BASIC CONVEYOR MAINTENANCE

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INTRODUCTION

This paper serves to remind and reinforce the value and necessity of maintenance on conveyors in mines, plants and other industrial operations. It goes further to emphasise to the younger generation of conveyor engineers and maintenance personnel as to the importance of continual corrective and planned maintenance.

It reminds supervisors who have the knowledge and experience, but more often than not spend their time in offices drawing up schedules of how and when maintenance should be done, yet seldom get into and under the plant to ascertain first-hand what the true situation is. Little time is spent conducting 'on the job training' by those who have the knowledge and experience to those who do not.

There are many instances where lack of pride in one's job, so to speak, is evident. Ultimately, many maintenance staff do not want to get their hands dirty and view their job as a source of income at month end.

We all go to work for a salary, but once you are at work you need to dedicate your time and effort to the allocated task. Regrettably, this is often not the case in these times, which becomes evident when taking an objective walk through certain plants.

This paper examines poor maintenance examples which reinforce the necessity of corrective and preventative maintenance in our industry. Maintenance cannot be over emphasized, even in a perfect plant, mine or operation where belt conveying is employed. It is thus vital to get down and dirty to highlight its importance.

Figure 1. Maintenance crew at work

MAINTENANCE

Objectives

- To keep the plant or works in good running order
- To maintain an acceptably high level of availability. Availability is an engineering function, while utilisation is a production function
- To keep the operational costs at acceptable and predictable levels
- To ensure that safety standards are upheld within the plant or works.

Who does the work

- Qualified and trained artisans with specific knowledge of conveyors, correctly supervised. Training is to be ongoing, keeping maintenance crews up to date with any changes and the latest technology
- Trained and accredited beltsman and splicers
- Engineers and technical planners
- Auxiliary services carrying out tasks such as temperature monitoring, vibration monitoring, oil sampling and analysis
- The safety officer who oversees the system prior to start-up.

PART I – PLANNED MAINTENANCE SYSTEMS

PURE MAINTENANCE CAN BE DEFINED AS:

The timeous fixing or replacement of any mechanical or electrical device should it become defective or out of order or broken in any way such that the plant cannot operate and produce as per requirements.

Classification of Types of Maintenance:

- Planned Maintenance — scheduled; preventative
- Unplanned Maintenance — unscheduled; emergency

MAINTENANCE METHODS

A large portion of the plant's operational costs can be attributed to maintenance of all equipment and as such any unplanned maintenance certainly increases these operating costs.

Therefore it is essential to have a properly structured maintenance schedule, and train the total workforce to use it to its best effect and advantage.

MAINTENANCE ALTERNATIVES

There are two alternatives

1. Operate the equipment and maintain it regularly *before* it breaks down.
2. Operate the equipment until it breaks down, then scrap it and buy new equipment (This can be considered as component replacement of irreparable items rather than maintenance).

In the case of failure of certain types of equipment, such as safety critical components, this alternative can prove to be extremely dangerous and cannot be allowed. For example, a hoist rope or a pressure vessel.

PLANNED OR PREVENTATIVE MAINTENANCE

To quote Mr Graham Shortt 'Planned maintenance implies we plan to fix it when it is broken'. This is often wrongfully practiced in our industry and is currently observed in many plants.

Planned or preventative maintenance is carrying out the work of inspection, servicing and adjustment, and so prevent failure of equipment during operation. It is the anticipation of failures before they occur.

It is thus further stated as:

Planned maintenance is not a specific type of maintenance, but the application of maintenance with a scientific approach. It is the comprehensive planning of the maintenance function. It includes the whole range of maintenance. It can apply to any of the following:

- Replacement
- Breakdown
- Preventative work

Provided that:

- The maintenance policy has been considered carefully
- The application of the policy is planned in advance
- The work is controlled and directed to conform to the prearranged plan
- Historical and statistical records are compiled and maintained to assess the results and to provide for future policy.

The essential structure of a practical planned maintenance system must include:

- A schedule of all plant and equipment to be maintained
- A complete schedule of all the individual tasks that must be carried out on each item of the plant
- A programme of events indicating when each task must be carried out
- A method of ensuring that the work listed in the programme is in fact carried out
- A method of recording the results and assessing the effectiveness of the programme.

