THE CONVEYING TECHNIQUE OF THE 1990's AN ENCLOSED BELT CONVEYOR WHICH CAN RUN AROUND SHARP CORNERS.

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Summary: The conveying technique of the next century will certainly be subject to much stricter environmental requirements than what has been accepted or tolerated so far. As the new types of enclosed belt conveying systems are gaining acceptance, the conventional open type belt conveyor will be ruled out in many of its present applications.

This paper will describe one of these new systems where most of the environmental constraints of the conventional belt conveyor has been eliminated.

Cost comparisons with conventional belt conveyors include investment cost, maintenance costs and operating costs.

References, particularly in Australia/New Zealand are described.

1. CONVENTIONAL BELT CONVEYOR TECHNIQUE.

Conventional belt conveyors are generally acknowledged as the most cost effective and reliable method of moving bulk materials on medium to long conveying distances.

The advantages of belt conveyors compared to chain conveyors, screw conveyors and pneumatic conveyors are:

- low power requirement.
- gentle handling
- long service life
- high capacity

The disadvantages compared to other systems are:

- spillage of material and generation of dust, particularly at the loading, discharge and transfer points.
- a limited degree of inclination.
- a very limited degree of horizontal curving.

1.1 Improvements.

Throughout the years, the conventional belt conveyor technique has been the subject of intensive product development. Designers and operators have sought solutions that would help to overcome some of the most important constraints imposed by the belt conveyor, etc.

- Endless efforts have been spent on developing various systems for belt cleaning. In spite of all these efforts, most operators will agree that there is no equipment available today which is maintenance-free, reliable and which does not create other problems such as increased belt wear. Environmentally, belt conveyors are still considered a nuisance because of spillage and pollution, particularly at the transfer points.

The restricted inclination of belt conveyors has called for improvements such as rubber cleats vulcanised to the belt. This in turn

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has further emphasised the problem of belt cleaning.

- Different designs of covered belt conveyors have contributed to a reduction in dust emission but offer no solution to spillage at the transfer points or from the return part.

- Several solutions have been developed to allow belt conveyors to run in curves. These systems tend to be expensive, complicated and still only allow curves with very large radii.

1.2 Alternative Designs

Certain new design concepts have been introduced which meet some of the criteria for enclosed handling.

- The load carrying part of the belt can be covered, it can slide on an air-film in a U-shape duct or inside a pipe instead of being supported by idlers.

  Here the material and the dusty air will be kept inside the enclosure but it does not solve the problem with the spillage from the return part.

- A sandwich belt arrangement can improve the maximum inclination of the conveyor but again it does not solve the problem of spillage.

- The conveyor belt can be formed into a pipe which makes both the load carrying and the return part enclosed. The ability to negotiate curves is improved but it still requires considerable radii.

The common conveying element which has been the subject for all the above development and improvement is still the old, conventional, flat conveyor belt, used in various forms of troughed or tubular sections.

To overcome the fundamental problems of the belt conveyor there was a need for innovative thinking which was not constrained by the present technique, in particular with regard to the design of the belt.

2. THE SICON CONVEYING SYSTEM

The unique part of the SICON system is the conveyor belt itself. Although it is different in its design, it still provides the same functions as a conventional conveyor belt.

The three basic functions are:

- To support the material.
- To provide a track for the idlers and pulleys.
- To take up the tension from the drive machinery.

Whereas a conventional conveyor belt has a uniform construction over the whole width of the belt, the SICON belt is designed with the aim of optimising each of the above functions.

The result is a belt where the track for the idlers and the longitudinal reinforcements are concentrated to the edges of the belt and the intermediate part of the belt has only one function, that of supporting the cargo. See figure 1.

Hereby it has been possible to use steel wire ropes for the longitudinal reinforcing and the profiles at the edges of the belt are designed and reinforced in the same manner as for normal V-belts. This arrangement has made it possible to design a conveyor system with some exceptional features.

2.1 Enclosed Handling

A cross-section of the conveyor shows the two steel cord reinforced rubber profiles vulcanised to the load carrying belting. The profiles serve as tracks for the angled support roller and vertical guide roller and, with the steel cord reinforcing, they absorb the tension of the conveyor drive system. The pear shaped belt is manufactured from a quality of rubber which has very flexible, elastic and wear resistant properties. This makes the belt capable of negotiating very sharp corners. See figure 2.

