ENGINEERING
TOMORROW

Case story | Drytech Wet Screw Feeder

Danfoss plays role with Drytech and BMG in improving material processing at South African platinum processing mine and smelter

Danfoss, in support of engineering components provider BMG Electronics, an authorised DrivePro® service partner, has helped to assist DryTech International in its development of a unique wet screw feeder for use by a South African platinum mine processing plant and smelter situated in the Bushveld Region, within the Limpopo province.

DryTech provides innovative design solutions to thermal processing problems, successfully developing a variety of complex thermal processes ranging from mineral concentrate flash dryers to high-temperature reduction kilns and continuous vacuum dryers.

Challenge: Unusual material characteristics **required unique solution**

DryTech developed the wet screw feeder for this plant due to unusual characteristics of the material being processed from platinum group metals (PGMs), chrome and base metals. The material is extremely sticky - similar in constitution to clay – and needed to be transferred into a dryer.

In addition, this material was to be received not only from mines within the immediate area, but also from mines in the Mpumalanga province of South Africa, a distance of over 300km away. During this transit period, the plant had found that some composites dried out, while others remained wet.

From a mechanical design perspective, the gears required for the feeder would be large-scale, posing some practical challenges when it came to physically fitting into the unit synchronisation without the screws clashing. Larger gears would also substantially increase the costs of the wet screw feeders. Ease of maintenance was a further requirement by the plant.

The throughput needed from the first wet screw feeder was between 30 and 40 tonnes per hour, with 15 tonnes per hour required for the second feeder.

Solution: A trial machine was built by **DryTech** for testing of application, and a three screw shaft solution was found to be **the most effective.**

While the three screw shafts were mechanically linked to one other during this trial, the client favoured a solution with independent shafts, using the preferred Danfoss VLT® AutomationDrive FC 302 22kW units controlling a 22kW motor/gearbox on each shaft, with electronic synchronisation between them.

This was a critical requirement, as all three shafts needed to rotate in a co-ordinated manner to help prevent mechanical damage. This is due to the fact that, should any of the shafts go out of synchronisation, even by a programmable limit, the machine must be stopped.

For example, if one of the motors, gearboxes or shafts became overloaded and slowed the motor down, it must be detected by an out-of-synchronisation function and all screw shafts stopped. Once the problem has been cleared and the application has been brought back manually then the application will revert back into the correct sychronized position automatically when started instead of having to return the shaft to a home position manually.

"The Danfoss VLT® AutomationDrive FC 302 offering provided the ideal solution for this client, due to its innovative alternative to the traditional servo control approach for positioning and synchronisation operations. The Drives are adapted to the applications through simple parameterisation."

- Stephen Brown, *Mining Business Development Manager* for Danfoss Turkey, Middle East & Africa

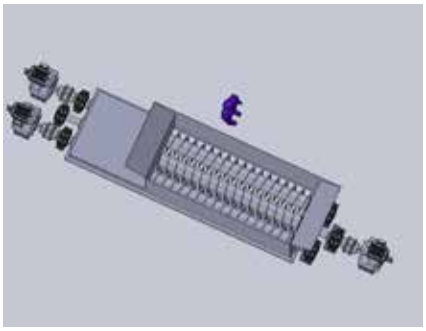
During normal operation, the load on each drive is relatively light – at less than 50 percent motor full load torque (FLT) - but because of the material's consistency, there are times when higher loads occur. It was for this reason that the 22kW drives with 22kW motors were put forward, and this has proven to be especially true during start conditions or low-feed rate conditions.

The motors are mounted above the gearbox driving each screw shaft, which, according to DryTech, means that the motor drives the gearbox via a belt drive.

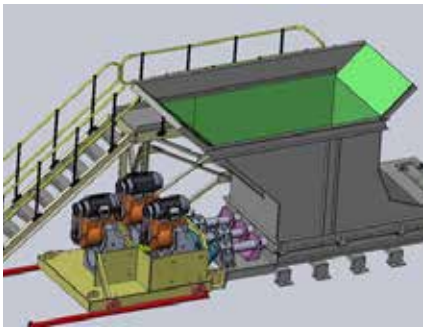
"We needed the flexibility to be able to adjust the belt pulley ratio during commissioning in order to set the maximum speed, and therefore throughput rate, of the feeder.

This also prevents mechanical damage at the belt, which will fail first."