Notes:

a. The above needs to be performed in conjunction with an Approved Risk Assessment for each task.

b. To keep control and effectively implement a planned maintenance system, a well organised documentation system is essential.

UNPLANNED MAINTENANCE

Unplanned maintenance is required on an unforeseen failure to which no advance consideration has been given. It is a failure that was thought could not possibly happen or one which is extremely unlikely. This may require corrective maintenance. These systems are also known as unscheduled or emergency maintenance systems.

No matter how good a planned maintenance system (PMS) is, there will always be some element of unscheduled maintenance necessary. This could be due to unpredicted circumstances, abnormal operating conditions and/or unexpected damage.

Typically these may include:

- Badly manufactured components. (There could be an inherent fault that may have gone unnoticed in the manufacturing process or assembly)
- Poor materials unknowingly used in the manufacture of the component
- Operating with the power supply outside of acceptable limits
- Operating outside of the equipment design specification
- Poor maintenance procedures or none at all.

Unplanned maintenance leads to:

- High failure rates
- Higher than normal rectification costs
- Unexpected personnel requirements
- Interruption of service at unplanned times resulting in poor availability
- Production losses.

The Advantages of a Planned Maintenance System include:

- The equipment is maintained before it fails
- Proper records are kept and continually updated
- The condition of the machinery is continuously monitored
- Regular maintenance is carried out
- There is a reduction in downtime and emergency repairs
- There is a reduction in spares inventory
- All maintenance is planned and executed
- A new crew can easily continue with maintenance in accordance with the planning schedule
- The plant is available for start-up when required
- Breakdowns within the plant are reduced
- The plant is more efficient with an increase in availability
- Downtime for the plant can be planned well ahead without adversely affecting production.

To operate a good Planned Maintenance System the following must be in place:

- Complete cooperation and mutual understanding between the departments concerned, such as production, engineering, services and contractors
- An effective maintenance policy for planning, controlling and directing all maintenance activities
- The maintenance/engineering department to be well organised, adequately staffed, suitably equipped and the personnel sufficiently trained to carry out the work
- The team must be progressive in their efforts to reduce or eliminate breakdowns
- Safety is a priority in all applicable operations.

PRINCIPLES OF PLANNED MAINTENANCE

The following needs to be considered before the maintenance can be executed:

- **What** work needs to be done. The Schedule must define in accordance with the risk assessment exactly what must be done.
- **When** is the work going to be carried out? Stop and re-start times must be clearly indicated and understood.
- **Materials** and equipment required to conduct the maintenance. All planned material must be on site prior to shut-down.
- **Who** is going to conduct the maintenance? Under what appointment and supervision this maintenance be carried out.
- **Limitations** that may hinder doing the work. This could include lack of power, bad weather or high humidity in the case of splicing.

Supervision of Planned Maintenance

When planned maintenance is scheduled and carried out, it needs to be correctly supervised by a competent senior foreman or engineer. Although a Quality Control Plan or QCP is generated that is signed off by the artisan executing the work, a supervisor is required to oversee the project. These QCP documents often contain tick boxes or signature blocks which are duly completed and submitted once the maintenance is complete.

PREVENTATIVE MAINTENANCE

Predictive maintenance is a more modern and scientific approach to incorporate into a planned maintenance programme.

It cannot replace a planned maintenance program but will assist and guide the maintenance team along a 'Measure to Manage' path within the process.

The elements are not new and have been used rather sporadically for decades.

Predictive maintenance tools like vibration analysis and thermography are utilised to analyse the condition of key components within the conveyor where potential failures can be flagged timeously and repaired or replaced to avoid unplanned breakdowns, provided that the data is correctly reacted upon. The incorporation of this process decreases maintenance costs and increases plant availability.

Major Component Change Out

For a major component such as a conveyor gearbox there are several maintenance options.

1. From the design and installation records, it is possible to determine a suitable time to change out the gearbox and send it for overhaul, irrespective of its condition.
2. Alternatively, regular monitoring of bearing temperatures, oil sampling and changing if necessary, vibration monitoring etc. can be monitored against a benchmark. In most cases this ensures a better life expectancy from the sub-assembly by predicting the anticipated time of potential failure.
3. The third option which is practiced in some plants is to leave the sub-assembly to fail and then replace it provided that a spare is available. This is NOT ADVISABLE.