Except for loading and discharge, the belt is at all times enclosing the material.

Figure 1 - Cross Section of the SICON belt.

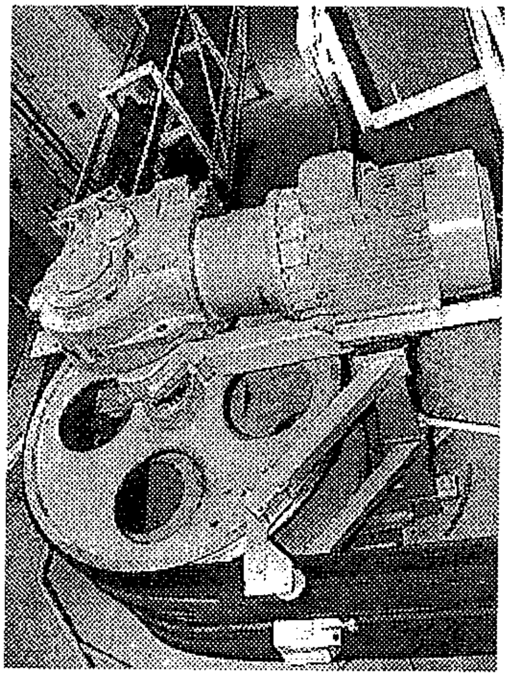

Figure 2 - 90° corner with intermediate drive unit.

Also the return part of the conveyor is closed in the same manner. The result is a totally enclosed conveyor which transports bulk materials from the loading point to the discharge point, without transfers, spillage or pollution.

The environmental advantages when handling dusty, sometimes even toxic materials, are quite obvious but it also leads to direct cost savings in reduced maintenance and cleaning, caused by dust and spillage.

2.2 Ability to Negotiate Sharp Corners.

Thanks to its unique design, the SICON conveyor can negotiate very sharp corners. The minimum radius of the deflection sheaves depends on the size of the belt.

Data	Sicon 100	Sicon 1000
Handling rate m^3/hour	10-100	100-400
Belt speed m./sec.	1-3	2-4
Min. curve radius m	0,4	0,75
Max. lump size mm	- 40	- 70

2.3 Steep Inclination and Two-Way Conveying.

The conveyor can run in a steep inclination (max. 20-35° depending on the transported material).

The return part does not have to follow the load route and therefore the conveyor can be arranged as a closed loop with maximum flexibility in plant layout. It is also possible to transport material in the return part simultaneously, thus making it a true two-way conveyor.

2.4 Multiple Drive Units - Low Belt Tension.

Due to the very good traction on the V-shaped profiles, it has been possible to install multiple drives. Drive units can be fitted to any curve where the belt wrapping is minimum 90°, Figure 2. This will reduce the maximum belt tension for long conveyors.

The energy consumption is the same as for conventional belt conveyors, thus considerably lower than for screw or chain conveyors and a fraction of the power required for corresponding pneumatic conveyors.

2.5 Smooth Loading and Acceleration even at High Belt Speeds.

Loading of the belt can take place anywhere along the conveyor. In order to ensure a controlled flow rate of the transported material, it is recommended to use either a vibrating feeder, screw feeder, rotary vane feeder or similar.

At the loading stations, the conveyor belt is opened into a U-shape with sufficient opening for the loading chute. As all the belt tension is taken up by the two reinforced profiles, the payload carrying belting is completely slack and can therefore, in the best possible way, absorb the impact of the loaded material. The result is very efficient and quick acceleration of the material, even at comparatively high belt speeds. See figure 3.

For the conventional belt conveyor, the material falls onto a belt which is in tension and therefore acts like a trampoline making the material bounce and start rolling before it finally comes to rest on the belt.

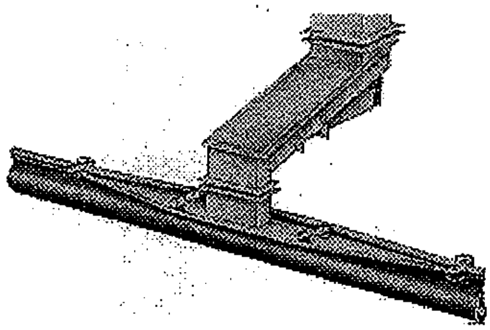

Figure 3 - Loading point with a vibrating feeder.

