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PROFIBUS Remote I/O with fiber optics in explosive environments

Interference immunity even over long distances

In the chemical, petrochemical and pharmaceutical industries as well as in oil and gas environments explosion risks have to be prevented by protective suitable measures. Here, automation technology plays a key role. It must ensure safe and at the same time economic operations. The example of a polyethylene factory demonstrates how Remote I/O for modern measuring and control devices can be operated safely using fiber optics at high data rates even over long distances.

One of the largest plants in the world for the production of the synthetic material Low Density Poly-Ethylene (LDPE) for the packaging industry is being operated near Marseille. A cracker produces the base chemical for the reactor from natural oil. The resulting polyethylene is fed to an extruder which ultimately can deliver an annual quantity of 320,000 tons of LDPE.

Figure 1

Operational safety and economy

There are potentially explosive chemicals present in the production process. The plant, therefore, has dedicated explosion protection zones. The instrumentation and automation technology used in these zones must be approved and installed in accordance with explosion protection regulations.

Due to its high economic importance redundancy has been installed throughout the plant which is controlled by eleven controllers from ABB to which a total of 42 equally redundant Remote I/Os from Pepperl+Fuchs, have been connected. The dimension and importance of the process control technology can be seen in the number of input and output signals: Approx. 3,000 signals from the reactor and extruder have to be transmitted via the Profibus system. In addition, there are more than 1,000 signals from other plant components.

Figure 2

Modern automation technology meets all requirements

In addition to the realtime safety demands regulations resulting from Zone 1 hazardous area requirements apply to the especially process-critical data of the site automation devices. Therefore, the communication between the controls and the Remote I/Os takes place via PROFIBUS DP with fiber optics technology protected against interference and explosions. Fiber optics offer a number of benefits. Three basic differences to copper cables are particularly useful in process technology and demonstrate why fiber optics are the right choice in this case. Firstly, they ensure complete electrical separation between the field and the control room. Secondly, the small amounts of light energy cannot generate dangerous sparks or hot surfaces. And thirdly, electromagnetic fields – unlike in data transfer using copper conductors – cannot cause radio frequency interference (RFI).

Figure 3

Benefits of fiber optics for process automation

In explosive environments the question whether fiber optics can generate a source of ignition is of paramount importance. By nature they do not transport or store electrical energy. Therefore, even their destruction does not result in sparks. If the fiber optics cable is torn during a failure and there is an explosive atmosphere near the now exposed fiber end, it must be ensured that the emitted light cannot cause an ignition.

The Federal office for physics and technology and other institutes have carried out investigations of these optical rays and their capability to cause an ignition of a flammable atmosphere. This was done to establish limits for the maximum optical exposure intensity and energies for European and international standardization. The result was that with an optical source controlled by less than 50 mW, the radiation within the standard infrared wavelength spectrum emitted from the fiber optics cannot cause an ignition of an explosive atmosphere.

For standardization a limit value of 35 mW was suggested to achieve a safety margin. Commercial fiber optic repeaters are well below this limit value by a factor of 100. This means that the repeaters can be designed in such a way that the connected fiber optic cables can enter the explosive zone without limiting the data transfer properties.
Another advantage of fiber optics technology is the bridging of large distances at high transfer rates. Whilst a PROFIBUS using copper cable may only have a line length of 200 m at 1.5 MBit/s to prevent reflection and interference on the bus. Even at this high data rate a fiber optic cable may have a length of 1,000 m or more, depending on the fiber used.

The fiber optics PROFIBUS repeater shown here has some additional features. It can either be used as a point-to-point coupler or in a redundant ring. It can detect faults on the PROFIBUS and automatically arrange for redundancy switching. It also monitors the signal quality and provides an alarm message if the transfer quality has dropped below a threshold value.

Process control via fast and realtime-capable field busses

The fiber optics connection is therefore ideal for the Profibus connection of a Remote I/O to the process control system of the plant described above. Within and maybe even in the vicinity of the Remote I/O station short conventional bus cables are normally used. As the RS485 interface used for the PROFIBUS DP is NOT intrinsically safe, the electrical cable must be installed in the increased safety mode of protection similar to power supply cables. As an alternative some Remote I/O manufacturers use a modified RS 485 interface made intrinsically safe by energy-limiting devices in the bus nodes. When using RS 485-IS intrinsic safety does however, go hand in hand with slightly degraded bus properties. The current and voltage limitations required for intrinsic safety result in a reduced interference immunity for the IS PROFIBUS compared with the increased safety PROFIBUS. For this reason the project managers in the South of France preferred the NON intrinsically safe PROFIBUS in protection category Ex-e (increased safety) together with the FB Remote I/O from Pepperl+Fuchs.

Summary

The chemical industry with its specific requirements benefits from the technical advances in bus technology. Fiber optics are the key to the uninterrupted use of powerful busses even in explosive environments. This means that the efficiency increases achieved in other automation sectors are also possible in process automation without any limitations. Plant operators can profit from the resulting cost reductions. The significant increase in fiber optic installations in process automation will continue, especially since major investments are expected in order to modernize control systems to extend plant life time.

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Fig. 1: Remote I/O distributed over several floors of a silo

Fig. 2: Example of a redundant Remote I/O station

Fig. 3: New Zone 1 fiber optic repeater in plastic housing