

Preventative condition monitoring in sewage treatment plants

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Condition Monitoring System by Mitsubishi Electric with SmartCheck promotes overall plant efficiency

Nearly everyone uses this facility every day: 99 percent of households in Germany are connected to a sewage treatment plant. Sewage treatment plants purify our waste water to such an extent that it can be returned into rivers and waterways safely, and thus put back into the water circulation. The plants carry out this task non-stop, 24 hours a day, seven days a week. The basic precondition is that all waste water purification processes work smoothly. In the Stadtwerke Rotenburg an der Fulda's waste water treatment plant, however, the following problem has arisen: spiral pump gearbox failures have occurred repeatedly in the sludge recirculation pumping station.

Failures due to the design

Stadtwerke Rotenburg a. d. Fulda's sewage treatment plant is designed for a load of 34,000 population equivalent, and it actually caters for around 20,000 people at present. Three Archimedes pumps are connected to the secondary settlement basin at the sludge recirculation pumping station. They ensure that biological sludge from the secondary settlement basin does not flow into the Fulda, but back into the aeration basins, where the micro-organisms break down dissolved and fine particulate organic pollutants in the waste water. "The sludge from the biological treatment should under no circumstances enter the Fulda, because the micro-organisms would lead to environmental problems. We

have to make sure that the pump drives in the sludge recirculation pumping station are always running perfectly. In an emergency, we can make do with submersible pumps to maintain the flow rate”, explains Antonio Genovese, waste water treatment plant manager at the sewage works in Rotenburg.

Due to a design fault, each of the three pumps failed within a period of about a year. The maximum service life of a gearbox was about two and a half years. At the time the failure occurred, only mechanical damage could be found: because of bearing damage, the gear block was literally torn apart and had to be completely replaced – which was a costly affair.

Monitoring solution implemented quickly

Stadtwerke Rotenburg has been working with Willich since 1992. The system integrator relies on automation solutions by Mitsubishi Electric. This means that various generations of Mitsubishi Electric inverters, control systems and I/O modules, as well as operating units, can be found in Rotenburg. To solve the problems in the sludge recirculation pumping station, Willich and Mitsubishi Electric proposed to the Stadtwerke the condition monitoring solution with FAG SmartChecks, which they intended to test in use in the field as a reference project within this context. Michael Böttner, a programmer at Willich, describes the idea: “By monitoring with the vibration sensors we obtain information early regarding any deviations from normal values which could lead to damage to the machine. The exact cause can be determined depending on the type of deviation, and the problem can quickly be targeted and corrected. This means that a time and cost intensive total breakdown can be avoided, with a positive effect on operational safety and overall operating costs.”

A few weeks passed from the original idea until monitoring was implemented: the system layout was defined in an on-site meeting,

pre-wired and installed and commissioned within one day. The first pre-alarm came after nine months. After a further four months, the gearbox failed completely. Antonio Genovese explains: “The documentation to date makes clear how early the initial warning points to a deviation from normal – which can presumably be corrected easily – but can lead to total failure about three months later. With the assistance of condition monitoring, it is possible to target the fault and correct it.

Depending on the severity of the problem, it is also possible to keep using the motor until the end of its service life, but order a replacement in good time thanks to the advance warning. Replacement can therefore be carried out without any time delay.”

Intelligent sensors report an alarm

Generally, a MELSEC controller monitors mechanical parts with the FAG SmartCheck, as in the case of Rotenburg, or also electrical components. The communication protocol SLMP, implemented specially for the Mitsubishi MELSEC controllers of the L and Q series, allows direct transmission of the characteristic values. An intelligent vibration sensor is attached to each of the three pump drives and the system provides early information on vibration changes which are above the defined threshold values of the normal range. The rise in temperature associated with this if damage occurs is detected by the sensor through a rise in temperature difference, and thus corroborates the error message. “For example, if a gearwheel is faulty, vibrations occur on the drive which are initially imperceptible to humans. Over time, further gearwheels become wedged into one another. It is not until a few months later that noises are heard as well, and then it is only a matter of a few weeks until the motor temperature rises and total breakdown finally occurs within a few days. So vibration changes are the first sign that something isn't right,” explains Michael Böttner.