Record Keeping

In all maintenance programmes it is critical to keep accurate records of sub-assemblies and major components in the plant. Here, there are two categories:

1 All sub-assemblies to be recorded and must have serial numbers hard stamped or engraved onto the component.

2 A full record of all maintenance needs to be kept. Any work that is done and completed during a planned or unplanned maintenance shift must be accurately documented. The importance of this is simply to ascertain past failure history and the records must continuously be analysed with the objective of improving maintenance schedules and detecting possible design flaws.

Statistics

Statistics convert data into actionable information that aids decision making as whether to do anything and what to do, to what, when, and to what extent. This information can halve field service costs, or highlight unexpected consequences that companies don't normally disclose. Don't give up on statistics, even for reliability predictions. Uncertainty can be likened to gambling without knowing the odds.

Condition Based Maintenance

Condition based maintenance (CBM) is a maintenance strategy using the actual condition of the asset to decide what maintenance needs to be done. CBM dictates that maintenance should only be performed when certain indicators show signs of decreasing performance or upcoming failure. Checking a machine for these indicators may include non-invasive measurements, visual inspection, performance data and scheduled tests. Condition data can be gathered at certain intervals, or continuously, as is done when a machine has internal sensors. CBM can be applied to mission critical and non-mission critical assets.

The goal of CBM is to spot upcoming equipment failure so maintenance can be proactively scheduled when it is needed and not before. Asset conditions need to trigger maintenance within a long enough period before failure, so work can be finished before the asset fails or performance falls below the optimal level.

Example of Condition Based Maintenance

- Motor vehicles come with the manufacturer-recommended interval for oil replacements. These intervals are based on manufacturers' analysis, years of performance data and experience. However, this interval is based on an average or best guess rather than the actual condition of the oil in a specific vehicle. The idea behind CBM is to replace the oil only when a replacement is needed, and not on a predetermined schedule.
- In the case of industrial equipment, oil analysis has an additional function. By looking at the type, size and shape of the metal particulates that are suspended in the oil, the health of the equipment it is lubricating can also be determined.
- The monitoring of temperature against a benchmark is practised in all good condition based maintenance systems.

The Three Phases of Condition Based Maintenance

- Surveillance - monitoring the equipment condition to detect developing problems
- Diagnosis - isolating the root cause of the issue and developing a corrective plan based on priority, equipment condition and its remaining life
- Remedy - performing the corrective action.

Remember: **If you want to manage it, you need to measure it and document it.**

PART II – WHO DOES THE MAINTENANCE?

ARTISANS – THE BACKBONE OF PLANT MAINTENANCE

Throughout history the tradesman has been central to all civilisations. In medieval times the blacksmith was the person in the village whose skills ranged from making swords and plough shears to pulling teeth.

This has however changed drastically, but technical issues remain the same and maintenance remains technical in nature.

So who does the maintenance? This is a question that needs to be asked and honestly answered in all maintenance related areas of operation. It may appear obvious to many with procedures documented and specified, but the actual labour employed to conduct the work in a satisfactory manner is often left wanting.

Maintenance is normally correctly carried out by technically competent and trained staff experienced and well versed in the type and class of equipment under their jurisdiction.

Training of Artisans

In spite of a high rate of unemployment in South Africa, trained artisans are scarce in our industry at present, with demand exceeding supply. Twenty-one years ago the Apprenticeship system as operated by the Department of Labour was abolished and later replaced with a Learnership system not clearly defined nor managed which has resulted in a drastic decrease in the number of qualified artisans entering the workplace.

All businesses have to contribute financially to a Sector Education and Training Authority (SETA). There are various SETAs for all sectors of industry and commerce. The intention is that these funds are to be put towards skills training. Soon after introduction of the SETA system, SETA sector offices were built and staffed, while little and inadequate time and funds were spent on training

In 2010 the average age of the artisan was quoted as being 57 years.

