ifm electronic

Project:

ifm flexpro gmbh

Biological reprocessing of sewage water

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and ifm sensors in plant technology

Biological reprocessing of sewage water automated with AS-interface and ifm sensors

ifm flexpro in Wasserburg at Lake Constance, part of the ifm group of companies, produces electronic circuits on a flexible base material, so-called carrier films (flexible printed circuit boards), for the production of sensors. These carrier films make the production of very small designs and vibration-resistant circuits for ifm sensors possible. During the production of the carrier films for ifm sensors, sewage water containing heavy metals occurs, which has to be cleaned before it is discharged into the public sewerage system.

Figure 1: ifm film technology

A biological reprocessing plant is used for cleaning this sewage water. This reprocessing plant works to the bio-substrate method. It removes heavy metals, in particular copper, and other harmful substances from the sewage in a biological way. The plant was put into operation in 1998 and was extended in 2004 to increase capacities. The control and wiring concept of the plant was implemented by means of the intelligent wiring system AS-interface in connection with the Profibus DP fieldbus system.

Bio-substrate method

The bio-substrate method is a process for reprocessing industrial sewage. Heavy metals and other harmful substances can be removed economically and ecologically. At the same time the legal requirements for feeding the sewage into the public sewerage system are complied with. The bio-substrate method is a technical solution by means of anaerobic biology. The raw sewage is coarsely cleaned by means of neutralisation. For fine cleaning an external biological-adsorptive step - the bio-substrate method - is used. Still remaining solid materials containing heavy metals are filtered out by continuously operating cross-current microfiltration (CMF). The metal-containing sludges resulting from this heavy metal elimination can be reprocessed by special companies and the contained heavy metals can be returned to the recycling process.

This process ensures that the amount of chemicals can be substantially reduced.

Plant concept

The plant concept is based on a modular structure to ensure an easy extension of the system. All containers such as neutralisation, bioreactors etc. had been right from the beginning laid out for the maximum plant capacity in order to minimise the piping work in case of extensions. In the first stage in 1998, the system was equipped with one microfiltration unit. In 2004, a second microfiltration unit was added in order to increase the capacities. In the whole planning process since 1998 an easy expandability had to be taken into account also as regards the control concept, in order to ensure production even during extension measures.

Control concept with AS-interface

The control concept of this plant is based on the intelligent wiring system AS-interface (AS-i). In this system, sensors as well as actuators are connected to the control technology (PLC) via a two-wire profiled yellow cable in a reverse-polarity protected way by means of field modules (AS-i slaves). The transmission of all system signals as well as the sensor supply are ensured via AS-i. Two AS-i controllerE modules of ifm electronic serve as PLC in this system. The AS-i master required for AS-i communication is already integrated. Each plant section (1998 and 2004) is controlled by one AS-i controllerE. The modular components of the process plant are allocated to different AS-i lines / masters. The AS-i controllerE modules are connected to the central visualisation and controller via Profibus DP. In case of a Profibus DP failure each AS-i controllerE module can independently carry out control tasks. The central visualisation and controller is an industrial PC which is programmed by means of the CoDeSys programming and visualisation software. The software for the AS-i controllerE modules is also created via CoDeSys. The complete system was connected to the existing building system automation of the company Kieback & Peter via Profibus DP. Operation/visualisation, central controller and connection to the building system automation could thus be implemented at a low cost via a hardware component.

