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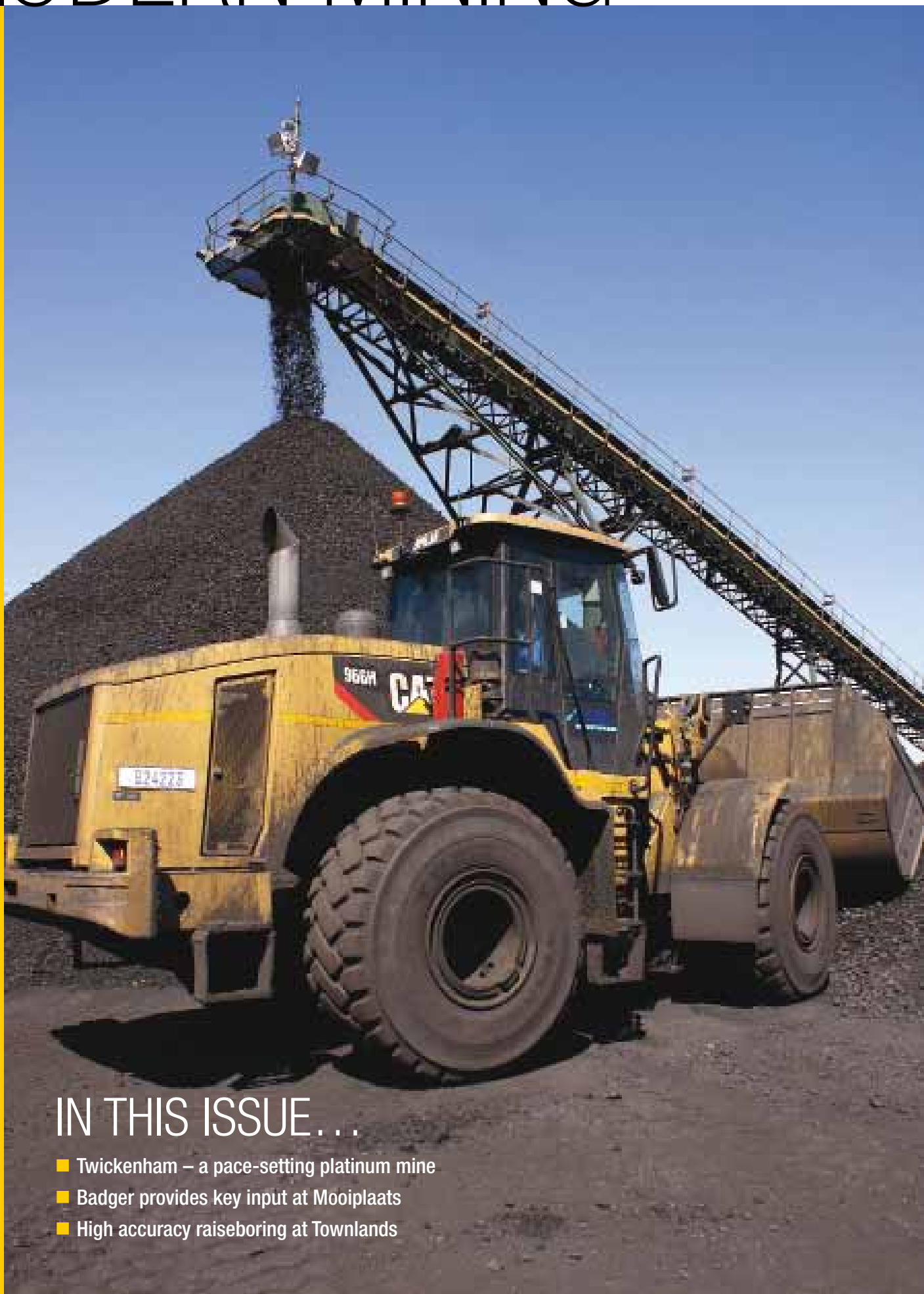


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*The highly photogenic Obajana Cement conveyor in Nigeria. It is an elevated 7 km-long, 2 400 t/h conventional troughed conveyor – running at 5 m/s – in a triangular spaceframe support structure.*

# AC-TEK TAKES CONVEYOR TECHNOLOGY TO THE LIMIT

*One of the world's leading experts on the design of overland conveyors, David Kruse of Advanced Conveyor Technologies Inc (AC-Tek), was recently in South Africa to speak at the Beltcon 15 conference, held in Johannesburg in early September.* ***Modern Mining*** *managed to catch up with him at the offices of Sandvik Materials Handling (SMH) for an interview which focused on AC-Tek's considerable contributions to overland conveyor technology.*

Kruse, along with his partner Ryan Lemmon, established AC-Tek in 2004. Both men had previously worked for a leading conveyor designer and now have over 30 years of combined experience in designing complex overland conveyor systems. Kruse is based in AC-Tek's office in Mankato, Minnesota, while Lemmon works from a second office in Idaho.