In 2014 the MEC for Economic Opportunities, Alan Winde, said that the average age of artisans in South Africa was 55 years while the number of young people being trained to produce the next generation of artisans was only a fraction of what the country needed.

'The National Development Plan says we need 30 000 trained artisans a year in South Africa. There are probably only 10 000 trained in a year. This shows the massive gap we've got. If we don't change the maths and science coming in, we won't change the skills gap.' (Cape Times, August 14, 2014).

The curriculum for a fitter and turner now falls under Code 6523020 which is a hefty 150 page document. It is extensive and covers all the requirements of training on a practical basis. This however, requires support from the learner furthering his/her technical studies in order to support the practical skills obtained during training.

Furthermore, it is imperative that newly qualified technical staff at all levels be *mentored* in such a manner that they can apply themselves with confidence in the workplace.

In this field, South Africa is lacking to the detriment of industry as a result of the drastically reduced training of competent technical personnel since the collapse of the apprenticeship system in 2000, as previously operated by the Industry Training Boards.

All have been affected by rolling electricity blackouts due to poor and limited foresight by government planning bodies, and equally so by the inadequate supply of competent maintenance staff and implemented maintenance systems. It is unfortunately a technical issue that needs to be solved by politicians as the decisions for the future of the country rests in their hands.

On 4 February 2013, Dr Blade Nzimande focused on the country's urgent requirement for more artisans by declaring 2013 as the 'Year of the Artisan'. Then in a media release on 3 February 2014, a year later, Dr Blade Nzimande stated 'Starting with today's launch event, the department is embarking on a ten-year campaign called *2014 – 2024 Decade of the Artisan*, which has the theme *It's cool to be a 21st Century Artisan*.

Experience vs. Qualification

It is important that maintenance staff are qualified and well versed in the work discipline in which they are employed. Engineering today is a very wide and specialised industry, and artisans who are well qualified and experienced in a certain sector of engineering would be totally lost in another sector. For example, an artisan who has worked in the construction machinery sector would find it difficult to work effectively in the pumping industry. Equally so, a Certificated Mechanical Engineer with a long service history in a sweet factory would lack skills and experience in a bulk handling situation, although the required Certificate of Competency in both disciplines would be mechanical and technical. It would indicate that the engineer is suitably qualified and thus deemed competent.

Note that experience in any technical field cannot be studied, bought, stolen, nor can it be inherited. Experience is assimilated over a period of time. It is thus a prerequisite that young engineers and artisans are mentored towards competency.

PART III – EXAMPLES OF POOR MAINTENANCE

POTHOLE THEORY

To put maintenance into perspective an example is the Pothole Theory.
Many roads worldwide, particularly in Africa, including South Africa, have potholes caused mainly from water seepage entering through the supposedly sealed surface into the substructure of the road. What has this to do with maintenance?

Preventative maintenance
The objective is to prevent the ingress of water through the cracked surface structure. These cracks cannot always easily be seen. The first solution is to resurface the road until fully sealed. This prevents water entering the substructure.

Corrective maintenance
Wait for the pothole to develop and when the rain has subsided and the pothole has dried out, it is repaired.

Operational maintenance
Fill it temporarily with sand or gravel until permanent repairs can be done.

Figure 2. Typical pothole

NON-MAINTENANCE

Many plants in South Africa operate on a non-maintenance basis. In visiting some plants whilst conducting conveyor audits, the general condition of some of these plants was atrocious. Poor belt tracking is the highest contributor to blatant damage resulting in failed components and excessive spillage.

It is easy to use the term 'non-maintenance' when in reality, irrespective of how bad the plant may be, all managers will insist that they conduct regular maintenance. However, when inspecting these plants it is sometimes difficult to notice any aspect of the plant that looks as if it is maintained.

A single example hereof is the return idler bracket, below, cut off by a mistracked belt. The idler is hanging at 45° above a bin that loads onto a reclaim conveyor by means of a vibratory feeder.

Since the idler is above a bin with a feeder loading onto a reclaim conveyor shared with eight other product bins, should this idler dislodge itself and drop into the bin, it will pass through the feeder onto the receiving reclaim conveyor. All being well, assuming that no damage is done, the flat return idler ends up being transferred to many other conveyors where it will either be physically removed or alternatively deposited as part of the product mix at the smelter furnace, which is obviously an undesirable end result.