After installation, the system determines the standard values in normal operation by auto-tuning. Certain alarm ranges are established on this basis depending on the type, strength and origin of the vibrations. The warning messages, sent via the controller to the control centre or remote maintenance unit, differentiate in clear text between different breakdown types such as bearing damage, imbalance, incorrect axis alignment or lack of lubricant. The deviations are translated into specific error codes, to which certain measures are allocated. Antonio Genovese explains: "The system differentiates between no alarm, and the pre-alarm and main alarm, i.e. a slight or massive deviation from the normal values. Then it's our responsibility as operators to judge whether there is an immediate need for action or whether maintenance within the next 24 hours will suffice. A LED lamp directly on the sensor also displays the maintenance status: green means no alarm, and yellow pre-alarm, which means maintenance is needed. Red indicates a main alarm and immediate action is called for." The microprocessor integrated in the FAG SmartCheck not only creates the error messages, but stores all the values over the long term, so that they can also be viewed retrospectively and evaluated externally via the integrated web server through the MELSEC controller.

Minor hurdles in the development

The monitoring solution integrated in the existing system consists mainly of three FAG SmartChecks by Schaeffler FAG, an eWon Router of the 4005CD type and a Mitsubishi Electric MELSEC System Q control system. Mitsubishi Electric and Schaeffler FAG have been working together since 2010 within the framework of the e-F@ctory Alliance; eWon has been an e-F@ctory Alliance partner since 2011.

The compact FAG SmartCheck monitors the vibrations in the pump drive, but is also able to record other machine and process parameters such as temperature, speed or pressure, which the MELSEC controller transmits,

in correlation with the vibration. This means that the measuring system recognises possible damage to the machine reliably at an early stage, as a function of the parameters. It contributes to preventing unplanned downtimes and stopping expensive consequential damage. The compact, intelligent system monitoring is easy to operate and allows permanent decentralised online monitoring in real time.

For an accurate analysis of the vibrations, the FAG SmartCheck needs the values from the frequency inverters, which control the pumps with variable speeds to adjust to the relevant flow rate. The frequency inverters are not attached directly to the pumps in the case of Rotenburg, however, but are located in a switch cabinet about 50 metres away, and are controlled by a MELSEC control system installed there. "What now?" the installers wondered. There was no fieldbus network cable present, but there was an unused seven-core signal cable. The integration experts used this signal cable to connect the MELSEC controller with the process control system to which the three frequency inverters are connected. The connection problem was solved.

"To determine the speeds for the different flow rates the MELSEC System Q had to access the values from the frequency inverters. Direct access to the inverters' network was not possible, though. For this reason we transferred the values to an existing process control system and created an analogue connection to the System Q via the seven-core signal cable", says Michael Böttner. "The Mitsubishi controller converted the analogue values into frequency values and passed these on to the FAG SmartChecks. This meant that we could use the existing control infrastructure. Additional network cables weren't needed." In this case the controller does not fulfil a control task, but handles all the information for the FAG SmartChecks. It transmits the speed values from the inverters to the sensors for comparison, receives a status report if deviations are detected and passes this on to the higher level control

system.

When the project was implemented, signal transfer to the PC at control level did not prove altogether unproblematic without an existing network connection. With the special remote control router 4005CD by eWon, however, the transfer of information could soon be achieved. The attached access point on the router passes all the information from the control system to the control centre via a wireless Ethernet connection.

For external access eWon offers the Talk2M function with an integrated VPN (Virtual Private Network), through which the system integrator can configure and display the MELSEC System Q and the FAG SmartChecks. The information is exported as a web interface in Internet Explorer. System integrator Willich therefore has rapid, flexible remote access at any time.

