Designing and operating environmentally friendly overland conveyors Hector N. Dreyer

- Anglo Operations Limited

Introduction

The problem that environmentalists have with industry (and the impact of humanity in general) is the interference with nature's equilibrium. All species in nature co-existed over aeons through cycles of drought and floods; heat and cold. Each specie fulfilling its role in the operation of this wonderfully balanced machine that in turn ensures the existence of each of the species.

Humans have a tendency to selectively destroy one or other species, either through the need to satisfy fashion or to promote economic growth. I don't think anyone will argue against the need to develop and grow the country's economy and thereby create jobs and prosperity. The problem is how it is done!

The subject that we are discussing here deals with the industrial growth element of upsetting the ecological balance - specifically insofar as overland conveyors are concerned. Three phases, each with its own way of interfering with nature, are identified during the life of a conveyor system.

- Construction phase
- Running the system
- Shut down and rehabilitation

Instead of giving a dissertation of ail the bad things that can be blamed on industry, this paper rather focuses on the action that has been taken by industry to ensure a peaceful coexistence of overland conveyors and nature. Many good ideas have been developed over the years by innovative engineers to minimise the effect of overland conveyors on the environment. This paper records a number of these in the hope that those involved will develop sensitivity for nature.

1. Life cycle cost

Construction projects are usually (if not always) under a threat of a shortage of funds, to the extent that project engineers tend to focus completely on the capital cost element of the life cycle cost of the project. All construction works have three main cost elements:

- Capital
- Running
- Rehabilitation

None of these can be ignored! Our experiences show that overland conveyors, where the capital cost had been minimised, ended up skimping on pollution control measures. Later on these run at excessively high operating cost due to the continuous mopping up of spillage and retrofitting dust control and other pollution control systems. At the end of the life of the system the cost of rehabilitation is equally high!

Smart engineers will understand the principles of life cycle cost. Their designs will include adequate and cost-effective pollution control measures to ensure best performance at the lowest overall cost.

2. ***Performance***

Any design has to cater for the duty expected from the system. The basic elements to consider are:

- Cost
- Capacity
- Reliability
- Construction time

We have already dealt with the cost element where we pointed out the importance of the design engineer seeing the big picture.

One way of saving capital when designing a conveyor is to increase the belt speed. This ensures that the capacity is achieved with minimal belt width and in addition belt tensions are reduced resulting in lower class belting. The list of advantages does not end here! The important factor though is to strike the correct balance of belt width and speed to achieve capacity with no spillage or wind losses causing ground and air pollution. These things will come back to haunt you! We are certainly not advocating "over design" but rather adequate design!

Inadequately or under designed conveyor systems result in frequent breakdowns which causes spillage and hence pollution. This in turn delays the repair job. Such conveyors also spill during operation and this also causes breakdown of the system. This is a vicious circle to be avoided!

What is then the conclusion? Thus, reliable conveyors are designed with adequate capacity to ensure zero spillage!

Construction time affects capital cost and overall completion of the project that may result in production losses. Cutting down on construction time tends to result in messy construction sites and poor environmental management during construction. This is another one of those that come back to haunt you! Only this one is much quicker! It usually catches the project manager during the commissioning phase when things start going wrong! How often have we seen that a little extra effort during construction result in well managed, clean construction sites? The benefits are reaped before the conveyor is commissioned and certainly immediately afterwards when it starts off and continues to run trouble free!

3. Potential effect of conveyors on the environment

3.1 Visual

An overland conveyor simply "does not belong" in the environment where it is constructed! It cuts through maize fields, indigenous forest and green pastures!

3.2 Disturbance of the ecological balance

Let us take a closer look at this aspect since an understanding of this phenomenon will create the kind of awareness needed for sympathetic design work.

- Vegetation in an area is easily disturbed. Foreign plants are carried into the area by construction teams. These plants normally thrive on disturbed soil. Indigenous flora, on the other hand, is destroyed during construction.
- Erosion of the disturbed surface from wind and water is quite common.
- Watercourses are changed intentionally or through ignorance by ill-conceived embankments created through low-lying areas. Deviation causes wet lands to dry and flood plains to be created. Blocking natural flow or restricting tidal movement causes silting and salt water is often turned to fresh and vice versa.

3.3 Spillage

Spillage from conveyors is caused by a number of factors.

- Overloading has been dealt with before. Here we see two types of overload namely continuous and instantaneous. We laid the blame with the design engineers! Is that correct?