2.6 Multiple Discharge Methods.

Vertical Discharge

The belt opens out by a gradual transition from its pear shape into a flat, vertical orientation. After discharge, the return part again closes to its original shape. Figure 4.

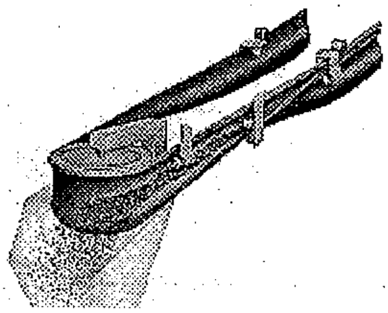

Figure 4 - Vertical discharge

Horizontal Discharge

Here the belt opens out in a horizontal orientation (similar to conventional belt conveyors). After discharging the belt remains in its flat position while it turns forward again to get the dirty side facing upwards. Any spillage from the discharge points is gathered on the lower part of the belt before it closes again to the pear shape.

The receiving chute can be fitted with a gate which will direct the material either onto the next mode of transportation or back into the belt for further transport to the next discharge station. See figure 5.

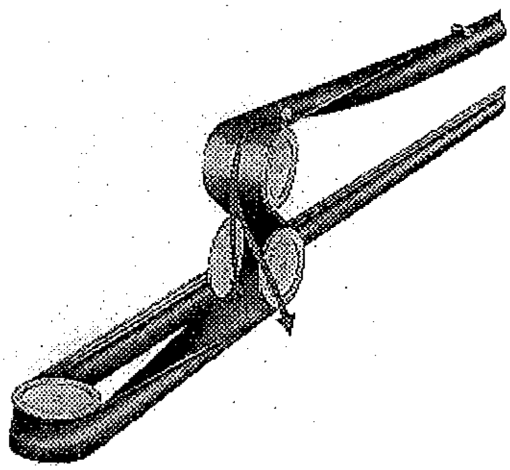

Figure 5 - Horizontal Discharge

2.7 Simple Supporting Structure

The SICON conveyor requires less space than a conventional belt conveyor and the supports are simple.

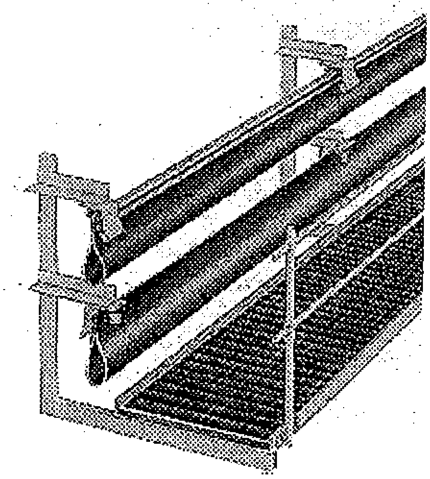

Figure 6 - Supports for wall mounting with optional walkway and inspections.

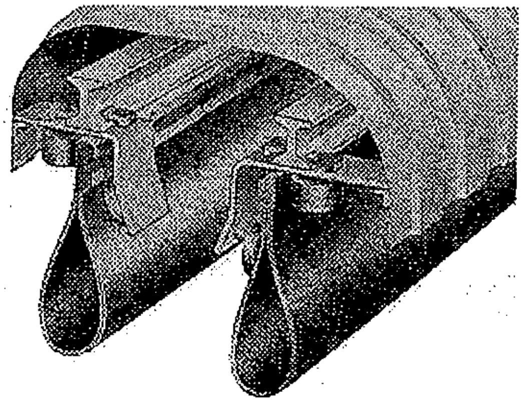

Figure 7 - Outdoor support with simple cover.