Improved overall plant efficiency

The FAG SmartCheck makes an essential contribution to increasing overall plant efficiency and is part of the OEE Control Packs by Mitsubishi Electric (OEE = Overall Equipment Effectiveness). This scalable real time condition monitoring system assures high plant availability, whether in production or in sewage works as in Rotenburg, where it is not a matter of maximising productivity or profit, but ensuring continuous, disruption free operation. Overall plant efficiency and energy efficiency are closely connected with one another here, because predictive maintenance minimises life cycle costs – also by reducing energy consumption thanks to early recognition of wear. In combination with an energy management system such as the Mitsubishi Electric Energy Control Pack (ECP), the OEE Control Pack can also use electrical current values for condition monitoring, which means energy costs can be reduced.

The OEE solution is suitable for various areas of use. In the Rotenburg sewage works, for instance, the condition monitoring system could be

use on the inlet pumps, in the aeration basin, on larger drive systems or also on the cogeneration unit. As well as its use in waste water, solids, liquid, vacuum or heat pumps, the FAG SmartCheck can also be used, for example, in fans, ventilation units, compressors, CNC machines, separators or centrifuges. “The vibration sensor can guarantee efficient condition monitoring wherever mechanical, rotating parts lead to wear, or where changes occur because of other influences. In the Mitsubishi Electric solution the sensor measures condition changes which are compared with an established normal value. If this value is exceeded, an error message is generated – and promptly, some months before total failure occurs. This means that servicing can be planned better”, is how Michael Böttner sums it up. “With the good results of the test run in Rotenburg we can make the benefits of the system even clearer when talking to our customers.”

Not least, the Mitsubishi Electric condition monitoring solution also brings with it some ecological benefits, in that it guarantees fault-free process sequences. For example, in the case of Rotenburg it ensures that the sewage sludge stays where it belongs, namely in the sewage works – and not polluting the Fulda.

Image Captions:



Picture 1: The municipal treatment plant in Rotenburg a. d. Fulda is designed for the equivalent of 34,000 residents and serves around

20,000 people.

[Source: Mitsubishi Electric Europe B.V. , Germany]



Picture 2: The intake pumping station feeds the waste water into the treatment process. Screw pumps of different sizes are operated according to the volume of water in each case.

[Source: Mitsubishi Electric Europe B.V. , Germany]



Picture 3: The switching cabinet installed directly at the return activated sludge pumping station houses a MELSEC System Q control unit and an eWon router.

[Source: Mitsubishi Electric Europe B.V. , Germany]



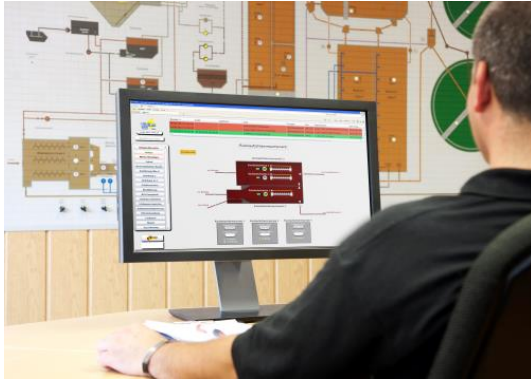
Picture 4: An intelligent FAG SmartCheck vibration sensor is attached to each of the three pump drives in the return activated sludge pumping station.

[Source: Mitsubishi Electric Europe B.V. , Germany]



Picture 5: In order to be able to analyse the vibrations precisely, the FAG SmartCheck needs the values from the frequency inverters that control the variable-speed pumps and adjust them to the relevant delivery rate.

[Source: Mitsubishi Electric Europe B.V. , Germany]



Picture 6: Data are exported via a web interface in Internet Explorer and displayed on the PC at the control centre. Data can also be flexibly accessed remotely at any time.

[Source: Mitsubishi Electric Europe B.V. , Germany]

Additional images are available on request.

Note to Editor: if you would like the text in another language please contact Nicola Bigmore at DMA Europa – nicola@dmaeuropa.com.

