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15 Years Oilsand Transportation by Belt Conveyor Systems — From a Manufacturer's Viewpoint

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Summary

The authors review the special problems related to handling oilsand by conveyor belts. Very low temperatures and the nature of the product to be conveyed pose the most serious problems.

1. Introduction

In the current period of expensive energy and growing demand for raw materials, various articles reported in detail on the oilsand deposits in Northern Canada. Initial steps to develop these deposits were taken about 20 years ago. The oilsand mines, opened in this region caused a change from wilderness to industrialization. In the meantime this development has been the subject of various controversial discussions. There is, however, no doubt that the activities undertaken in this region permitted access to enormous oil reserves and have caused a significant advance in technology.

The following figures highlight the technical details of the extraction of oil: After passage through the extraction plant 1 m^3 oilsand in situ is processed to 1.4 m^3 loose sand, 0.22 m^3 bitumen and 15 m^3 gas, as well as secondary products, such as oil coke and sulphur. The daily production of 188,000 barrels of oil, obtained by Suncor and Syncrude, requires a throughput of 395,000 t of oilsand per day.

Since this is not the place to report on the enormous difficulties which had to be overcome — it would fill books with interesting stories — the present paper only reports on the conveying problems of the mines.

These problems can be mainly attributed to the following:

- operation has to be continued at temperatures as low as —45 °C,
- oilsand is an extremely difficult material: abrasive and sticky with partly sharp-edged/large lumps.

Owners invested a lot of spirit and persistence in solving these problems. The engagement of the equipment manufacturers contributed also to the required high technological standard of equipment.

Demag Lauchhammer is among the suppliers for the two opencast mines of Suncor and Syncrude and has done pioneer work in development of belt conveyor systems for oilsand transport.

For the basic outfitting of all mine conveyors as well as for subsequent extensions and further supplies, the Owners could make profitable use of our rich experience in this special field. The belt conveyor length designed, built, erected and commissioned by Demag for the Athabasca region totals about 22 km.

2. The Belt Conveyor System of SUNCOR and SYNCRUDE

In both mines belt conveyor systems are exclusively used for oilsand transportation. Mining, loading, transport and dumping of overburden in Suncor mines is done with such equipment as tractors, loaders, heavy trucks, bucket wheel excavators and hydraulic shovels (Demag H 241).

Syncrude practices nearly the same method, but in addition their overburden draglines move the overburden according to the direct-overcasting principle.

Mining of oilsand at Suncor is done by means of bucket wheel excavators, feeding via mobile transfer conveyors into the hopper cars of the belt conveyor systems. Syncrude uses draglines for mining and subsequent dumping of oilsand onto piles. Bucket wheel reclaimers are used for reloading of the oilsand and transfer onto the belt conveyor systems via bridge conveyors.

The system in Suncor mines is composed of a two-bench- and three-bench system with two face conveyors which have been constantly extended (Fig. 1). It guarantees now both oilsand transport from the bucket wheel excavators and the conversion from truck transport to continuous haulage.

Syncrude built a belt conveyor system comprising four bench conveyors feeding via connecting conveyors and four stackers into a storage yard, each stacker serving one quadrant (Fig. 2).