  Design normally considers continuous loading on conveyors. With long belts it is very easy to overload sections of the belt without overloading the system through uneven loading. There are some things one would do, like placing weightometers close to the loading point and installing surge smoothing facilities. Foolproof systems are however normally not affordable!

  Correctly designed systems need also to be correctly operated to ensure reliability, best performance and a spillage free environment.

  Transfer stations are major sources of spillage, causing pollution and conveyor breakdown. We have come to believe that transfer station design is more of an art than a science. It deals with

  - Type of material (size and flow characteristics)
  - Angle of transfer
  - Relative belt speeds
  - The type of belting used and the need to prevent belt tear
  - Belt cleaning systems and devices
  - Maintainability issues like access for inspection and maintenance

The reader will know that the list continues. A good designer will get most of these correct. Failing in one aspect will cause spillage! Overdoing it will on the other hand increase the capital cost. The art lies in getting the balance right!

- Carrying water with the conveyed material results in wash down of the load at the vertical radius in the conveyor. Water lubricates the belt material and causes loss of friction between the belt and the conveyed material. Inclines can then not be negotiated and these points become major spillage points! This phenomenon has to be managed correctly - water is to be kept off the belt! The system design and operation must ensure this.
- Material carry back on the return belt from a transfer point is quite common. This causes spillage at each return roller set for a long way behind the transfer station. The first line of defense is to ensure adequate belt cleaning systems are installed and that these are well maintained. There are other things one can do to prevent pollution from material carry back. These will be discussed later in this paper.

3.4 Dust

Whilst spillage is concentrated and messy, it could be argued that one can recover the situation by a concerted clean-up effort. Dust on the other hand gets out of control very quickly. Airborne dust settles over a wide area and cannot be cleaned up! Dust is generally yielded due to,

- Wind coming in contact with dusty material on the belt
- Belt speed creating its own wind forces
- High transfer points
- Excessively long transfer chutes causing falling material to form a draught

3.5 Noise

We said earlier that overland conveyors don't belong where they are installed. That referred to their visual appearance. When running, they generate a disturbing noise that is often amplified by poor application of wind and rain protection "dog house" covers over the conveyor. This causes problems with neighbours!

3.6 Radiation

Some materials can be nasty! Radiation from material on conveyor belts is not common anymore since industry realised the potential of this hazard. Designers must at all time, though question the hazards associated with the material intended to be transported.

4. The things we can do

By now the reader is probably totally depressed. This is not the intention. We are merely trying to create awareness with designers and conveyor systems operators to ensure that we do the common sense things that are available to all of us at very little extra cost and effort.

4.1 Design

- Study and understand the characteristics of the material to be transported
- Strike a balance between system capacity, belt speed and width for the material size and type. High-speed belts cause dust and are noisy!
- Optimise the use direction of wind and rain covers to address the question of noise suppression versus amplification
- Specify construction materials that will not themselves become a pollutant -disasters happen; consider the remnants from a fire on the conveyor
- Transfer stations are major pollution hazard areas. This is where dust, spillage and noise are generated at their worst. Tips include
  - Fully enclosed chutes extending far enough along the receiving belt to allow for dust settlement
  - Fully enclosed transfer stations dampen noise and contain dust
  - S-shaped chutes to ensure minimal material disturbance and a soft transfer onto the receiving belt. This reduces noise, spillage and dust!
  - Dust suppression and extraction systems are not always effective and can be expensive! That is why designers should first design for minimal dust generation and then consider suppression and extraction systems. Note that too much water used to suppress dust creates its own problems! Material becomes sticky and excessive water will wash the material from the belt at the next belt incline!
  - Sufficient height at acutely angled transfer station to allow for a steep dribble chute from belt cleaners

- Effective belt cleaners are easy to specify - are they maintainable and being maintained? Ongoing maintenance of belt cleaning systems is the key - not the so-called "maintenance free" belt cleaner. There is no such thing!
- Apart from being a pollution hazard transfer stations are expensive. Eliminate transfer stations by careful planning of the route. Curved conveyors are common these days. This often shortens the overall belt length and eliminates transfer points.
- If we have to have a transfer point, plan it such that it is placed in the best possible position.
- Provide adequate access and spillage catchment facilities to assist with clean-up action - which should be minimal!

