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Presentation:

THE RAIL-VEYOR BULK MATERIAL TRANSPORT SYSTEM
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RAIL-VEYOR BULK MATERIAL TRANSPORT SYSTEM

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INTRODUCTION

In the early 1960’s the French state railroad, SECCAM, developed the light rail transport concept of a unitized train consisting of a series of closely connected open cars moved by side pressure of rotating tires attached to stationary drive stations. The basic concept was excellent, but because the mechanical applications required significant improvements the system was flawed. However, at least two commercial applications were installed which collectively moved several million tons of iron ore in France (1) and nickel laterite ore (22 kilometer haul) in New Caledonia. Although the system used energy efficiently, the necessary mechanical modifications were not implemented by the system developer, and interest in the system declined in Europe.

The author was involved with a U.S. company that had licensed the system from the French in the late 1960’s. Several studies were made to reduce the mechanical shortfalls over the original French design and industry response to the improved design was good with a study made to replace large off-road trucks at a major open-pit copper mine. The economics were very attractive but the project was halted because of a management decision to shut down the mine. During this same time period there was the well-publicized failure of a misapplied competitive system, the Dashaveyor at White Pine Copper in northern Michigan. The combination of these two events led to a reduction of my former company’s interest in the light rail transport concept.

In 1979, while on a trip to China, I observed an application ideal for the SECCAM process. Upon my return to the U.S., I inquired as to the status of the system from my former company and was advised that there was no longer any interest in it.

It was at that time that I decided to attempt to make the necessary corrections to the system and try to promote a rebirth of this excellent concept.

DEVELOPMENT

Over the next several years the basic components of the old SECCAM system were reviewed. The apparent system shortcomings of drives, car shape, wheel orientation, car connections, car sealing elastomer sheets and other miscellaneous items were addressed. Because the resultant system resembled a deep trough conveyor moving as a unit train on light rail track, the evolved system was appropriately named “RAIL-VEYOR”.

The most significant feature incorporated on the RAIL-VEYOR SYSTEM was the use of inverter systems to operate all the individual drive stations. The inverter controls provided the ability to synchronize drive station rotation speeds, allow high torque startup, controls acceleration and de-acceleration and provides total integration of all the drive stations of a complete system. SECCAM did not have this type of drive controls; they are fairly recent innovations and post-date the operational time frame of the SECCAM system

After many back-of-the-envelope sketches, ongoing reviews of existing bulk material transportations systems, and the input and suggestions from competent operating people and equipment suppliers, it was apparent that the next logical step was to build a functioning demonstration system. I received encouragement from within the FLORIDA INSTITUTE OF PHOSPHATE RESEARCH (FIPR) to present a proposal to FIPR management to design, build, and operate a semi-works scale RAIL-VEYOR System (RVS)

DEMONSTRATION PLANT

Funding was provided to design the demonstration plant, which was completed in July, 1999. Approval to build the actual plant was given in January, 2000 with funds made available in March, 2000. Construction began almost immediately. Cargill generously provided a test site and electrical services adjacent to their Bartow Chemical Plant works.

Met Pro Supply of Bartow, FL fabricated the cars, drive stations, loading system, and car unloading stage. Concorde Tech of Lakeland, FL designed and installed the electrical services and control function for the drive stations.

The initial plant was a one-quarter mile loop, with no loading or dumping facilities. The demonstration train consisted of 42 cars each four feet long, for a total train length of 168 feet. Eight drive stations were installed with a spacing of 165 feet. The train, when moving, was always under control of a drive station. The initial phase of operation started in early December, 2000. Tests on various wheel bearings systems were conducted, with the application of inner and outer thrust bearings per wheel being the preferred choice. Once all thrust bearings were installed the train operated with a minimum of problems and appeared to be very reliable.

The ultimate objective for the project was to demonstrate the ability to load, haul, and dump rock. The track was modified to include a 12 foot diameter double track outside loop dumping station which included a car twist phase of 10 degrees every four feet, returning the inverted train, after dumping, to its normal operating position. Because of the necessity to recycle feed, the dumping section and feeder were located in close proximity, which would not be typical in a commercial RV train system. A surge feed hopper that loaded the train while moving, was added to the system and also operated successfully.

