Formellino Wastewater Treatment Utilizes Predictive Control for Process Optimization

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Alberto Tabanelli, Novanet Technical Manager

Results

- All plant data is collected and used for predictive calculations and for optimizing process efficiency
- Improved water purification process and 30% energy saving
- Improved water quality and better control of crucial river habitat parameters

The Formellino plant purifies 1000 m3/hour of water, diverting it from water flowing to the Lamone river.

Project profile

The Formellino Wastewater Treatment plant at Faenza is managed by Hera Imola—Faenza S.r.l. It is a medium-sized installation, which purifies 1000 m3/hour of water and runs 24 hours a day, seven days a week. The plant must ensure that all of the water produced by the purification treatment process meets or exceeds required quality regulations.

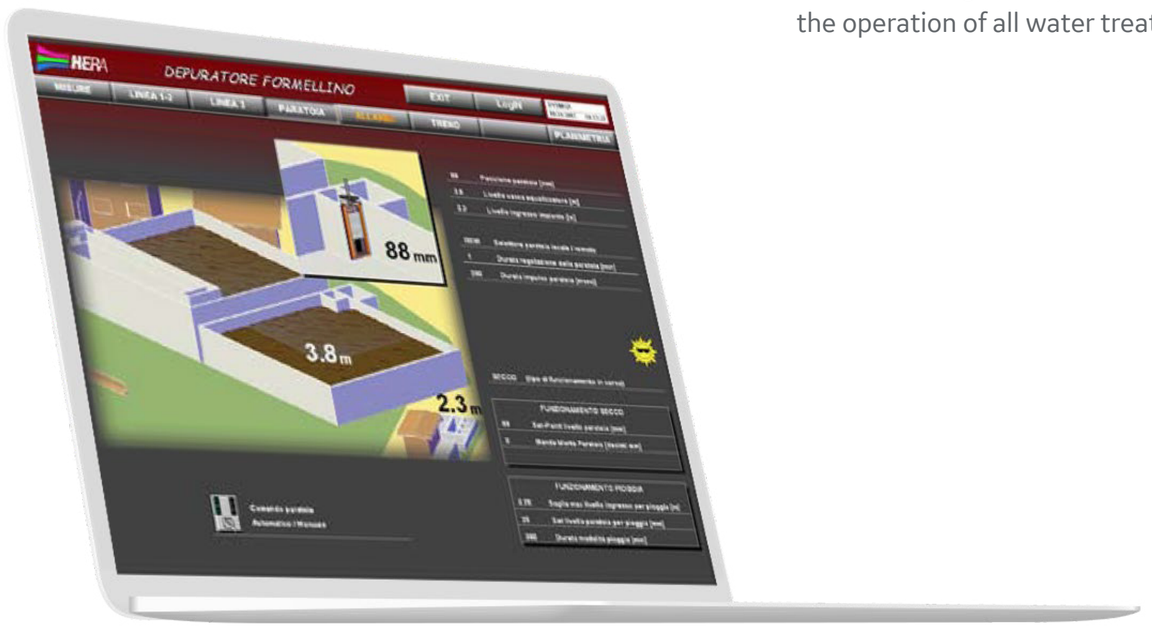
The purification treatment process

The Formellino Wastewater Treatment plant diverts the water flowing into the Lamone river, splits the flow onto two parallel lines, and directs the two flows to the treatment tanks. The water is pumped back downstream into the river after the purification treatment process. The activated sludge purification system is a biological type where organic substances and ammonia are oxidized in the presence of oxygen by the activated sludge. The nitrate products, typically eutrophying nutrients, are later removed in absence of oxygen. Consequently, the oxygen content, the active sludge concentration, the nitrates, and the ammonia are key data inputs of the plant process control system. The first steps upon entrance into the plant are grit removal and deoiling (not managed by the control system). The first active step of the plant follows: the equalization and primary decantation tanks form a vessel for controlling the sewage flow rate into the various tanks by means of sluices (a simple level gauge is used for this).

Then sewage reaches the oxidation and pre-denitrification tanks where the level of oxygen in the slurry is measured at the inlet and at the outlet. The nitrates and suspended solids are also measured in these tanks (by means of turbidimeters, which are designed specifically for measuring turbidity by implementing optical techniques), along with the phosphorous and ammonia contents, the level of decanted sludge, and the inlet and outlet water flow rate. Some of the output sludge is recirculated back to the inlet and reintroduced to improve the biological processes. After oxidation, the water flows to the secondary decantation tanks where the sludge deposited on the bottom is collected and conveyed to the thickener. Here, the sludge is prepared for drying and disposal. The clarified water is instead released into the river.

Plant criticalities

The water treatment plant is, due to its intrinsic nature, subject to seasonal variations determined by rainfall. Consequently, one of the process criticalities is that the quality of the water to be treated cannot be determined beforehand. Furthermore, the plant collection basin includes a number of industries, which introduce large amounts of waste, thus the water chemistry and flow varies greatly. Another criticality of a plant like this, with such an extensive coverage, is that it is always on. This is essential to prevent the risk of releasing polluted water into the river and to prevent being fined by the water quality monitoring authority.



The water flow through the various stations of the water treatment plant is adjusted by controlling sluices.