- Turnover of the return belt has prov to be a highly effective measure over the last 20 years.
    - Spillage along the length of the return belt is limited to an area concentrated at the transfer stations where it can be effectively managed.
      Return belt idlers are kept clean from carry back material caking on its surface, thus ensuring good return belt tracking and preventing corrosion of the return idlers
- Proactive measures during belt installation include a high standard of belt structure alignment to ensure trouble free operation. Maintaining belt alignment is equally important to protect the belt edges and to prevent spillage. A variety of belt tracking devices are available to monitor this aspect
- Likewise belt tear detection devices should be installed to detect tears early on and to minimise spillage from a torn belt.

4.2 Construction

- Bush and brush clearance for construction purposes is often done without any concern for the environment. We should not blame the construction contractor for this state of affairs. This element is usually written into his contract as a re-measurable item; why should he then limit the area that is cleared and why should he waste time to save a tree? It is the way we write our contracts and inadequate planning that causes this situation to develop.
- Berms and causeways are usually built as continuous units and culverts or water outlets are cut through at a later stage during construction. This might seem a minor point, but timing of these events with heavy rains in between can cause major erosion despite the environmentally friendly design that may have been done.
- Access to the site is another one of those aspects that is left to the contractor! This one speaks for itself - imagine the amount of damage that can be caused over the distance of an overland conveyor!
- Pollution hazards during construction include dust generation and oil and diesel spills. It is a matter of good management being practiced by those who are involved to control this hazard.
- Littering in South Africa is a big problem! Construction sites are equally guilty! When a long conveyor system is constructed the litter is spread that much wider and therefore much less recoverable! Cement bags, cable sheathes and plastic bags are but a few of the items seen left behind. Plastic bags are particularly nasty to game and cattle attempting to eat them!
- Material specifications not only refer to the material of the conveyor system. Road building material can be a costly item. Often one sees process plant discard material used for this purpose. In many instances this material turns nasty on the environment - if it is not nasty from the outset! We dealt with material selection under the element of 'design'. That is where it should be put right. Often, though it is left to the contractor and the company's project supervisors to select the material used for temporary access road construction. This is where it goes wrong!
- Campsites leave scars! More thought should be put into this aspect of project management. It is of particular importance on long overland conveyors where camps are often pitched in 'uncontrolled areas'.
- Open fires in winter run out of control by accident or through negligence, causing destruction and air pollution! One has sympathy for the workers, but then control needs to be exercised!

The points made are mostly common to all construction work. It is, however particularly harsh on the environment when constructing a long overland conveyor which passes through sensitive areas.

4.3 Operation

Good practices have to be enforced from the top. Operational and maintenance staff is always under the pressures of production and tends to take "short cuts". Some of the good things done by successful managers include

- Automation of sensitive operating systems
- instilling a sense of pride in workers to maintain facilities deemed to be "not critical to production " such as environmental control items (e.g. dust covers!)
- Maintaining steady operating conditions instead of trying to break records or falling behind, causing a need to "catch up".

5. Conclusion and recommendations

We have shown that there are many things we tend to overlook when designing and erecting structures. These are particularly important when working on overland conveyors because of the environment they are running through.

None of the action items listed are necessarily expensive or unduly onerous on construction time! The proposals also extend beyond theory; they are actually implemented on numerous overland conveyor installations. Some of the good ideas that we've listed include

- Belt turnovers
- Belt alignment
- Effective chute design
- Soft transfers
- Effective screening from wind and rain
- Various construction tips.

We do not believe one can single out any particular item as being more important than others are. This subject calls for a holistic approach. A lot of good work can be undone by overlooking a single element!

Project managers should produce a checklist that is referred to during each phase of the project and have"*environmental issues"* as an item on the agenda of

- Design reviews
- Site inspections
- Project review meetings
- Progress review inspections.

This will then become a way of life and care for the environment will no longer be an effort and seen as a pain in the butt. **It is simply a matter of awareness!**

Curriculum Vitae

Professor Hector Dreyer (Pr.Eng., MSc) matriculated in 1962 after which he joined the mining industry as an engineering learner official. He obtained a higher national diploma in electrical engineering and certificates of competency in both electrical and mechanical engineering. Subsequent studies through Wits University enabled him to obtain the MSc. degree in mechanical engineering. His career included appointments as responsible engineer in gold, copper and coal mining in maintenance and project work.

His current appointment is that of Consulting Mechanical and Electrical Engineer for Anglo Operations Limited (Coal Division).

He has also since 1993 been appointed as Industry Professor at the University of Pretoria. His work at the UP involves the development and presentation of Maintenance Engineering courses.