The operating speed of the demonstration plant was 588 feet/minute. This speed was good for dumping, but was borderline too fast for the feed hopper. The distance between the dump loop and feeder was only slightly greater than the length of the train. The loader was operated at maximum speed to fill the cars, with 8 tons of feed in the 17 seconds available at full speed (an incremental rate of over 1,690 STPH).

An inverter with light sensor switch controls and time delay sequence were used to start the train loader when the train arrived, and shut down the loader when the train had left. There was no dynamic brake available to stop the loader conveyor so momentum of the belt required that it be shut down prior to the end of the train leaving the last couple cars nearly empty. The demo plant had the capacity of moving 210 STPH as a single train or, if expanded to six trains, could have transported 1,260 STPH.

COMMERCIAL APPLICATIONS

Each drive station is dormant until a signal is received to start because a train is approaching and to be up to drive speed when the train arrives. When the last car of a train passes a drive station, that station again goes into the dormant mode until it again receives a startup signal. The spacing between trains can vary from only one train on the track or a whole series of trains with just a few seconds spacing, or a very long train that is under control of several drives at any one time. The individual drive stations really don't care. They are just waiting to be told to start, accelerate up to speed at a constant rate and, if necessary, all shut down if a drive malfunctions.

The SECCAM system operated with trains of 1,160 feet (350 meters) in length, carrying about 81 STPH (73 MTPH) at the Moineville iron ore mine in France. With the new stronger design RAIL-VEYOR, especially with more powerful drives and other system improvements, it is reasonable to expect trains for single drive power requirements can equal or exceed 1,320 feet (1/4 mile) in length and haul from 90 to 120 STPH per train.

When operating in a loop several trains can be incorporated in a system. If, for example a 14- mile (22 kilometer) haul was required to move 1,100 STPH then it would take about 18 trains @ 1,320 feet each, 4.5 miles of trains on 28 miles of total track, to move this load (16% of track occupied). By designing the system to operate with trains equally spaced around the track and by adjusting loading speeds, the load cycles could function on a half time on and half time off cycle. In the case of the 1,100 STPH rate the trains would be loaded at 2,200 STPH using a surge bin similar to the demonstration plant.

By incorporating a side rail section from the main track a couple of train lengths long, an individual train could be removed from the circuit for preventative maintenance or repair leaving in our (example) 17 trains still available to transport the product. When compared with an overland conveyor with 28 miles of belt continuously operating no equivalent alternatives are available. The operating factor of a belt system is zero when maintenance is required or belt failure occurs.

It should be fairly obvious that the above example of 4.5 miles of trains with free rolling wheels on an iron track would be more efficient in energy usage than a continuous 28 mile conveyor belt that has an inherent drag over its entire length from the load and return idlers and belt tensioning requirements. How often do you see even a moderate length conveyor with at least one non-rotating idler that the belt is being dragged over?

An analysis was made to compare a two-mile haul, 1,500 STPH wet sand with the RAIL-VEYOR and an overland belt conveyor. An engineering company, experienced in installing belt conveyor systems, provided costs for the conveyor analyses. The data summary indicated that the RAIL-VEYOR has an estimated installed cost of less than 70% of the overland conveyor and would require about 45% of the nameplate horsepower selected for the conveyor.

MAINTENANCE FOR RAIL-VEYOR SYSTEM

The RAIL-VEYOR system was designed for low maintenance and to be operator friendly. The low maintenance anticipated will result in reduced maintenance labor requirements. The programmable automated operation will reduce operational manpower over other bulk transport systems.

Each drive station consists of two vertical "C" face AC motors directly connected to a gear reducer which is in turn connected to a foam-filled drive tire with a low durometer tread surface. The whole drive unit is mounted to allow it to swivel around a vertical post, with horizontal side plate pressure applied with a screw drive jack system. In the unlikely event of a drive station failure, the power cables can be disconnected and the whole unit of motor, reducer, drive tire and brake lifted off the post. A replacement drive set is reset on the post, positioned with the drive screw and reconnected electrically with a quick connect system. The elapsed time to perform this change should be in minutes instead of hours expected in other transport systems

Using the example of a 14-mile haul of 1,100 STPH, each drive tire would be only turning at 117 RPM or less than 17 MPH @ 3.84 hours/day. The tire is dormant the rest of the time. This represents about 65 miles of use per 24-hour day. Because the drive tire operation is benign, tire life should be expected to be at least several years.