Before and after

The old plant was run according to a fixed time logic. This consisted of making the sewage water stand in the various vessels for a predetermined length of time and controlling the operation of the process-related machines (aerators, blowers, pumps, etc.) according to dissolved oxygen measurements and laboratory test data only. The goal set by Giovanni Tedioli, Water Treatment Manager of Hera Imola—Faenza, was to use the data collected by various sensors to control the transit times of the sewage in the tanks and machine operation according to the values of oxygen, ammonia, suspended solids, and nitrates to improve plant processing and energy efficiency. Furthermore, the new control system had to allow an operator to work at the plant as well as relaying data to the control room from where all Hera plants are monitored. The plants are manned during the day, but the control room alone monitors the operation of all water treatment plants during the night.

Massimo Zanoni, Electrical Maintenance, Automation and Remote Control Manager of Hera Imola—Faenza S.r.l., recollects the project start-up: “When we decided to refurbish the plant, we asked ourselves how to make sure that the new automation system would guarantee our peace of mind. The water treatment plant releases water into our own rivers and this implies additional responsibilities towards society: we need to guarantee faultless operation, for ourselves and for our environment.”

The “peace of mind” Zanoni mentions was then to be translated into high plant availability and reliability, data access by operators, and improved process management in terms of better results and more efficient use of energy resources. In order to reach these goals, Hera called Pastorelli’s Environmental Engineering firm to establish the project guidelines. The system was made by Novanet, a company based in Emilia-Romagna, Italy, with major expertise in the construction of large control and automation systems. Hera asked Novanet to use GE products for implementing the control system. These products are standard at Hera Imola—Faenza plants because they are reliable, competitively priced, the construction technology is good, and assistance in case of need is prompt and conclusive.

The control system

The “brain” of the system is GE’s PACSystems RX3i in redundant hot backup configuration, which interfaces with all the field instruments on a Profibus network (part optical fibres and part copper wires); there are several new and old sensors in total, amounting to approximately 600 controlled tags. The two redundant CPUs ensure the high plant availability required by the application criticality. The PAC Contoller establishes the standing times of the slurry in the various stages of the plant. By means of a direct Modbus/TCP link, the PAC communicates data to the Hera control room, where they are stored in a SQL database and concisely displayed so that the operator (present 24 hours a day) can be warned of faults and act accordingly.

At the Formellino plant, a local computer running CIMPLICITY from GE Digital, part of the HMI/SCADA suite, monitors and displays information and data in the form of trend or log, in addition to alarms, which may be silenced or not by the users according to their access levels. Ten profiles corresponding to ten different operative and data access levels have been created according to the privileges established for each user class.

The application allows for set up and program control parameters (the plant has been running only for a few months and the control logic is still being fine-tuned). Many fault detecting functions have been implemented in program running at the water treatment plant today to signal measurements deviating from expected values and to collect and use self-diagnostic data from the field sensors.

Novanet, the company who implemented the water treatment control process, was new to GE, despite having made control and automation systems for years.

“We used GE products in this plant for the first time and, despite the complexity of the logics and the installations, we encountered no problems at all,” said Alberto Tabanelli, Novanet Technical Manager. “The PLC hot backup function provided default hardware redundancy, which avoided us further complications, and the system performance allowed us to introduce a predictive control, which has greatly improved plant performance.”

The “brain” of the system is a PACSystems Rx3i in redundant configuration, which interfaces with the field instruments.

Intuitive displays show the plant status to operators at any given time.

The data collected from the field is used to carry out a predictive control and therefore optimize machine use.

The results

The new system collects plant data for constantly monitoring everything in detail. Edge data collection and analysis have been coupled with near real-time predictive control to optimize machine run rates and decrease energy consumption, all while achieving higher standards of water quality and efficiency.

A plant shut down of only about a half an hour was needed to allow the new system to be installed. Personnel training was swift, thanks to intuitive, self-explanatory graphic displays, and was carried out over several shifts to account for staff turnover.

The nature of the new automation system at Formellino makes continual adaptation and improvement of analytic processes simpler than before. Before installing the new system, for example, the water was over-oxygenated, and this was pointless from a microbiological point of view. After only 50 days, a reduction in energy consumption of 30% was observed.

Future developments

New actuators, which will be controlled continuously instead of in steps, will be added in the future. They will be installed on the Profibus field network and controlled directly by the PACSystems Rx3i. These improvements will provide the best results where the processed matter is kept moving: i.e., in oxidation and sludge recirculation tanks.

About Hera

The Hera Group was established in 2002 following the merge of eleven public utility companies from Emilia-Romagna. Other companies were acquired during the merging process, including Agea, based in Ferrara in 2004, and Meta in 2005. This completed the first Italian merge of listed stock multiutility companies. The Hera Groups works in approximately 180 towns in the provinces of Bologna, Ferrara, Forlì-Cesena, Modena, Ravenna, Rimini, and in some towns in the provinces of Florence and Pesaro-Urbino. It is split into seven Local Operative Companies, one of which is Hera Imola Faenza, which is responsible for managing water, gas, electricity, remote heating systems, and environmental hygiene over an area of 23 towns.

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About Novanet

NOVANET is a system integration and engineering firm specialized in building automation, management, supervision, remote control, and home automation.

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About GE

GE (NYSE: GE) is the world's Digital Industrial Company, transforming industry with software-defined machines and solutions that are connected, responsive, and predictive. GE is organized around a global exchange of knowledge, the "GE Store," through which each business shares and accesses the same technology, markets, structure, and intellect. Each invention further fuels innovation and application across our industrial sectors. With people, services, technology, and scale, GE delivers better outcomes for customers by speaking the language of industry.

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