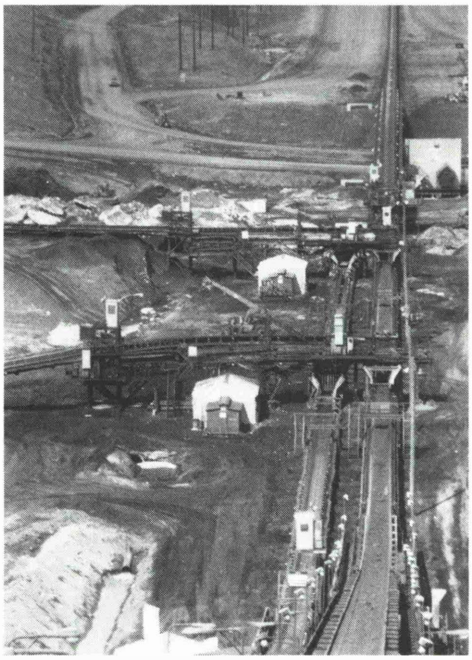


Fig. 1: Suncor conveyor system leading to extraction plant

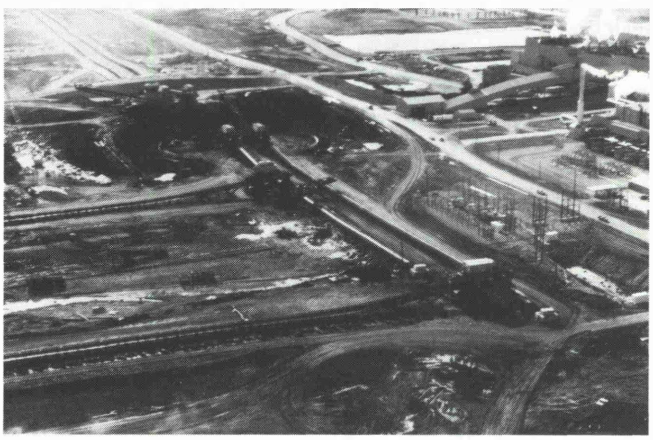


Fig. 2: Conveyor and storage system at Syncrude

3. The Problems and their Solutions

3.1 Low Temperatures

Ambient winter temperatures in the mine attain 55 °C below zero, with the need to keep operations running at temperatures as low as —45 °C (the values are measured under no wind). These extreme temperatures involve the need for uninterrupted operation of conveyors in winter, since otherwise the belts would freeze to pulleys and idlers. This in turn would lead to belt damage during re-start. Initially, creep drives were used and mounted behind the electric motors with second shaft end. Clutches were installed to avoid running of creep motors during normal operation. This solution was not successful and had to be abandoned. Actually the belt conveyors continue to run under no load under temperatures of —55 °C at nearly identical low energy consuption.

For mining under temperatures of —45 °C maintenance has to be reduced to a minimum. Repair welding is hardly possible and cleaning work — as far as not automated — is impossible. Enormous greasing problems are created. Oils and greases harden and lose their greasing capability. The drive power rating of the belt conveyors increases with decrease of temperature (Fig. 3).

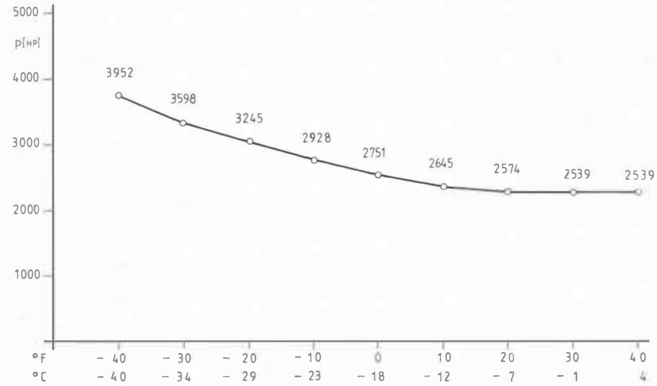


Fig. 3: Calculation of belt drive power accoriding to CEMA: Influence of temperature on power consumption

These problems were solved by the application of fine-grained and cold-stable steels as well as special oils and greases developed by lubricant suppliers together with the Owners.

3.2 Belt Idlers

The oilsand tends to rapid build-up on bare idler bodies and links, especially during rapid temperatures changes. Already in the tendering stage in 1964 the idler shells were to be covered with grooved laggings. This eliminated built up on idlers. Subsequent to some initial difficulties, both rigidly mounted idlers and garlands could finally be used with success. A further problem centered around the grease which lost its greasing capability under low temperatures. All these problems involved the need for the competent companies together with the Owner to invest a lot of development work.