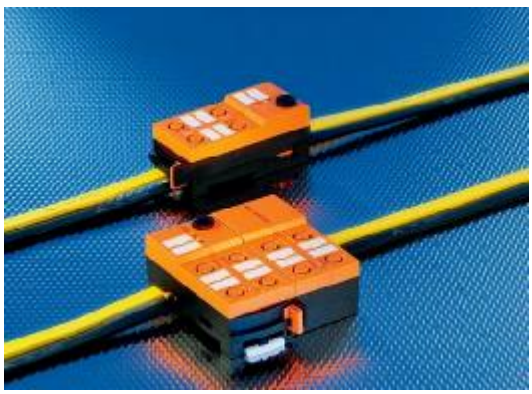

Figure 2: AS-i field modules

Figure 3: AS-i controllerE

AS-i as an economic technical extension

Based on the (wiring) system AS-interface (AS-i) consistent and, most of all, economical systems from the sensor/actuator to the control level are possible due to the easy system structure. AS-interface does not represent any competition to other higher-level bus systems because its structure is open to such systems. It rather is an addition to the plant structure which makes sense from a technological and economic point of view. For these reasons, it is often used in industrial and building system automation. With the wide range of products of many manufacturers and its comprehensive compatibility, AS-interface provides integration solutions for various sensors and actuators in almost all automation systems.

Control concept with AS-interface and Profibus DP

building system automation

Integrated visualisation

Figure 4: control cabinet 1 + control cabinet 2 with integrated industrial PC as central visualisation and controller

Profibus DP

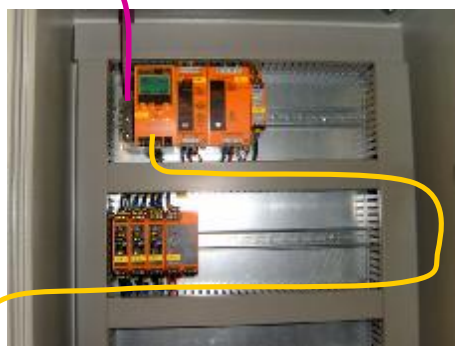

Figure 5: interior view control cabinet 2 (extension microfiltration 2)

Figure 6: interior view control cabinet 1 (microfiltration 1 + control bioreactors)

Figure 7: microfiltration 2

Figure 8: microfiltration 1

AS-i AirBox system solution

Figure 9:
AS-i AirBox

The AS-i AirBox is used in all areas of industrial automation. AirBoxes help reduce the wiring and tubing complexity wherever compressed air is used to operate the actuators.
Tube connections are short if an AirBox is mounted close to the pneumatic actuator. This keeps pneumatic delay times to a minimum and reduces air quantities thus leading to faster processes and lower cost for the compressed air generation. All tube connections are already integrated so that time-consuming installation, as in case of conventional solenoid valves, is not required. The AirBoxes incorporate industrially compatible solenoid valves with high pneumatic flow within a small space. On an area of 45x80 mm two single-acting cylinders or one double-acting cylinder can be triggered. Due to the integrated AS-i slave and the binary feedback inputs further savings as regards electrical wiring are possible.

Figure 10: Installed AS-i AirBox

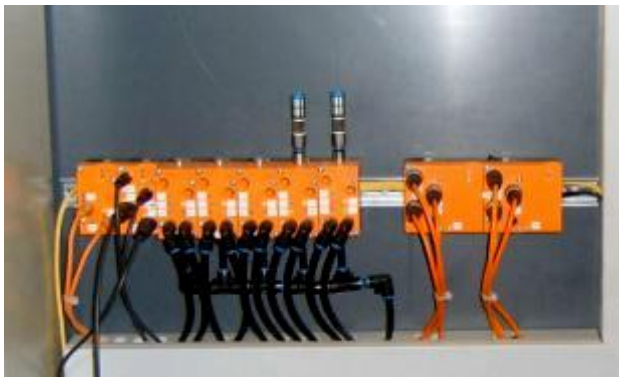

Figure 11: AS-i AirBoxes and AS-i analogue modules

Analogue input/output modules

Analogue input signals such as system pressures, temperatures, continuous level control and pH-value measurements are detected via analogue AS-i field modules on site and are passed on to the AS-i controllerE for further processing via the two-wire profiled cable. Frequency converters as well as continuous-line recorders are controlled via analogue output modules.
The transfer of analogue values is possible without further software as the required handling is integrated in the firmware of the master.
The slaves are connected to AS-interface via the conventional flat cable lower parts (EMS) and feature protection rating IP67. The connection of sensors / actuators is made via standard M12 sockets.
Powerful LEDs on the front panel indicate the states of the analogue channels, the voltage supply and possible faults.

