More print quality for the flexo-printing with direct drives

Torque motors directly drive the central cylinder
Quantum leap in quality
Torque motors provide further improvements for flexo printing

The central cylinder flexo-printing machines have established themselves for the printing of flexible packing materials. Thanks to the single-drive technology, their reliability, accuracy, flexibility and the production change-over times have been improved. These so-called gearless or shaftless machines are normally still equipped with motor-gearboxes. Nowadays, torque motors, as gearless direct drives, permit a further quality increase.

Currently, the single-drive technology is the state-of-the-art for modern central cylinder flexo-printing machines. For this type of printing machine, 4 to 10 printing units are arranged around a shared impression cylinder. The central cylinder and each other cylinder of the printing unit are driven by its own motor and servo-controller. These so-called gearless machines are primarily equipped with gearboxes on the motors. The gearboxes used here must be designed for continuous high-speed operation. These machines normally use solvent-based inks and for which, depending on the machine design, different classes must be observed for the EEx protection.

Picture 1: Siemens 1FW6 torque motor
Picture 2: The figure shows in dB the register error in µm depending on the interference frequency in Hz for an interference torque of 1Nm: the smaller the curve, the smaller is the register error (0 dB means 1 µm/Nm, -20 dB 0.1 µm/Nm, -40 dB 0.01 µm/Nm). Red: Conventional drive with gearbox and gear wheel. Black: Torque motor direct drive achieves approximately 200 times the accuracy.
Central cylinder direct drive – the state-of-the-art for drive engineering

In particular for the central cylinder drive, high demands are placed on the accuracy. The printed material is fed by this cylinder and because of the large diameter, any synchronization error directly causes a colour register error. Modern machines for large formats can have a diameter as large as 3 m with the processed strip width of up to 2 m. A directly-mounted high-precision sensor is needed to ensure the required accuracy. A register accuracy of at least ±25 µm is required on the cylinder surface. A sensor accuracy of 3 ° (angular seconds) is just adequate for a typical diameter of 1.8 m. Because the print format does not have any unique reference to the cylinder circumference, the repetition accuracy of the sensor typically required in the printing industry is not sufficient for this application. Not only the large circumference with its effect on the measuring accuracy but, in particular, the large moment of inertia represents a challenge for the control engineering. The mentioned large-size printing machines may well have a central cylinder with a moment of inertia that exceeds 20,000 kgm². A central cylinder with 3 m diameter with a machine speed of 500 m/min turns with only 53 revolutions per minute!

Torque motors mounted directly on the cylinder shaft prove their comprehensive control-engineering advantages here. A torque motor is a slowly-turning, multi-pole motor mounted as kit motor without its own bearing assembly. Relative to its volume, it has very large torque and is constructed as a permanent-magnet synchronous motor. It has more similarity to highly-dynamic linear motors than to normal laminated core motors.

The short construction form coupled with the large diameter means that the machine bearing can provide the motor bearing assembly. This permits a very rigid coupling of the motor rotor to the cylinder. The motor housing is screwed directly with torsion rigidity to the machine side wall.

The Siemens ultra-dynamic and precise torque motors of the 1FW6 series are available with maximum torque in the range of 750 Nm to 7500 Nm. The high power density means that they are provided with liquid cooling. In addition to cooling the motor power, a so-called precision cooler is also already integrated to cool the motor flange. This avoids heat from being transmitted from the motor to the machine and so prevents distortions arising as result of the heating. Because the central cylinder is in any case liquid cooled, the motor can also be cooled at the same time, with the subsequent improvement to the overall energy household.

The performance controller and the mechatronic tool are a duet optimally matched to each other

No matter how thick a shaft is, it cannot have complete torsion rigidity. The central cylinder with the torque motor produces a typical arrangement of a two mass oscillator. The drive controller must accelerate the large masses while at the same time damping the oscillations. Unfortunately, the mechanical characteristic parameters are often not known exactly. The Sinamics S120 servo drives offered by Siemens give the user not only the dynamic behavior but also the tools needed to analyze
the mechanics and so set the control parameters. These mechatronics aids feed a frequency band via the motor into the machine and analyze the response of the rotational mechanics using the motor sensor. This can be used to check the drive mechanical system that was dimensioned in a simulation during the development phase and so gain important feedback about the machine design. The drive controller also has special filters that permit a flexible and simple customization to the existing mechanical system and the required control behavior.

**Torque motor as single drive lies in trend**

Torque motors continue the trend away from mechanical drive elements to the electrical direct drive. This permits simplified mechanical designs, reduced wear, zero backlash, and consequently improved quality and flexibility. This is especially the case for very large moments of inertia and very high torque requirements. Here, the Siemens torque motors of the 1FW6 series with their integrated cooling and the flexible drive controllers have proven their capability – also in applications subject to lower masses.

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