General Examples of Poor or Non-maintenance

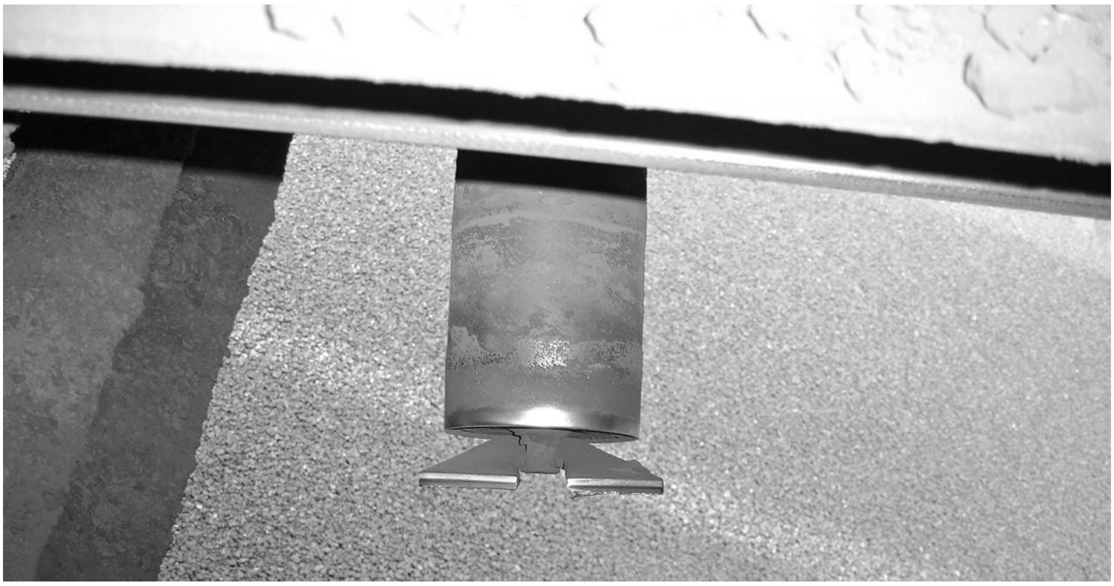


Figure 3. Serious belt drift caused severance of this idler bracket

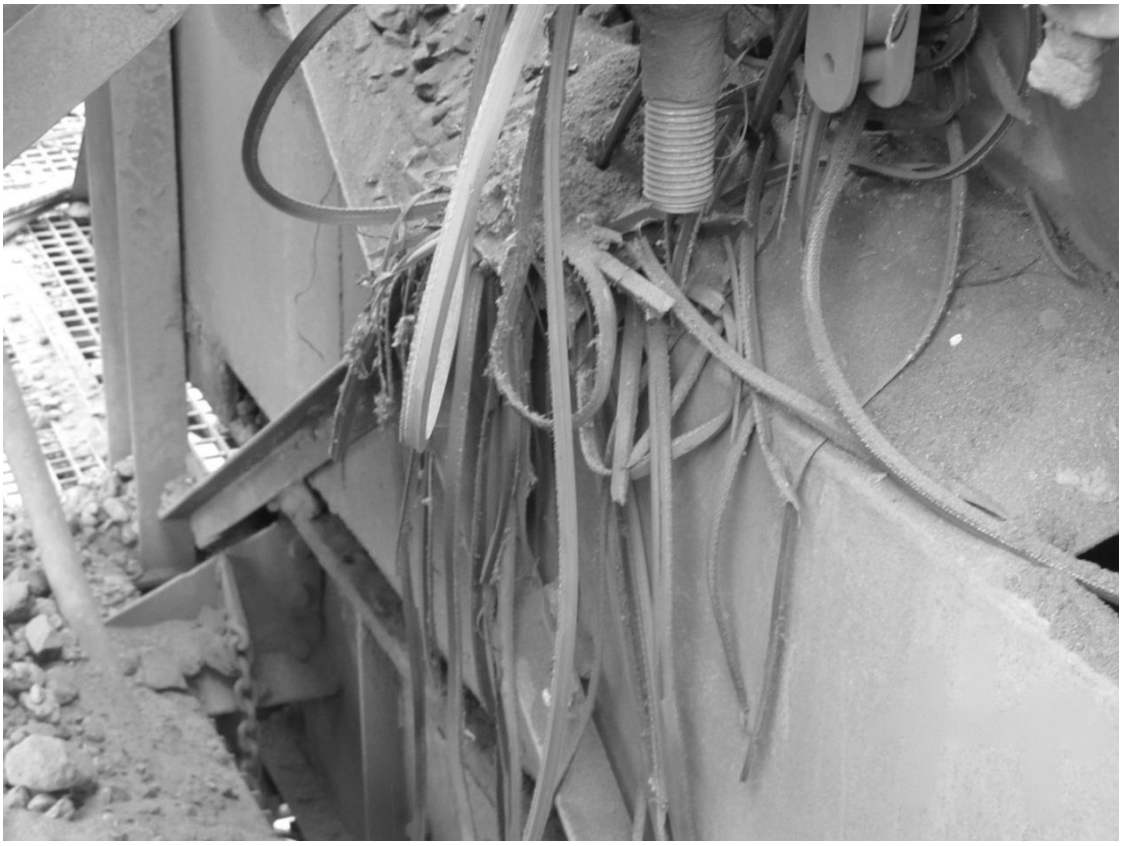


Figure 4. Severely damaged belt due to poor tracking

Figure 5. Severely damaged pulley lagging

Figure 6. A poorly tracked belt led to serious structural damage

Figure 7. Return idler buried and cannot rotate or be replaced due to tripper discharge