AC-Tek has prospered since its founding. Says Kruse: "We have been fortunate enough to have stayed extremely busy since starting up, even over the past year when the global economy has been in recession. The most challenging aspect of overland conveyor design is that every system is unique. Each conveyor has its own topology, design criteria, dynamic behavior, and other unique requirements. Consequently the design and engineering is never the same, and optimisation is almost always possible."

While AC-Tek works all over the world, it has been particularly successful in Africa, where it frequently works in conjunction with SMH. Contracts undertaken on the continent include Boschmanspoort, Modikwa, the Sishen Expansion Project and Khumani in South Africa, Lumwana in Zambia, Tarkwa in Ghana,

*David Kruse (left) pictured at SMH's offices in Johannesburg. With him is John Hill, Engineering Manager of SMH (photo: Arthur Tassell).*

Ngezi in Zimbabwe and Obajana Cement in Nigeria. Internationally, AC-Tek has an involvement in virtually every mining area, from the US to Mongolia and from Finland to Australia. One of its biggest current assignments is at the Aitik mine in northern Sweden, where – in association with Sandvik – it has designed eleven conveyors ranging from 50 m to 3 000 m to transport 8 000 t/h of copper ore. The largest belt is a 2 000 mm wide ST-6000 with 192 m of lift and an incredible 9,2 MW of installed power.

Of the African projects, perhaps the most innovative so far is the conveyor system installed for Obajana Cement. This consists of an elevated 7 km-long, 2 400 t/h conventional troughed conveyor – running at 5 m/s – in a triangular spaceframe support struc-

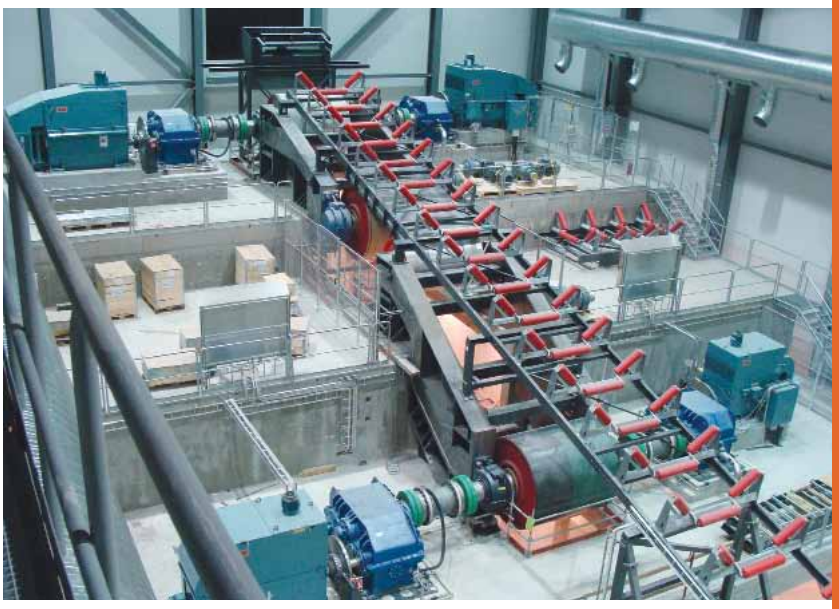
ture. It was a very complex project but the final result was an extremely lightweight structure with a running metre mass of 160 kg/m – much lower than it would have been for a conventional conveyor of the same width.

The Obajana conveyor is also curved horizontally. Comments Kruse: "Along with the introduction of variable speed drives and improvements in belting quality, the implementation of horizontal curve technology is one of the greatest advances in conveyor design over the past 10 to 20 years. Horizontal curves become important as conveyors become ever longer – some exceeding 20 km – and have to negotiate either natural or man-made obstacles. Using this technology, routes can be made shorter and the number of transfer points reduced over what would be required if sections of straight conveyor were used. In the case of the Obajana system, the client might have ended up with three conveyors instead of one."

According to Kruse, AC-Tek operates in two main areas. "Firstly, we have our overland conveyor section which designs systems using advanced techniques including dynamic analysis, FEA, DEM, and our Sidewinder conveyor design software. These tools are responsible for the advancements in conveyor technology, and our ability to engineer some of world's most complex conveyor systems. Secondly, we have our research and development section which encompasses everything from testing of various components (idlers, belting, rubber rheology) to obtaining field measurements on new and existing overland systems."

Kruse stresses that AC-Tek is essentially a consultant. "We design systems but we don't construct them," he observes. "For example, in the case of the 4,3 km long overland conveyor at Lumwana copper mine in Zambia, the contractor was SMH. We assisted SMH at the tender stage and we also, at the specific request of the client, conducted a dynamic analysis and optimisation of the system."

