As Tough As They Come - Extremely Robust Control System Provides Safety Underground

A control system is normally found inside a control cabinet, where it is well protected from all types of environmental influences. But control systems can also be installed on mobile machinery, where they may be subjected to rigorous shaking. Shock and vibration must not be allowed to compromise the safe function of the control system in any way. Consequently, the Pilz programmable control systems used in mining on roadheaders, to safely monitor the spray function, need to be especially robust.

Underground mining is still an explosive business. To ensure that man and machine are not exposed to unnecessary risks, special safety concepts are in place to keep the "explosive hazards" in check. Pilz has been able to put its years of expertise in control technology to good use in this sector: In conjunction with the Swedish mining machine manufacturer Sandvik Mining and Construction, Pilz has developed the first ultra robust PSS control system, designed in accordance with the principles for integrated explosion safety. In the mining sector it provides security against an excessively high and therefore explosive dust concentration.

Spray systems prevent dust explosions

Roadheaders made by Sandvik Mining and Construction are used in underground mining, in particular to excavate not just coal but also salt. Rotating cutter heads on the front of the machine excavate the material. A huge amount of dust is formed as a result, which can cause a dust explosion underground under certain circumstances.

A water-based spray system on the machine is designed to prevent this by binding the dust particles and preventing excessive dust concentration in the air. It’s important that the spray system operates reliably while the cutter heads are in operation, so it must be permanently monitored.

Until now the spray system on the cutter heads has been monitored using digital flow and pressure sensors. With the new concept from Sandvik, analogue sensors measure flow rate and pressure, while a PSS control system evaluates the results. The operating conditions of the machinery used in coal mining are a challenge in this case. Due to the hardness of the overburden material, the drilling device as well as the machine must be able to withstand particularly strong vibration. That’s something the control system is also exposed to, so it was important to find a “vibration-free” solution.

Robust control system monitors water pressure and flow rate

Pilz modified an existing compact PSS control system with digital and analogue inputs to make it suitable for use in mining, in accordance with Sandvik's requirements.

It’s called the “rugged version” of the PSS control system and is temperature-resistant as well as vibration-proof, naturally. What's special about it: The components are not free-standing; instead the boards are bonded and therefore “vibration-free”. This also helps to counteract wear, which is an additional benefit. As a result, the control system meets the high shock and vibration requirements. Even with three-dimensional, sinusoidal continuous duty with sliding frequency, the required vibration and shock resistance is achieved for up to 1000 half sine shocks. The PSS control system is installed on the roadheader in a flameproof enclosure, as the machine is located directly inside the potentially explosive area.

The spray system must operate reliably to guarantee safety underground while the roadheader is in use. Consequently, water flow rate and pressure must not exceed or fall below certain limit values. When the machines are operating properly, the conditions in terms of flow rate and pressure are almost constant. That's why the control system uses a calculation formula to constantly establish and compare limit values and operating values. If there are any deviations, as a result of a faulty spray system or a change in pressure or flow rate for example, the control system will stop the cutting motor that drives the excavation cutter heads. This stops any more dust from forming.
Various types are available for monitoring the spray system; these are defined in advance in the user program. Each of these is evaluated in the control system program.

Sandvik and Pilz worked closely together in developing the new control system type. The safety concept and technical design were planned and implemented in the hardware at the customer's end. Pilz generated the software, i.e. the user program for the PSS control system, in accordance with the customer's specifications.
The safety functions were verified during joint tests on the machine. The excellent co-operation kept the development time short. The first prototype was able to go into testing after just a few months.

Versatile and open for every requirement

Different projects require flexible control solutions. PSS control systems – whether in a compact or modular design – are versatile and can be used on stand-alone machines through to extended plants.
They can be used to meet the very highest safety requirements in accordance with the international standards for machine safety EN 954-1, IEC 62061 and EN ISO 13849, and also in accordance with application-specific standards for press applications, railway applications, cable cars and drag lifts, for example. They are approved by BG, TÜV and international certification bodies.
The openness of the control systems is corporate philosophy. The control systems have a wide range of interfaces for connection to all standard fieldbuses and, in addition to SafetyBUS p, can also exchange data via Ethernet-IP, PROFINET and SafetyNET p. So they are ideal for incorporating into existing control structures, while users are free to select how to network their plant.
PSS control systems are also designed with a modular structure. That means it's easy for Pilz to accommodate specific customer or industry requirements, even within a short timescale: from a PSS control system for specific environmental conditions, as is the case with cablecars for example, through to crane applications with a direct connection to external encoder systems.

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