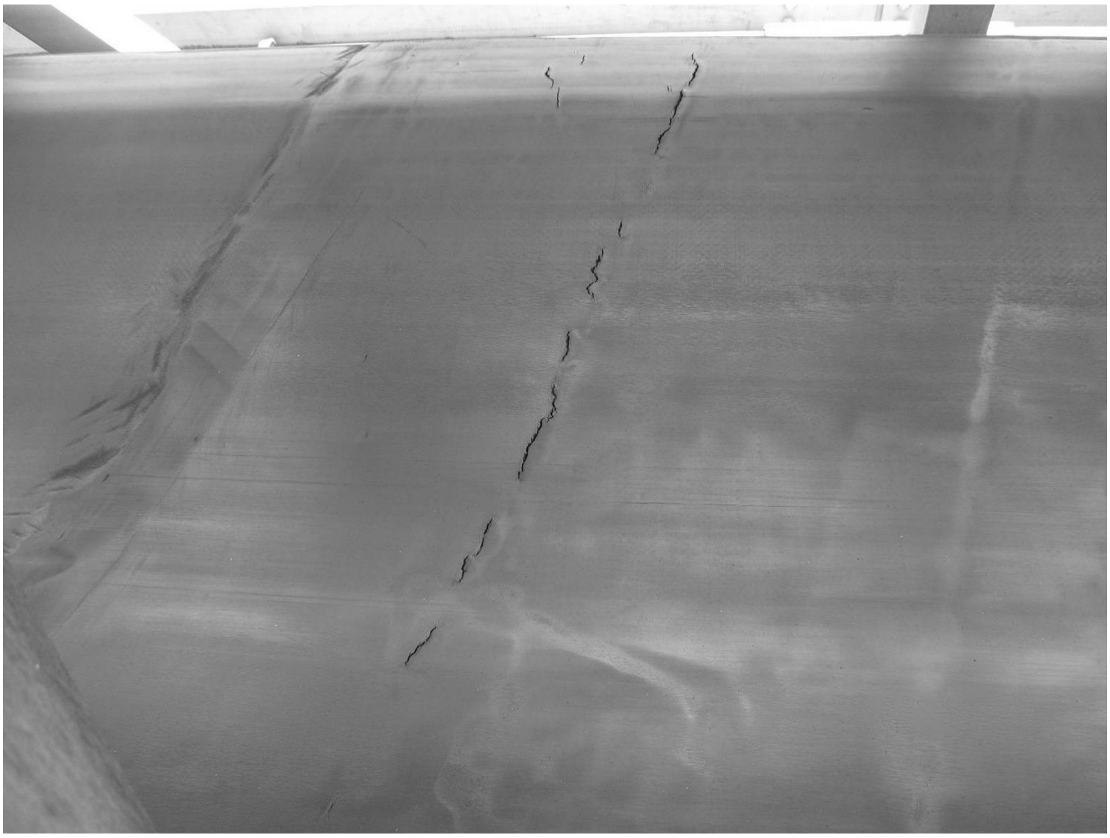


Figure 8. Damaged splice that requires replacement

Figure 9. Worn and seized idlers

Figure 10. No maintenance, totally overloaded

TWO TIPS TO CONTRIBUTE TO MEANINGFUL MAINTENANCE

1. Transfer Points and Spillage Control

The belt must enter the tail pulley centrally in order for it to leave the tail pulley centrally. The material being loaded onto the belt at the tail end or an intermediate loading point should be centrally loaded in such a way that there is no influence caused by the material to sway the belt to either side.

If the belt is on the centre line and loaded centrally, this would go a long way towards a successful discharge and a successful conveyor.

2. Housekeeping

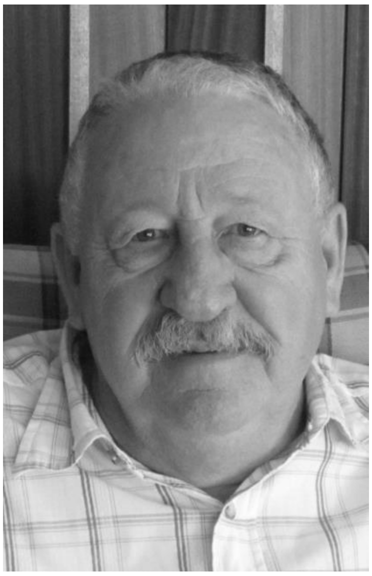
A very important task that is often neglected is proper housekeeping. Any build-up of material on or under the conveyor should be religiously removed at all times. Cleaning includes belt cleaning by means of the appropriate scrapers correctly fitted and adjusted.

Lack of proper housekeeping creates more downtime and mechanical breakdowns in the bulk materials handling industry than any other single maintenance procedure. Although it may not be the most exciting job to do, it has the greatest long-term value.

CONCLUSIONS

- Planned maintenance should always be executed by technically competent personnel
- Make use of proven methods and tools to assist in maintenance such as condition based maintenance principles
- Planned maintenance schedules need to be specifically compiled by a team of technically competent personnel who are entirely familiar with the process and all the technical aspects of the plant to be maintained
- The work schedules ought to be completely understood by all permanent staff and contractors carrying out the work
