ENGINEERING TOMORROW

Case story

Running a motor at **constant** breakdown **torque**

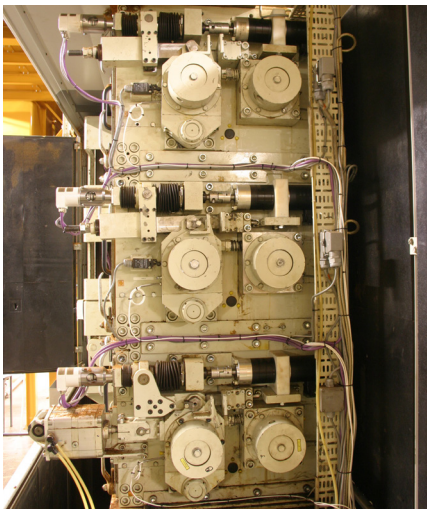
Danfoss VLT® Automation Drive provides micrometre accuracy for grinding process control at Markus Kaffee, a coffee-roasting company in Bremen, Germany.

The difference between a sellable product and expensive waste is a matter of only a few micrometres in the separation of the coffee grinder rolls, because there are no compromises when it concerns coffee quality. With its innovative VLT® Automation Drive FC 300 drive concept, Danfoss helps keep the grind quality of the coffee constant so customers can always enjoy the taste they are accustomed to.

Consistent granularity

Maintaining a consistent granularity is an important qualify factor for coffee. At Markus Kaffee, two high-performance coffee grinders from Neuhaus Neotec do their part to assure constant grind quality. They grind up to 6000 kg of coffee per hour. Their working principle is fundamentally different from that of familiar household grinders.

Each of the two grinding machines has three sets of rolls stacked vertically, each with its own grinding gap. The gap size decreases from top to bottom, starting with a gap of nearly 1 mm. The desired coarseness is only achieved after the coffee passes through all three gaps. In order to achieve the desired result, grinding rolls with a weight of more than 500 kg are used. With each pair of grinding rolls, one roll is fixed and other is mounted on moveable supports to allow the desired coarseness to be set precisely. The coffee is heated by the grinding process, and this can in turn affect the roll spacing and thus cause the grinding degree to change. The grinding process is constantly monitored in order to prevent this. Naturally, this monitoring is performed automatically, but the experienced specialists also check the grinding degree regularly by hand using the finger test, and they have a perfect feel for the optimum grinding degree. The coffee roasters aim for an overall medium coarseness, without too high a proportion of fine particles but also without to many 'flakes'.



Side view of the machine. The three vertically stacked grinding units and the device for adjusting the positions of the large grinding rolls are clearly visible.

Markus Kaffee in Bremen ships 240,000 packages of coffee every day to the German branches of Aldi Nord and its foriegn branchs in the Netherlands, Belgium and Denmark.

Adjustment by one-hundredth of a millimeter

The grinding gap is the key to it all. It must be possible to adjust it to within one hundredth of a millimeter, and as quickly as possible. For trouble-free operation, it is necessary to shut down the grinders from time to time. When this is done, the roll gap is increased to around 2 mm to reduce the torque load during start-up operation. The gap cannot be brought back to its specified value until the grinding rolls have been brought up to normal operating speed.

Adjusting the grinding gap demands speed and accuracy because the gap must be reduced quickly over a relatively wide range in order to avoid lost time waiting for the rolls to move together. In addition, it must be possible to adjust the system very precisely, because the fine adjustment of the grinding gap is a matter of micrometers.

The Danfoss frequency converters from the VLT® AutomationDrive FC300 family.

12.4 watts is enough

As the travel distance is very small, the drive power for the grinding gap adjustment is extraordinarily low despite the required torque level of several hundred newton-metres. The adjustment mechanism is based on a three-phase induction motor with a rated power of 12.4 W and a rated current of 92 mA. The drive is fitted with an 8-pole, standard-winding three-phase motor operating at 400 V / 50 Hz. To arrive at the desired specs, the drive unit is fitted with a four-stage planetary gearbox (ratio 2076:1) on the output side, which acts on a threaded-shaft drive with lever transmission. A high-resolution absolute position transducer on the threaded shaft measures the actual position.

As standard commercial frequency converters are not available in this power range, it was necessary to find a converter that could reliably drive this motor, which has a power rating around 20 times less than usual. Neuhaus Neotec took this requirements profile to drive specialist Danfoss, with which the company has worked for many years with very satisfactory results.

A freely configurable drive

The application uses Danfoss frequency converters. Although the VLT® AutomationDrive FC300 family is designed and rated at 0.37 kW and up, the modularly adaptable frequency converters can master a wide variety of applications. They are able to drive these relatively small motors with suitable parameter settings. For instance, they can easily be programmed for a variety of control methods, ranging from basic V/f control to VCC+ vector control and even flux vector control. Wide parameter ranges and versatile configuration options allow the VLT® AutomationDrive FC300 to be specified exactly for a wide variety of motors, such as induction and synchronous motors, AC and PM servo motors, and torque motors.

However, standard settings do not always lead to optimum drive control results. An experimental setup put together by the employees of Neuhaus Neotec in cooperation with Danfoss specialists was necessary in order to determine the optimum parameter settings for the grinder positioning drive. Using this setup, they established a non-linear V/f characteristic that intentionally undermagnetises the motor over the entire frequency range such that the breakdown torque of the motor is constant over the speed range of 0 to 120 Hz. The specialists programmed this curve as a freely configurable V/f characteristic curve with multiple breakpoints.

Electronic overload coupling

With this form of motor flux control, Danfoss managed to eliminate a mechanical overload coupling on the output shaft of the gearbox for torque limiting, which had been planned into the design. Now if a foreign object is located in the grinding gap while the rolls are being moved together, the motor will apply the reduced maximum torque level and then stall. With their electronic overload coupling, the Danfoss specialists not only achieved a very economical solution but also created additional installation space, because the new drive unit is considerably more compact. With the VLT® AutomationDrive FC300, the Bremen-based coffee roasters can always control their grinding process with micrometre accuracy because Danfoss has the optimum drive, even for drive systems rated at 20 times less than usual.

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