Although the layman might think overland conveyor design is a fairly straightforward task, Kruse stresses that it is, in fact, a high-tech discipline. "The starting point is the optimisation of the conveyor route," he says. "The best route is not necessarily obvious and it is not always a straight line. Then there's the question of the optimum vertical alignment of the conveyor. Accurate belt stresses and tensions must be determined before the minimum radii (both vertical and horizontal) can be calculated. Another issue to be addressed is the trade-offs between the conveyor design and the earthworks requirements. The complex interactions between these items require a high level of expertise in order to minimise capital costs while providing a safe and reliable system."



*Current construction progress at the 9 200 kW head drive station for the 8 000 t/h incline conveyor at Aitik, Sweden. According to David Kruse, the design contains significant advancements in conveyor technology and is one of the largest belt conveyor systems currently under construction.*

One of the techniques that Kruse and his colleagues can deploy on behalf of clients is dynamic analysis. According to Kruse, it is used to predict a belt's response to transient starting and stopping forces which may be applied by – for example – motors, brakes and take-up. "It is crucially important to undertake this type of analysis on all overland conveyors" he emphasises. "Using dynamic analysis, we can test and fine tune starting and stopping controls, simulate 'what-if' scenarios such as PLC failures and power outages, and simulate the control algorithms and mechanical responses of drive systems."

Rubber rheology is another area of expertise for AC-Tek. Rubber indention losses and material flexure can consume 50 to 60 % of the power consumption on a long overland conveyor. However, standard calculation methodologies such as CEMA and DIN cannot accurately predict the power and belt tensions for these systems. To overcome this problem, AC-Tek has developed a proprietary rolling resistance model, which takes into account the belt's bottom cover rubber properties. The company has also invested in a rheometrics solids analyser, which is

*In conjunction with Roberts and Schaefer, AC-Tek designed and commissioned this 3,3 km long, 7 000 t/h conveyor (with an 1 830 mm belt) at the huge Black Thunder coal mine in Wyoming in the US. Owned by Arch Coal, Inc, Black Thunder produces nearly 3 tons of coal per second around the clock, sufficient to fill 18 to 20 trains a day. It is one of the largest coal mines in the world accounting for nearly 9 % of US production.*

capable of measuring the visco-elastic properties of rubber samples at various temperatures, frequencies (speeds) and strains (idler normal forces).

Designing advanced conveyor systems is all very well, of course, but how does one know just how efficient they are in practice? Responds Kruse: "Accurate field measurements of system performance and other factors are absolutely essential if the science of conveyor technology is to continue to advance. One of our great strengths at AC-Tek is our commitment to improving data acquisition techniques required to validate our theoretical models."

Kruse says that field measurements serve four basic functions. "Firstly, they can be used for equipment and design validation," he notes. "They provide answers to basic questions such as whether the equipment meets design specifications and is operating properly under all load conditions. Secondly, they provide valuable data for forensic engineering purposes. We tend to get called in when something has failed and the cause of the failure is not obvious. Thirdly, field measurements are essential if a client wants to upgrade an existing system. Unless you know how the system is currently operating, you don't know how far you can safely increase the tonnage, or what changes may be required to meet the new design capacity," he explains. "And finally, field measurements are used for the verification of theoretical calculations, in the process allowing us to expand the design limits of what is currently possible."

Much of AC-Tek's expertise has been put into its 'Sidewinder' conveyor design software. Sidewinder reflects the company's collective experience and has been developed using the latest programming tools. The program is said to have an easy-to-use flexible interface, and can handle conveyors of any geometry, length and drive configuration. Its capabilities include static and dynamic calculations, horizontal curves, control system logic, and terrain modelling. It is already available in English, Spanish and Portuguese language versions with German, Italian, and other languages being added.

***The 4,3 km long overland conveyor at Equinox Minerals' Lumwana copper mine in north-west Zambia. The contractor was SMH with AC-Tek providing specialist input. Lumwana is probably the biggest copper mine in Africa.***

Another software package written by company is 'Newton', which carries out discrete element calculations to model granular flow. In addition to modelling material behavior and flow patterns, the software also allows prediction of the wear on liners, belts and other wear surfaces. Furthermore, the engineer using the package can quantitatively compare two similar designs, selecting the geometry that provides the minimum amount of wear, dust generation and material abrasion.

Summing up, Kruse makes the point that the sophistication of overland conveyor systems is increasing year by year. "While there are no quantum leaps forward, incremental improvements in conveyor components and design methods are allowing us to engineer safe, reliable and cost effective systems that were considered impossible 20 years ago," he says. "This is an exciting field to be in, and one which is having a major impact on the efficiency and profitability of mining operations."

***Photos (unless otherwise acknowledged) courtesy of AC-Tek.***