Higher flexo-print quality when using direct drives

SIMOTICS T torque motors directly drive the central cylinder

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Quantum leap in quality

SIMOTICS T torque motors further improve flexo printing

Flexo-printing machines with central cylinder have established themselves for printing flexible packing materials. Thanks to the single-drive technology employed, their reliability, accuracy, flexibility and production changeover times have been improved. These gearless or shaftless machines are normally still equipped with motor gearboxes. Today, torque motors, as gearless direct drives, allow a significant increase in the quality.

Currently, single-drive technology is state of the art for modern flexo-printing machines with central cylinder. For this type of printing machine, 4 to 10 printing units are arranged around a common impression cylinder. The central cylinder and each additional cylinder of the printing unit has its own motor and servo controller.

These gearless machines are primarily equipped with gearboxes mounted on the motors. The gearboxes used here must be designed for continuous high-speed operation.

These machines normally use solvent-based inks. Depending on the actual machine design, different classes must be observed for the EEx protection.

Central cylinder direct drive – state-of-the-art drive technology

High demands are placed on the precision, in particular for the central cylinder drive. This cylinder feeds the printed material and because of the large diameter, any synchronization error directly causes what is known as a register error (register error in the multi-color printing).

Modern machines for large print formats can have a diameter as large as 3 m with the web width of up to 2 m that can be printed.

The diagram shows in dB the register error in μm depending on the interference frequency in Hz for an interference torque of 1 Nm: The lower the curve, the smaller 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 pinion
Black: Direct torque motor drive achieves approximately 200 times the accuracy
High dynamic performance and precision

Siemens SIMOTICS T torque motors get a high score with closed-loop control advantages

A directly-mounted high-precision encoder is needed to ensure the required accuracy. A register accuracy of at least ± 25 μm is required on the cylinder surface. An encoder accuracy of 3" (angular seconds) is just about 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 encoder 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 especially the high moment of inertia represents a challenge for the control system.

The large-format printing machines being discussed can have central cylinders with a moment of inertia that exceeds 20,000 kgm². At a machine speed of 500 m/min, a 3m diameter central cylinder only rotates with 53 revolutions/minute! Torque motors mounted directly on the cylinder shaft prove their comprehensive control-related advantages here.

The torque motor

A torque motor is a slowly-turning, multi-pole motor mounted as kit motor without its own bearing assembly. Relative to its envelope dimensions, it has a very high torque and is constructed as a permanent-magnet synchronous motor. It has more similarity to a linear motor with high dynamic performance than to normal laminated core motors. The short design coupled with the large diameter means that the machine bearing can be used as the motor bearing assembly. This allows the motor to be stiffly coupled to the cylinder. The motor enclosure is bolted directly to the machine assembly with high torsional stiffness.

SIMOTICS T-1FW6

1FW6 SIMOTICS T torque motors are available with maximum torques in the range of 750 Nm to 7500 Nm. They have a high dynamic performance and a high degree of precision. Their high power density means that they are equipped with liquid cooling. In addition to cooling the motor, a precision cooler is also integrated to cool the motor flange in the motor enclosure. This avoids heat from being transmitted from the motor to the machine thus preventing any distortion as a result of the temperature rise. Because the central cylinder is liquid cooled anyway, the motor can also be cooled at the same time. This in turn improves the overall efficiency.
The performance controller and the mechatronic tool are a duet optimally matched to each other

No matter how thick a shaft is, it cannot be completely torsionally rigid. The central cylinder with the torque motor represents a typical arrangement with a two mass system capable of oscillation. The drive controller must accelerate the large masses while at the same time damping any oscillations. The mechanical parameters are unfortunately often not precisely known.

In addition to the increased dynamic performance, Siemens Sinamics S120 servo drives are equipped with the necessary tools required to analyze the mechanical system and to set the control parameters.

These mechatronics aids feed a frequency band via the motor into the machine and analyze the response of the rotational mechanical system using the motor encoder. This can be used to check the drive mechanical system that was dimensioned in a simulation during the development phase, thus obtaining important feedback about the machine design.

The drive controller also has special filters, which permit a flexible and simple adaptation to the existing mechanical system and the required control behavior.

The trend is towards torque motors as single drive

Torque motors consequentially reflect the trend away from mechanical drive elements to direct electrical drive. This innovation permits simplified mechanical designs, reduced wear, no gearbox backlash – resulting in higher quality and flexibility. This is especially the case for very large moments of inertia and very high torque requirements.

Here, Siemens 1FW6 SIMOTICS T torque motors with their integrated cooling and the flexible drive controllers have proven their capability – also in applications involving lower masses.

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