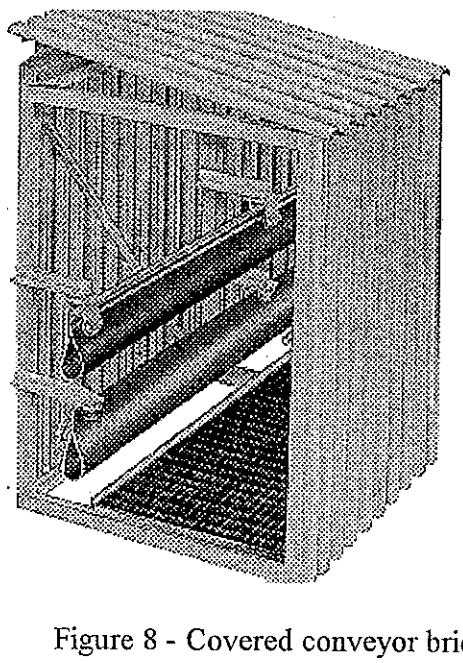

Figure 8 - Covered conveyor bridge

2.8 Capacity Range

So far the conveyor has been manufactured in two basic sizes which are related to the size of the profiles (SICON 100 and SICON 1000). Each size of profile can be used for different widths of belt and at different belt speeds, the present two sizes cover a handling rate from 10 to 400m^3/ hour. (See section 2.2).

The longest belt in operation has a conveying distance of 800m and the highest capacity so far is 350 t/hour.

3. OPERATING EXPERIENCE

3.1 Reference Installations for SICON 1000

The very first SICON conveyor was installed by Cementa AB at their main production plant in Slite, Sweden. This conveyor has been in operation since April 1988.

Cementa used the SICON belt to transport 250 t/hour of sand and limestone from the stockpile up to the buffer hoppers at the mill. Two feeder conveyors from under the stockpile load the material into the SICON belt which at the other end discharges onto a distributing conveyor above the buffer hoppers.

Earlier, the same transport was handled by four conventional belt conveyors connected via transfer chutes. The new conveyor takes the material all the way, without any transfers and the related dust and spillage.

The order was placed in August 1987 and the installation was commissioned in April 1988.

As a result of the very good performance of this first conveyor, Cementa placed an order for a second conveyor of similar size for handling of hot cement clinker. This has called for a conveyor belt of special quality, approved for handling material with a temperature of max. 90°C.

3.2 Reference Installation for SICON 100

The first conveyor of the SICON size 100 was ordered by the Swedish company Höganäs AB for installation at their new production unit at Höganäs. This conveyor handles iron powder at a rate of 40 t/hour.

The total transport distance is 280m and the conveyor has 10 loading points and two alternative discharge points. Strict environmental requirements have influenced the design of loading and discharge points, all of which are connected to a dust extraction system. Hereby the transport is free from any dust emission and spillage and the material is protected from moisture.

The conveyor was commissioned in January 1990 and in spite of being the first of the size 100, only minor modifications had to be made after the trial period.

Since then, a series of conveyors of the size 100 has been commissioned.

3.3 References in Australia/New Zealand

3.3.1 *Pacific Power*

In March 1990, the Electricity Commission of New South Wales, Australia, obtained development consent from Lithgow Council for the disposal of ash on the western Main Colliery Site, adjacent to Mount Piper Power Station.

In order to minimise the environmental impact on the surroundings, the ash deposit will ultimately be "landscaped" and covered with vegetation.

It has therefore become necessary to change to dry conveying system instead of the conventional methods of pumping the ash in the form of a slurry.

The dry storage technique offers the advantages of lower water consumption, better water quality management and much greater flexibility in ash storage sites.

In December 1990, ECNSW placed the order with John Thompson (Australia) Ltd. for the complete ash handling system. The system represents the first use of a new ash handling technique pioneered by John Thompson and SICON AB of Sweden. The fly ash will be "conditioned" with 10-15 per cent water before it is transported to the disposal area on the enclosed belt conveyor developed by SICON.

The SICON system at Mount Piper consists of two 360 t/hour conveyors providing 100 per cent duty standby. The conveyors stretch some 800 metres from the main storage silo to the ash disposal area.

The ability of the SICON system to run around narrow curves has made it possible to adopt the conveying route to the configuration of the terrain.

The supporting steel structure (see figure 9) is light and simple.