3.3 Belt Pulleys

Besides the cold-stable steels, used for the pulley faces and shells for operation in cold temperatures, it was necessary to carry out extensive development work to find laggings resistant to oil and Kerosine, in order to reduce build-up of oilsand on idlers and pulleys.

Initially, pulleys were caked with oilsand in a few seconds. The usual methods of cleaning with multiple blade scrapers could not manage these encrustations. Subsequently, motorized pulley cleaners were developed by Suncor (formally GCOS Great Canadian Oils Sands) and Demag Lauchhammer, comprising hard-faced knifes circulating around a chain, peeling off the oilsand from the pulley and leading it to the outer sides. These pulley cleaners have to be provided with a Kerosine greasing, so that oilsand cannot build up.

3.4 Belts

Without reporting in detail about the concerns of the belt suppliers, it has to be stated here that the aggressive oilsand, the abrasive quartz sand and the high portion of stones, the Kerosine used for cleaning purposes and last not least the low temperatures caused a lot of difficulty in solving these problems.

3.5 Belt Cleaning

All commonly practiced methods of belt cleaning showed no success, since the degree of contamination of the sticky material was very high and the quartz sand caused complete wear of the belt scrapers within minutes. A method was found of avoiding build-up of material on the belt:

In summer the belt is sprayed ahead of the feeding points with detergent-containing water and in winter with Kerosine. This involves, especially in the prevailing dry atmosphere, the danger of fires and higher stress of belts. Temporary, non-circular idlers were used which caused vibration of the belt and thus discharge of the dirt. This method had to be rejected for several reasons.

3.6 Chutes

Main difficulties encountered centered around wear of chute walls, destruction by lumps and stones and build-up of material. Chute wall heating in winter was initially done by oil burners, to avoid encrustation. Later on electric heaters were used.

GCOS experience with the wear on grizzlies led to special soldered-on wear materials, incorporated to reduce impact forces of lumps and stones and to guarantee a modified loading. This permitted stones to fall into an oilsand bed. This method was, however, not always successful. Stones were dancing around on the belt over long distances, could not come to rest and jumped finally of the belt often in remote locations. In spite of the very strong and robust design, the grizzly bars have frequently broken away during the first years and caused damage to belts.

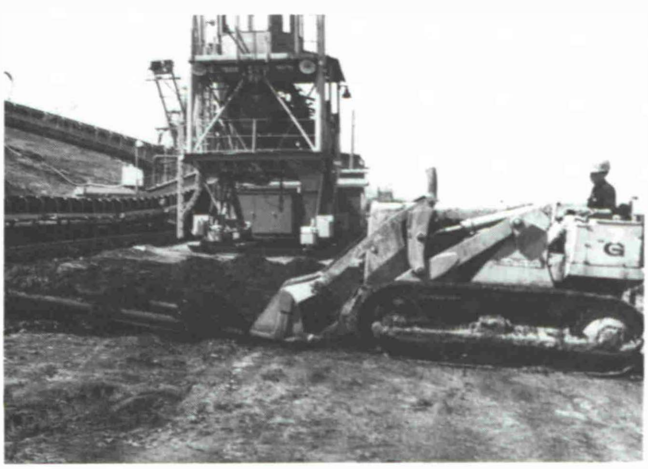
GCOS introduced open fire heating (so called Fire Dragon) which is actually still in practice to avoid material build-up in excavator buckets.

3.7 Cleaning of the Conveyor Route

The commonly used cleaning methods, such as turning of the lower belt strand, belt washing etc. were not considered from the outset.

A cleaning device — orginally developed as a secondary product — is up to now the only efficient solution for belt conveyor cleaning and is still in use (Fig. 4).