The switchable AS-i socket - the AS-i PowerBox

The AS-i PowerBox is used to enable triggering of single-phase loads such as pumps and motors via AS-i. In this project diverse pumps are triggered via the integrated and easy to exchange changeover relay. Electrical connection is made via 7/8 connectors. The AS-i PowerBox can be connected to the profiled AS-i cable as well as to conventional round cables by means of flat cable or cable gland lower parts. Furthermore sensors, e.g. inductive sensors or flow sensors, can be connected to two digital inputs by means of M12 connectors.

Figure 12: The AS-i PowerBox

The AS-i motor starter - the AS-i PowerSwitch

The AS-i PowerSwitch is an active AS-i module by means of which any three-phase load up to 2.2 KW at 400 V AC can be triggered. The AS-i PowerSwitch has an integrated electromechanical contactor-type reverser by means of which direct or reversing operation is possible. An overload or short-circuit protection is integrated below a transparent cover and can therefore be diagnosed either visually or via the AS-i data. Due to the IP54 housing and an integrated cover, it is not possible to touch live parts even when the cover is open.

Figure 13: The AS-i PowerSwitch

Feedback of the auxiliary contact of the power switch as well as the manual operating mode are scanned via two internal inputs. Furthermore, two additional digital inputs and outputs are in connection with the outside of the housing via M12 plug-in contacts. The AS-i PowerSwitch favours the decentralisation of control systems and considerably reduces wiring complexity as well as the volume of control cabinets.

Input/output signals in the control cabinet

Analogue as well as digital signals can be picked up in the control cabinets via the AS-i SmartLine modules. These modules are connected to the AS-i line via conventional Combicon connectors. The sensors/actuators are also connected via Combicon connectors, so that a replacement of individual peripheral modules is possible without any problems. Powerful LEDs on the front panel indicate the states of the inputs and outputs, of the voltage supply and faults in the module, if any.

Figure 14: AS-i SmartLine control cabinet modules (lower row)

Applications for capacitive sensors

Capacitive sensors are used in a variety of industrial and process plants. Mostly, such applications are limit detection of liquids and the detection of water penetration. The capacitive sensors of the KN and KNQ series of ifm electronic can be used in various applications due to the easy adjustment to the medium by means of a pushbutton or teach element using microprocessor technology.

Limit detection on sight glasses

The units of the KNQ series can be installed to sight glasses by means of simple material (fixing adapter and cable ties).
The unit detects through the sight glass and without contact when a level defined by means of the teach element (inductive sensing face) has been reached and converts this into an electrical switching signal.
The integrated electronics ensure exact repeatability of the set switch points. The signal "limit reached" and the function check signal can be evaluated as digital transistor switching signals via every PLC or used for simple contactor circuits via auxiliary relays.

Figure 15: KNQ series mounted to a sight glass / bypass pipe

Switch point detection through tank walls

Capacitive sensors also allow the detection of media through up to 15 mm thick tank walls (referred to water) e.g. by means of the M30 or M18 designs of the KN series. For most applications, adjustment to the empty tank is sufficient. In addition, however, for example to increase the excess gain, an adjustment to the tank medium can be carried out (full adjustment). The switch point adjustment is carried out by pressing a pushbutton on the unit. The adjustment process is displayed on the unit by means of LEDs.

Figure 16: KN series for switch point detection

Detection of water penetration

Signalling of water penetration is absolutely necessary in many systems and buildings to protect the installed machines and equipment. In this case, the plant is set to NOT-STOP in case of water penetration (e.g. burst pipes) in order to prevent a further flooding of plant and building sections. The sensor is mounted to the floor by means of a simple plastic adapter (plastic base with recesses at the bottom).
Signal evaluation can for example be carried out via a PLC, building system automation or via a relay contact.