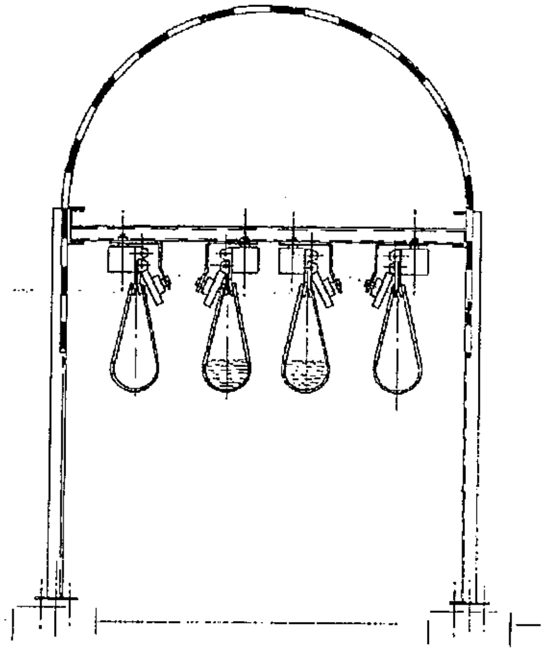

Figure 9 - Section through the dual conveying system

Technical Data

The conveying system has the following data:

Conveying distance (m)	810
Elevation (m)	0
Handling rate (m^3/hour)	360
Material handled	Conditioned fly ash (10 - 15% water)
Belt speed (m/sec)	3,45

3.3.2 ACI Glass Packaging.

3.3.2.1 ACI at their Penrith plant, west of Sydney, contracted John Thompson Australia to install three SICON belts of 50m, 100m and 40m lengths to handle moist sand and broken glass (the glass has its sharp edged removed in the crushing and mixing process) at a tonnage throughput of 120 tonnes per hour per belt.

The first belt, installed in September 1992, whilst only 50m in length has to negotiate a 25 degree vertical incline to climb the top of the silos where it discharges. (See figure 10).

The moist sand and crushed glass has a tendency to stick to the conventional belt conveyors causing piles of sand under each return belt idler. This continual clean up of spillage has been eliminated by the installation of the SICON's. Any spillage at the discharge is directed back to the belt as it passes under the head of the conveyor.

Technical Data - Penrith Plant

Conveying distance	50/100/40m
Elevation	12/12/8m
Handling rate (m^3/h)	80/80/80
Materials handled	Glass batch mix 5% moist Glass batch mix 5% moist Wet sand 6 - 8% moist
Belt speed (m/sec)	1,8/1,8/1,8

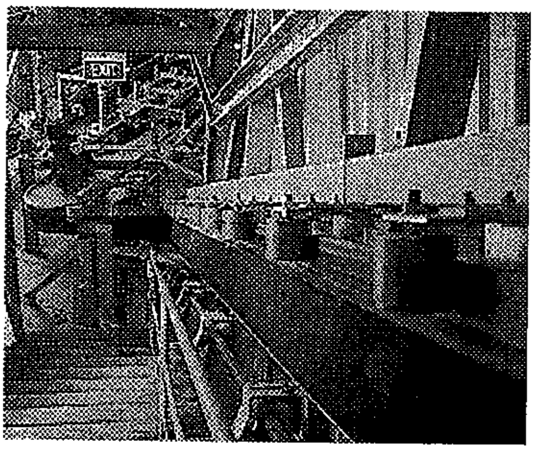

Figure 10 - Transition from horizontal to a steep inclination via an S-curve with 0,6m radius.

3.3.2.2 ACI at their Adelaide plant again contracted John Thompson Australia in November 1994 to install a SICON conveyor to deliver glass batch mix to their new furnace installation. The SICON belt conveyor had to be constructed partly over the top of an existing conventional belt conveyor gantry before entering into its own dedicated gantry system to convey the product to the day bins above the furnace.

On this project the SICON conveyor system showed its versatility in being able to divert around existing equipment with no spillage and without the use of other high maintenance items (eg. dust collection, transfer points and loss of height).

Technical Data - Adelaide Plant

Conveying distance	68m
Elevation	5m
Handling rate (m^3/hour)	80
Material handled	Glass batch mix 5% moist
Belt speed (m/sec)	1,8

3.3.3 New Zealand Aluminium Smelters.

New Zealand Aluminium Smelters had a new SICON conveyor installed at its Bluff aluminium smelter plant near Invercargill on South Island in June 1993 by John Thompson Australia.

