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Magnetic rotary sensor in use: On the road with London taxis

Short version:

Today the operating principles frequently used for contactless angle detection include magnetic methods. They supply absolute measured values, operate reliably even under harsh environmental conditions and, due to the low costs compared to other measuring methods, are suitable not only for countless measurements in mechanical and process plant engineering, but also for use in mobile applications. The RFC4800 magnetic angle sensor from the product line of the sensor specialists at Novotechnik in Ostfildern, Germany, proves this in the so-called CleanCab System developed by STT Emtec for exhaust-gas recirculation in London taxis. The rugged sensor detects the valve position on the diesel injection pump. As the sensor element and the position-marking magnet are designed as separate modules, it was particularly easy to integrate in the application. The measured value is made available to the primary controller with a resolution of 12 bits and an independent linearity of +/- 0.3 %. The harsh environmental conditions encountered in mobile use do not impair operation.

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conditions and, due to the low costs compared to other measuring methods, are suitable not only for countless measurements in mechanical and process plant engineering, but also for use in mobile applications. This is proven in the application examples from the motor vehicle engineering sector described in the following.

The Swedish company STT Emtec has developed a retrofitable exhaust-gas recirculation (EGR) system for the nostalgic-looking taxis in London with which the vehicles (Figure 1) meet the requirements of the Euro 3 standard. The pollutant emissions are drastically reduced (Figure 2). The new CleanCab System has successfully passed all tests and was approved by both the EST (Energy Saving Trust) and the PCO (Public Carriage Office). It can easily be integrated in the taxis' diesel engines. Install it and forget it is the motto for drivers and vehicle owners in this case. For nothing about the running characteristics changes due to the conversion, the exhaust system doesn't need to be modified and no fuel additive is required when refuelling. The rugged system requires no special maintenance measures, meaning that no additional operating costs are to be feared.

The system operates based on the principle of exhaust gas recirculation. That means part of the exhaust gases is returned to the combustion process. The mixture which results in this way has a lower combustion value, and therefore no longer achieves the high temperature in the combustion chamber required for the formation of nitrogen oxide. This effect is intensified by the fact that the exhaust gases are also cooled prior to being returned. The CleanCab controller monitors the fresh and exhaust-gas feed and controls it in dependence on the engine load, speed and combustion chamber temperature. Here the valve position of the diesel injection pump provides information on the engine load. It is detected with a magnetic angle sensor from the standard product line of the sensor specialist Novotechnik.

Rugged sensor with a broad range of possibilities

There were many reasons for this choice: The angle sensor supplies absolute measured values over the full 360°, and the electrical range is programmable in 10°-steps. The inevitably harsh environmental conditions in mobile use do not impair operation. The angle sensor operates at ambient temperatures between - 40 °C and + 125 °C and can withstand oscillations and vibrations of up to 2,000 Hz (in accordance with IEC 6672-6) and impacts of up to 100 g (11 s, in accordance with IEC 6672-27). In the standard version it meets the requirements of the protection class IP67, i.e. is completely dust-tight and protected against jet-water. On top of all that, the sensor is also very inexpensive and can be easily integrated in the application. As all components of the CleanCab System must be fitted into an engine concept that already exists, this was an important criterion when making the choice.

The simple integratability results from the magnetic operating principle (Figure 3): For contactless angle detection, a magnet is mounted on the rotating axis. Depending on the angle of rotation, the orientation of the magnetic field changes, and with it the signals of the sensor element. This signal

change is then converted into an analogue signal proportional to the angle of rotation within the sensor IC, which is then available to the customer's controller. The sensor operates with a resolution of 12 bits and an independent linearity of +/- 0.3 % in the application.

Great installation freedom and good integratability

Here there's no need to integrate the sensor and the magnet in a housing (Figure 4). They can also be designed as separate modules (Figure 5). The position-marking magnet is simply mounted on the rotating shaft. A marking shows the correct alignment relative to the sensor, which can be positioned at a distance of up to 1.5 mm from the position marker. And even greater distances up to approximately 4 mm are possible; a stronger magnet is available for this purpose. The CleanCab designers appreciated these advantages during installation. As neither a shaft nor a mount are necessary, and the measuring distance is variable, application-related installation tolerances are no problem at all. In addition, transmissive measurement is possible, i.e. through other (non-magnetic) materials, which opens up further design freedom.

Figure 1: Taxis in London. Thanks to the retrofittable CleanCab System, the diesel engines can meet the requirements of the Euro 3 emission standard (Photo: Novotechnik)

Figure 2: Emission values in comparison (Photo: STT Emtec)

Figure 3: For contactless angle detection, a magnet is mounted on the rotating shaft. Depending on the angle of rotation, the orientation of the magnetic field changes, and with it the signal voltage of the sensor element (Photo: Novotechnik)

Figure 4: An RSC 2800-600 magnetic angle sensor for detecting working angles up to a full 360° (Photo: Novotechnik)

Figure 5: A magnetic angle sensor in which the sensor and the position marker are designed as separate components (RFC 4800). The position-marker with incorporated magnet is simply mounted on the rotating shaft. With the CleanCab System as well, this simplifies the integration, as no shafts had to be centred (Photo: Novotechnik)

Text: Stefan Sester, Engineer, Technical Marketing of Rotary Sensors at Novotechnik, and Ellen-Christine Reiff, M.A., Stutensee Editorial Office

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