Figure 17: KN series for signalling water penetration

System pressure detection

Due to the various applications, ifm electronic offers a wide range of pressure and vacuum sensors. So, ifm electronic can accommodate various applications for pressure sensors and transmitters in different industries. Depending on the application, units with ceramic-capacitive measuring cell or units with stainless steel measuring cell and thick film DMS are available. Different output functions and housing designs adapted to the area of application ensure an optimum integration into different processes.

Figure 18: Pressure sensor of the PF series with flush diaphragm for pressure measurement in microfiltration

Avoiding deposits on the sensor diaphragm

Figure 19: Pressure sensor of the PF series for system pressure measurement downstream of the booster pump controlled by a frequency converter

The PF series of ifm electronic is recommended in order to avoid deposits on the sensor diaphragm. Due to the flush diaphragm and their origin from hygienic applications the units are particularly suited for this application. The pressure sensors of the PF series operate using a ceramic measuring cell which is largely resistant to aggressive media and abrasion. Pressure pick-up and pressure display are implemented in only one unit. This guarantees use in a wide range of applications. Due to the ifm-specific thread concept all common process adapters can be connected.

System pressure of the compressed air pipes

The pressure sensors of the PN series serve for digital switch point setting and as analogue sensors for measurement in pneumatic as well as hydraulic applications. The process connection is made using a threaded adapter via a G 1/4 internal thread. Depending on the version, 1 digital or 2 digital switching outputs or combined switching and analogue outputs can be selected. In this plant, units of the PN2 series with 1 switching and 1 analogue output are used.

Figure 20: PN pressure sensors for compressed air measurement

The slanted 4-digit LED display, which is clearly visible over large distances, is ideal for set-up, maintenance and operation. Due to the structured menu navigation, intuitive operation is possible. The electronic lock protects the unit from unauthorised access.

Detection of temperatures

Figure 21: Use of PF pressure sensor and TR temperature control monitor in the pressure pipe

For the detection of system temperatures, the displays and control monitors of the TR series are recommended.
The temperature measuring amplifier type TR is a universal control and display unit for the connection of platinum temperature sensors (Pt100 or PT1000 elements). The electronics automatically detect whether two-wire, three-wire or four-wire Pt100 or Pt1000 sensors are connected. In combination with the wide measuring range of -40 to +300 °C an enormous number of common temperature measurement and monitoring tasks in the manufacturing and process industries can be solved using just one unit.

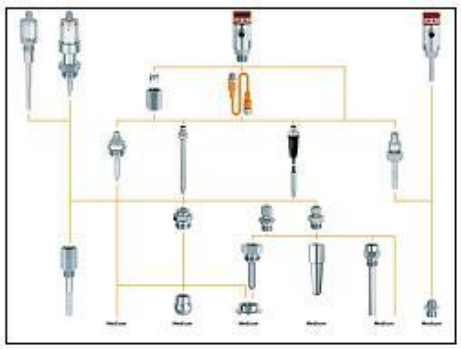

Figure 22: Modular system for ifm temperature sensors

For continuous temperature measurement, the measuring amplifier has a high-resolution and scaleable analogue output transmitting the measured values to a control system. The integrated display allows direct readout of the current process temperature at any time. In addition, critical process states, e.g. reaching of minimum or maximum limit temperatures, can be directly monitored by means of the switching output. Consequently, only one unit instead of several units is needed for process control and limit temperature detection and significant savings can be achieved by reduced installation, purchasing and maintenance costs.

Conclusion

Water-reprocessing costs can be reduced to approx. 10-20% of the costs of a conventional chemical-physical plant if the bio-substrate method is used. Personnel is needed for an average time of 20 minutes daily.

Using the industrial PC with combined Profibus DP master/slave interfaces, the plant sections controlled via AS-i controllerE modules can be connected without any problem to higher-level systems such as the building system automation (e.g. Kieback & Peter DDC3000) and visualised at the same time. For the user this is a further step in building and plant management towards the "transparent factory". Remote maintenance and setting of parameters are also possible.
Another saving potential can be found in the high diagnostics capability of the plant which means only short downtime.
Due to the easy structure of the AS-interface technology, such a system can be easily extended by further components.
On this basis modular plant concepts can be easily implemented.

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