Fig. 4: Special dozer-mounted cleaning device for conveyor belt system



3.8 Take-Up Winch

Conveyor belts were initially operated at a defined belt pretension. Afterwards, several conveyor systems were equipped with an automatically controlled take-up device, adopting the following working sequence:

— Running-up the take-up winch to maximum pre-tension

— Starting of motors up to full load speed

— Reduction of the pre-tension to the operational value.

This involved difficulties in various cases. Insufficient pretension could not guarantee uniform load distribution onto the two drive pulleys. This in turn caused longitudional vibrations of the belt with overload disconnections, etc. Moreover, frequent change of belt elongation is a negative feature. Uniform — even higher — pre-tension is naturally more favorable. It has to be stated here that the dimensioning of the winch has frequently to be derived from the forces during braking of the belt.

3.9 Gear Reducers

The usual method of gear heating by means of heater rods inside the gear housings caused coking and burning out of the heating elements due to reduced heat transmission. At present the tensioning gears are heated at their bottoms by means of heating plates (Suncor). The main gears, used in the latest conveyors for Suncor, have a combined heating system by means of heating plates at the bottom and not air heating, acting as a cooler in summer. Syncrude uses low temperature gear oil developed by inhouse and lubricant supplier's research.

Operators of opencast mines still have reservations about using hardened gear wheel pairs. Soft wheel pairs and somewhat unorthodox transmission ratio caused extremely high weights for one gear manufacturer. When adopting this method for shiftable belt stations, the masses to be moved and the forces acting on the pulley shafts — with riding arrangement of gears — become very high. Even here, shaft fracture occurred for partly peculiar reasons, although the calculated tensile forces can be considered to be extremely low.

In the new drive units disc brakes are used throughout because of their easy cooling and accessiblity. Furthermore, the comparative small rotating mass allows smaller brakes than required in case of double shoe brakes. The hydraulic control system permits easy heating and simple maintenance.

3.10 Transfer from Heavy Truck to Belt Conveyor Operation

In Suncor mines part of the oilsand is excavated by bucket wheel excavators and Demag shovels (Fig. 5) with subsequent feed into trucks. These trucks dumped initially into so-called Kolberg Loaders, feeding via vibrating grizzly and connecting conveyor onto the surge bin conveyors. A Demag Lauchhammer Trench Reclaimer (Fig. 6) improved this operation considerably:

— several trucks can continuously dump into the trench without any delay,

— expensive foundation work and supporting walls, as required for the Kolberg Loaders, can be avoided

— possibility to re-locate the Reclaimer as required

Fig. 5: Demag H 241 shovel loading oilsand onto trucks

- the trench acts as storage, emergency pile and/or buffer if the truck operation is continued but onward haulage stopped
- the storage capacity can be increased by extension of the trench.

3.11 Electrical Equipment

Reporting on the experiences with the electric equipment should be left to the electricians. But difficulties had to be overcome in this special field, too.

Smooth starting of the motors and speed control of the conveyors with reference to one another is of decisive importance for the operation of belt conveyor systems. For all those tested (such as Turbo couplings, Eddy Current couplings etc.) the application of contactor controlled slip ring motor drives has proven to be the best choice.

All other features of a large-scale conveyor system, such as monitoring of

- off-center belt run
- belt slip
- belt tension
- belt sequence control

have been achieved successfully in the usual manner.

4. Development Trends

The oilsand deposits will be exploited in the future to a constantly increasing extent.

Reflections made by new investors tend clearly to the application of belt conveyor haulage.

Developments made up to now in this special field have been successful, but are still expandable. A series of tasks has to be brought to better solutions:

- lighter, shiftable conveyor head stations by pulleys and gear reducers of lower weight
- hopper cars causing reduced encrustation of belts and permitting better sorting out of oversize material (stones, lumps)
- improved cleaning equipment for the conveyor routes
- better cleaning devices for belts and pulleys.

Acknowledgement

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Photographs: Authors and Demag Lauchhammer

Fig. 6: Demag Lauchhammer trench reclaimer