Torque about sensing!

Due to the features they provide, TorqSense sensors and transducers from Sensor Technology of Banbury have been adopted for use within test and measurement applications

TorqSense torque sensors

From its base in Banbury, Sensor Technology has developed a range of rotary torque transducers based on surface acoustic wave (SAW) technology. By harnessing the benefits of this technology, the company has produced the TorqSense sensors and transducers which are said to overcome the problems associated with traditional torque sensors. As TorqSense is fundamentally a digital system, it has a broader signal bandwidth than other analogue based technologies and electromagnetic interference is eliminated, explains the company.

The advantages provided by this technology have led to its adoption within test and measurement applications, with one example taking place at the University of Bradford.

Here, Professor Hadj Benkreira and Dr Raj Patel, in collaboration with Dr Martin Gale (formerly of RAPRA Technology), have been developing a miniature mixer (5-25g batch) incorporating a set of integral instruments which work in real time to monitor the properties of materials as they are being mixed. Their output is then captured to a PC for subsequent analysis.

One of the key parameters to be measured is the torque of the mixing element, as this will become constant once mixing is complete – and this is where TorqSense comes in. The non-contact sensor has provided the advantage of not requiring complex and delicate slip rings, making the mixer easier to build (and re-build between trials) and far more robust in operation.

The Mini Mixer development and validation is the result of a three year EPSRC sponsored programme of research, the results of which are expected to have a major impact on the formulation of viscous mixes and scale-up of extruders.

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Recipes have traditionally been developed in 25 and 50kg batches and mixed in an industrial scale twin screw compounder. Several batches may be required before the recipe is finished. The new device must be able to duplicate mixing in the larger scale and guide design and operation of large machines – but in a smaller size. The fact that the technology will transfer to the plastic industry and other soft solid sectors means it is likely to recoup development costs, explains the company.

The technology

The TorqSense torque sensors use two tiny ceramic piezoelectric frequency resonating combs (SAW devices) that are fixed onto the shaft of the sensor to measure applied torque. As the torque changes the combs vary their spacing and consequently the resonant frequency of the SAWs changes proportionally to the torque applied in the rotating shaft. In effect, the combs are frequency dependent strain gauges that measure changes in resonant frequency of the shaft. A wireless radio frequency (RF) coupling is used to interrogate the SAWs and transfer the data signal to a pick-up head as well as to supply power to the SAW devices. Because the gauges are based on piezoelectric technology, they need less than one milliwatt of power. This arrangement removes the difficulties of fitting slip rings and maintains the measurement quality throughout an extended test run.

Commenting on why TorqSense was selected, Dr Patel said: "In a development project like this you are constantly dismantling and rebuilding the equipment. TorqSense torque sensors save us considerable time and effort because it is so simple to set up."

The University of Texas has also selected TorqSense technology.

Testing motors

While getting the right motor for a demanding application isn't exactly a hit and miss affair, says Sensor Technology, the performance curves supplied by the manufacturer can only tell so much. Real world performance evaluation is needed, so modern test beds are used, offering the ability to test actuators under a static load (such as a brake) and providing an important indicator of long term performance and reliability. Even then, however, the overall picture is limited.

Recognising the need for a test architecture that would look at all possible operating conditions, the Robotics Research Group (RRG) at the University set out to design a test bed that would measure and record an array of physical properties during both dynamic and non-linear load testing.

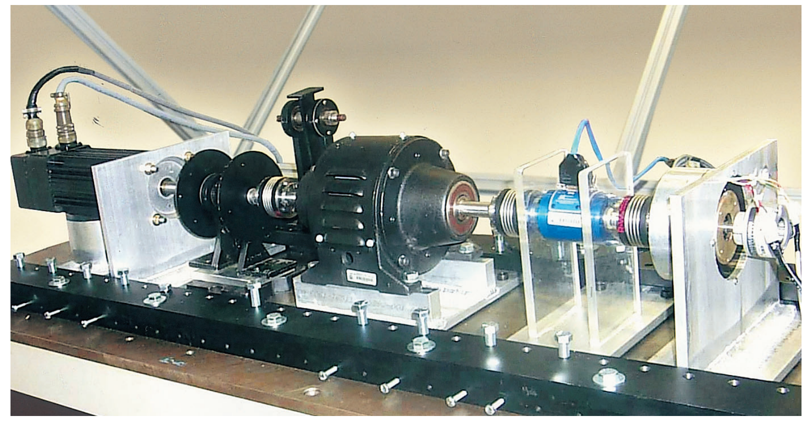
The result is the Nonlinear Test Bed for Actuators (NBTA) which is able to simulate real world operation under both linear and non-linear loads. This comprises a load motor, a four bar linkage, a brake/clutch and a torque sensor. Each component is linked to the next via a bellows coupling, with a second one connecting the torque sensor to the motor under test. All components are held rigidly against a variety of load profiles by long steel rails, which are secured to the test bed to resist horizontal and vertical forces, enabling the tests to provide an accurate picture of motor performance.

In operation, the load motor provides the dynamic test by generating various types of load, while the four bar linkage creates the non-linear periodic load. The load profiles can be readily defined to simulate real-world conditions for the test motor. An encoder is connected to the motor to provide position, velocity and acceleration data, while the torque sensor measures the torque between the applied load motor and the test motor.

When selecting the sensor, the Group had a number of requirements: it needed to have a torque, speed range and torsional stiffness higher than the operational range of the test motor; and because the test bed had to test a range of different motors with different torque-speed curves, the torque sensor also had to be extremely accurate.

Measuring rotary torque has historically been difficult and expensive because traditional techniques are invasive to the mechanical systems being measured. TorqSense, however, is an affordable and practical solution, explains Sensor Technology.

The SAW based transducer is essentially a 'frequency dependent' strain gauge that measures the change in resonant frequency caused by an applied shaft strain. Two SAW devices embedded on a shaft form part of a high frequency oscillator circuit. When the shaft is twisted, the resulting deformation of the substrate creates a frequency difference between two embedded SAW devices. The two frequencies are mixed together to produce difference and sum signals – the difference signal is a measure of the induced strain due to the twisting moment, and from this the torque can be derived.



The Nonlinear Test Bed for actuators

The RRG is focusing on assessing permanent magnet synchronous motors, which are often used in robotics applications and for heavy duty applications because large output can be obtained during high acceleration and deceleration rates.

For the purposes of evaluating the test bed, permanent magnet synchronous motors have the advantage of high torque, low speed characteristics, enabling the researchers to give the test bed a thorough workout. The hope, however, is that it will soon be testing a range of prime movers, assessing the motor's characteristics for demanding and diverse applications.

Sensor Technology
T: 01295 730746 **Enter 672**
www.sensors.co.uk