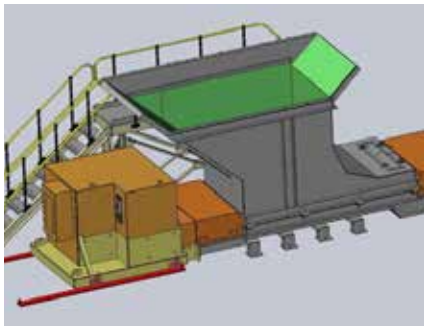
- Riaan Van Niekerk, *DryTech spokesperson*



3D wet feeder model without guards



3D wet feeder model with guards



DryTech wet screw feeder setup via VSDs

Results: Tighter speed and **operation control**

The final application set up by Juan Lerm Field Service Techician BMG Electronics comprises three screws, connected to the 22kw motors and reducing gearboxes. The master – or centre – motor is attached to a Danfoss VLT® AutomationDrive FC 302 with a PROFIBUS® and encoder option.

The PROFIBUS® master is the plant control system controlling the operation and speed of this motor according to process requirements. The master motor is fitted with an encoder to increase its dynamic torque response, and the shaft of this motor has a reference encoder to measure the actual screw shaft rotational speed.

The higher the PPR (pulses per revolution), the better the syncing, as the increments are closer to each other, thus increasing the resolution of the feedback. "In this application we used 8192 PPR multiturn absolute encoders," explains Mick Baugh, Electronics Manager, Electromechanical Division, BMG. "When the wet feeder needs to run, it gives a 'start' command to the master variable speed drive (VSD) via PROFIBUS®. The master VSD then gives the start signals to the follower VSDs."

The two follower screws are connected to Danfoss VLT® AutomationDrive FC 302 with an VLT® Synchronizing Controller MCO 350 option also with PROFIBUS®, but for monitoring purposes in this case and not control. The Master encoder is connected to both the MCOs as a master reference, which means that the MCO 350 cards monitor the speed of the master shaft.

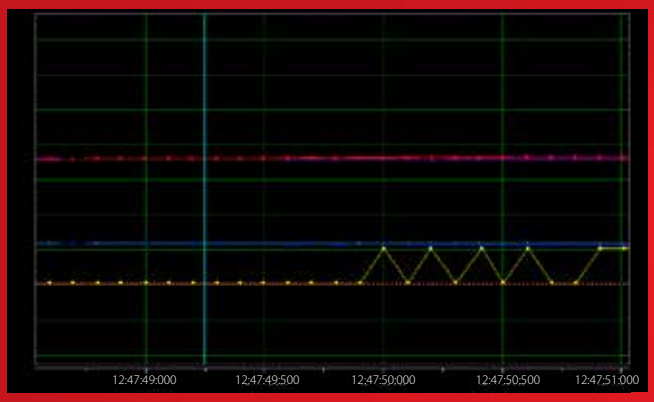
The follower encoder is fitted on the screw shaft of the follower screws, and these encoders are connected to each respective MCO as a feedback signal.

"The way this works is that the follower effectively mirrors the master encoder: if the master screw shaft runs at a certain speed, the follower MCO card monitors that speed and matches it so that the follower shaft is running in sync with the master reference," states Baugh.

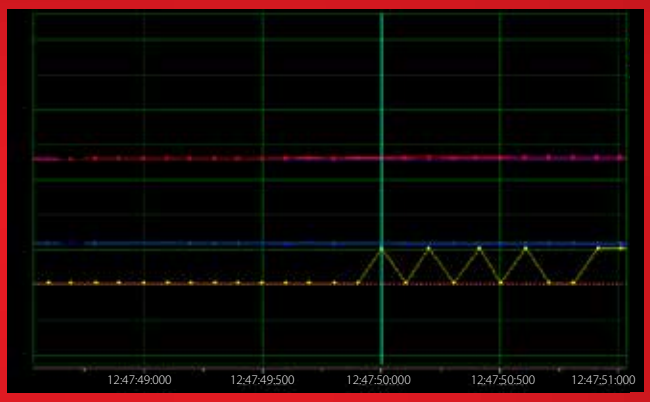
"If the application stops in an alarm state, all the motors will coast to a stop, and the follower shafts will be out of sync. When a start command is given, the master VSD has a five-second delay, so that the screws will ramp up, and the application goes back into sync by itself. The master will then ramp up to the speed reference as per the PROFIBUS® signal."

If maintenance has been done on the application, the screws will be out of sync. A manual sync was programmed so that the VSDs will go into a second setup, and now each screw can be jogged in forward and reverse to put all the screws into a sync position. Once the screws are correctly aligned, the sync button can be pushed and the VSD will have a new, zero position. The application can be started up again and can run in sync.