This conveyor replaced an existing system where "bath" was transported from the bath preparation plant to three potlines by truck. At the same time, a new route was established to convey alumina back to the preparation plant. (See figure 11).

The SICON system here offered a unique combination of a dust free handling system where a mixture of alumina, screened bath and crushed bath is picked up from three different silos, conveyed to the potline buildings and providing the discharge into the three different silos.

On the return run, the conveyor picks up alumina which is conveyed back to the bath preparation plant. The conveying distance is 500m.

The special features of the SICON system is utilised to the full extent in this installation, including:

- flexibility in the layout - the conveyor follows over existing building structures and existing conveyor bridges (the belt has 29 ninety degree bends within its length).

- enclosed handling - the transported material is protected from moisture and the environment is protected from dust emissions (the site has 214 rain days a year).

- the possibility of multiple loading points, multiple discharge points and multiple drive units on one and the same conveyor.

- plus, true two-way, simultaneous, conveying. The belt is housed in a steel plate shell, open on the underside and with the idlers mounted direct in the sides and top of the shell.

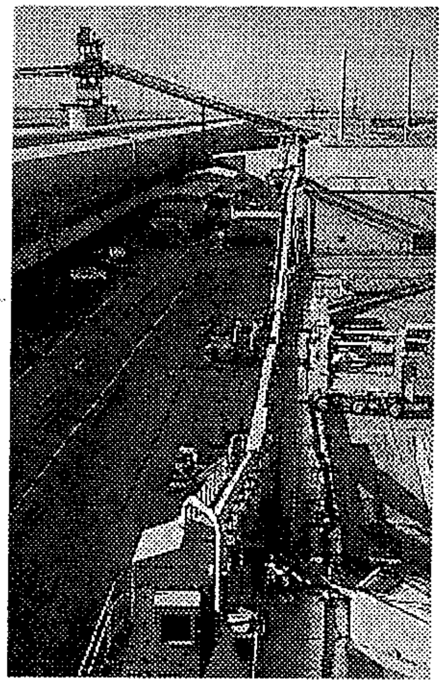

Figure 11 - The NZAS - conveyor includes numerous vertical and horizontal curves

4. APPLICATIONS

The SICON conveyor has created a great interest from many different sectors of the industry and for handling of a wide range of products. The following type of products require special attention regarding spillage and pollution.

- *Building Industry.*
  Sand, limestone, clay, cement, gypsum, etc.

- *Power Generation*
  Coal, wood chips, peat, bottom ash, fly ash, lime, gypsum, etc.
- *Paper Industry*
  Wood chips, paper, pulp, kaolin, chemicals, waste paper, sludge, etc.

- *Steel and Metal Industry*
  Ore, coal, slag, metal concentrates, alumina, foundry sand, etc.

- *Mining Industry*
  Ore, minerals, etc.

- *Food Industry*
  Flour, sugar, vegetables, fish, frozen food, cereals, residues, waste, etc.

- *Feedstuff Industry*
  Grain, soya meal, fish meal, tapioca, pellets, pet food, etc.

- *Chemical Industry*
  Minerals, chemicals, ready made products in granular or powdery form, etc.

5. COST COMPARISONS

5.1 Investment.

The SICON belt itself is more expensive than corresponding conventional belts. The reason for the higher cost is the fact that the belt is built up from many components and that the production volume is still comparatively low.

The idlers are fewer and less expensive than for conventional belt conveyors.

The head and tail ends are more expensive for the SICON system as the diameter of pulleys are larger.

The cost for introducing a curve in the SICON system is considerably less than the corresponding cost for a transfer point for conventional belt conveyors. particularly if the comparison includes the cost for a transfer house, dust filter, servicing platforms and the loss of elevating height at all the transfer points.

The supporting structure is in most cases simpler and less expensive for the SICON system. Also, the flexibility of the conveyor allows a layout where one can make use of existing structures. It could be an advantage to suspend the conveyor from the walls of a building, or to follow an existing pipe line rather than building a new structure along a straight line between loading and discharge points.

The above cost comparisons indicate clearly that the SICON conveyor is not very competitive for a short conveying distance along a straight line and for a material which is not creating any environmental problems.

However, if the route calls for one or more transfers over a longer distance and the nature of the materials handled is such that it requires a cover or enclosure, the SICON system will be competitive even comparing the first costs (investment).