incidence and in such a way that the pressure mechanism is set to operate over a period of time rather than just at the set-up time.
The contractor has this incentive. He does not want to make unnecessary repeat site visits and so he is under pressure to deliver the service required at minimum cost both to himself and his customer.

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