- After each maintenance procedure, a close-out discussion is necessary to ascertain the condition of the plant and to make the necessary adaptions to the schedule for the next maintenance session
- A committed and accountable team is vital in meeting the objectives of the planned maintenance
- The Total Cost of Ownership can only improve when effective planned maintenance is applied
- Through proper documentation of maintenance history, potential causes of repeated failures can be identified and possibly eliminated.

ABOUT THE AUTHOR



ALAN EXTON

Alan Exton has been involved in the mining industry since 1969 when he commenced his training at West Rand Consolidated Mines Ltd as an apprenticed fitter and turner. During his Apprenticeship, he obtained a National Technical Diploma in Mechanical Design. After seven years employment in the mines, he joined the private sector as a design engineer in the mining division of Dowson & Dobson (Pty) Ltd. He was involved in the design fields of both coal and hard rock mining equipment for various companies until 1990 and then specialised in belt conveyors.

He was the founding managing director for Nepean Conveyors (Pty) Ltd. in South Africa and retired from this position after 13 years in 2008.

Currently he is the MD of Accrete Consulting (Pty) Ltd., a company servicing the needs of the belt conveying industry.

He is a member of the South African Institution of Mechanical Engineers, a Professional member of the South African Institute of Materials Handling, past chairman and honorary member of the Conveyor Manufacturers Association of S A Ltd., past member of Beltcon 8, 9, 10, 11, 12, 13, 14, 15, 16 and 17 committees, and chairman of Beltcon 18, as well as a qualified amateur radio operator and member of the South African Radio League.

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