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About Stadtwerke Rotenburg a. d. Fulda

Stadtwerke Rotenburg a. d. Fulda is an owner-operated municipal enterprise of the town of Rotenburg a. d. Fulda. According to the enterprise's articles of 13.07.1989, its services include supplying all customers in the area of the city with water and the disposal of waste water.

The supply and disposal area includes the town centre of Rotenburg a. d. Fulda and all the town's districts. The drinking water supply is from four deep wells, two shallow wells and several springs. Waste water disposal first and foremost includes purification and disposal of waste water from homes and from the industrial and service companies located there. A central waste water treatment plant is operated for this purpose in the district of Braach. A mixed water treatment plant has also been constructed in the district of Schwarzenhasel for Haselgrund.

For further information see:

www.stadtwerke-rof.de

About Willich Elektrotechnik GmbH

Willich Elektrotechnik GmbH was established in 1985 by Uwe Willich as a sole trader company in Breitenbach near Bebra. Today the company employs around 90 people.

As well as comprehensive building system technology, Willich Elektrotechnik provides services in the area of environmental technology, especially in water supply and disposal. Integrated solutions are its special feature. Another focus of the business is the provision of services for industrial customers, such as outsourcing, switch cabinet construction, maintenance, energy optimisation or repairs. The company is also in cooperation with Mitsubishi Electric Automation-Center Nordhessen and is the official dealer for SPS control systems, operating terminals, frequency inverters etc. Special solutions are also developed and implemented in information technology, such as Intranet, BDE systems, LAN or WAN networks, for commercial, municipal, State and industrial customers.

For further information see:

www.willich.de

About the e-F@ctory Alliance

The e-F@ctory Alliance, an initiative of Mitsubishi Electric Europe, is a partnership of companies sharing experience, expertise and integrated industrial automation products and services. It is dedicated to helping improve the performance of any manufacturing enterprise.

Each partner has unique mastery and expertise in a particular field, which they can bring to different production environments to reduce total cost of ownership, maximise productivity and provide truly seamless integration of various automation systems and subsystems.

Any number of partners can be brought together to work on a given project, the objective being to deliver the best possible skill set. Because they work together regularly, the partners are able to act in perfect harmony to produce the optimum solution for the customer demand in the minimum time.

Other partners include: 3S-Smart Software Solutions GmbH, Adroit Technologies, Atos Origin, Auvesy, CLPA, Cognex, Datalogic, DP Technology, Emulate3D, Eplan, eWON, Schaeffler FAG, Felten, HMS, IBHsoftec, INEA, Invensys/Wonderware, Janz Tec, LEM, Mitsubishi Electric Europe Factory Automation, mpdv, nxtControl, ProLeiT, Raima, Real Time Logic, RITTAL, RT Leaders, SCHAD, Schaffner, Visual Components.

Further Information:

<http://www.e-factory-alliance.com/>

About Mitsubishi Electric

With over 90 years of experience in providing reliable, high-quality products to both corporate clients and general consumers all over the world, Mitsubishi Electric Corporation is a recognized world leader in the manufacture, marketing and sales of electrical and electronic equipment used in information processing and communications, space development and satellite communications, consumer electronics, industrial technology, as well as in products for the energy sector, water and waste water, transportation and building equipment.

With around 129.000 employees the company recorded consolidated group sales of 36,0 billion US Dollar* in the fiscal year ended March 31, 2015.

Our sales offices, research & development centres and manufacturing plants are located in over 30 countries.

Mitsubishi Electric Europe, Industrial Automation – Irish Branch is located in Dublin, Ireland. It is a part of the European Factory Automation Business Group based in Ratingen, Germany which in turn is part of Mitsubishi Electric Europe B.V., a wholly

owned subsidiary of Mitsubishi Electric Corporation, Japan.

The role of Industrial Automation – Irish Branch is to manage sales, service and support across its network of local distributors throughout Ireland

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