Other potential wear areas are the car wheel bearings, clevis connections, and elastomer sealing flaps between cars. Thrust bearings are very common, easily replaced at low cost with operating life measured in multiple of years. Each clevis connection forward and aft is held in place with a large locking nut that allows for easy replacement. An individual damaged car can be removed from a train by pulling two clevis pins and inserting a new car. Life of elastomer flaps again would be measured in terms of years.

Car troughs are inexpensive rolled stock that can be easily replaced should excessive wear occur. Trough materials of construction would be site specific and be supplied to best suit the material being transported. Again, this would be measured in several years of time for required replacements.

The RAIL-VEYOR system has free rolling wheels at the back of a car. The wheels roll around curves, rather than skid around, as experienced when located at the front of a car. The SECCAM system was quite noisy because of front wheel placement, and they added oiling stations to reduce wear and noise, unnecessary with the RAIL-VEYOR system.

PHOSPHATE MATERIAL TRANSPORT APPLICATIONS

The largest tonnage application of the RAIL-VEYOR in the phosphate industry would be in the transport of phosphate matrix. By recovering matrix at natural moisture content and transporting in a static environment to the process plant by use of the RAIL-VEYOR system the transport energy savings are significant when compared to the very dynamic, low solids environment of a slurry pipeline. Building a windrow of matrix rather than spot feeding a well significantly enhances dragline efficiency. A study by FIPR in 1988 (publication #04-031-068) indicated that dragline efficiency is improved by 27% when windrowing matrix rather than spot loading a well. By recovering matrix from a windrow the process plant is divorced from the dragline and can receive a constant matrix supply independent of the draglines stripping and matrix-mining schedule.

The steady state dis-aggregration of matrix at the process plant can then be done under a controlled environment. This action could be conducted at higher percent solids than experienced at the mine site because of pumping solids requirements, resulting in higher solids clay waste product, which would require less storage volume and offer accelerated thickening potential. Resultant process feed would also be far more consistent than now experienced, leading to higher recovery rates.

In addition to the transportation of matrix, the RAIL-VEYOR offers the ability to transport sand tailings from the process plant to disposal sites without the high-energy transport of water as now experienced. The phosphate industry consumes a great deal of energy in just transporting water, much of which may be unnecessary.

In addition to mining, the RAIL-VEYOR can be used to transport phosphate concentrate, upgraded fertilizers and agriculture products for large farming operations. The light rail track system is very flexible and can be easily moved. It is a volumetric transport system that is not restricted to mining applications only. Multiple loading and dumping units can be incorporated in a single loop track system.

CONCLUSIONS

The excellent concept of the French SECCAM system was not developed to its fullest extent and eventually led to its demise. If the inverter control system had been available at an earlier time, SECCAM potentially might have played a significant role in the intermediate bulk material haul industry for the past several years.

The RAIL-VEYOR system that has evolved from the SECCAM has obstacles to overcome that are more emotional than technical. A fear of this or any new technology has to be overcome before it becomes commercially successful. The comment that “it is not proven technology” is often heard. This same statement was undoubtedly used before the advent of the overland conveyor, cable-belt systems, large haul trucks and certainly slurry transport of phosphate matrix.

Scale-up in capacity for large commercial operations has already been demonstrated by SECCAM. The successful RAIL-VEYOR demonstration plant indicated that the energy savings offered would be substantial. In addition, the operational concept would lead to reduced maintenance and operational personnel. Reduced energy consumption and personnel requirements are the two most important features offered by the RAIL-VEYOR system, and most desired by industry today.

(1) OPERATIONAL HISTORY OF THE SECCAM PROCESS-MOINEVILLE IRON ORE MINE FRANCE, B. BRARD Undated est. 1972 (translated from French – G. d’Aquin 11-02)