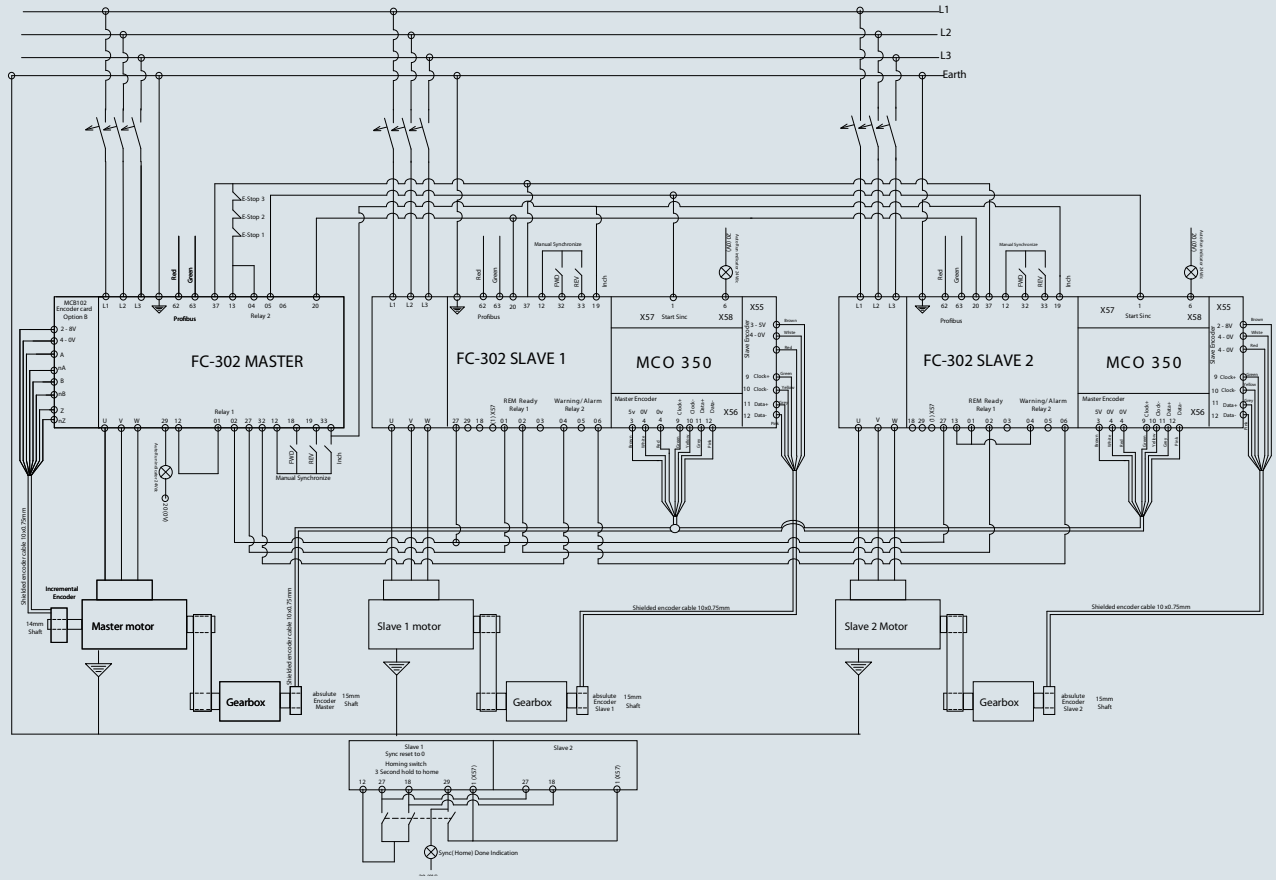
The charts shown are depicting the Danfoss VLT® Motion Control Tool MCT 10 Set-up software and indicate the readings under motor running conditions from the Master and Follower Variable Speed Drives



- Red Line 1801.52 RPM: Indicates the follower Shaft Speed from the Encoder
- Yellow Line 0.00: Refers Follower Synchronisation Errors
- Blue Line 11.36: Shows the follower Motor Current
- Pink Line 1801.00 RPM: Reflects the Master Encoder Speed
- Light Blue Line 11.66: Indicates Master Motor Current



- Red Line 1818.25 RPM: Indicates the follower Shaft Speed from the Encoder
- Yellow Line 1.00: Refers Follower Synchronisation Errors
- Blue Line 11.29: Shows the follower Motor Current
- Pink Line 1803.06 RPM: Reflects the Master Encoder Speed
- Light Blue Line 11.67: Indicates Master Motor Current



Electrical diagram of the application

"The fact that the Danfoss VLT® Synchronizing Controller MCO 350 option did not require the writing of a special APOS program was also a significant deciding factor," Baugh adds.

Acknowledgements

Thank you to the following personnel for providing information and assistance in this Drytech Wet Screw Feeder case study; Riaan Van Niekerk EC&I Project Engineer Drytech International (Pty) Ltd, Alistair Thornton-Smith Operations Manager Drytech International (Pty) Ltd, Juan Lerm Electronics Field Service Technician BMG, Charl Kruger Product Specialist Electronics BMG, Mick Baugh Business Unit Manager Electronics BMG.