Automated water management system reduces engine test bench shutdowns

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The challenge faced by the Austrian Magna subsidiary company Engineering Center Steyr GmbH & Co. KG was that of automating the monitoring and control of two coolant circulation systems for engine test benches. All operations of the water treatment plant, such as surveillance of the water level and water supply, switching the softener container, and initiating regeneration, needed to be registered and controlled by the new system.

The solution they chose was a system based on National Instruments' FieldPoint 2000 intelligent, distributed I/O and LabVIEW Real-Time software. The system ensures stability and enhances reliability and compactness due to the capability it provides to directly integrate sensors without signal conditioning. Continuous data acquisition offers complete documentation, and the system can be monitored at any workstation via Ethernet and a Web browser.

Reasons behind the change

Engineering Center Steyr decided to install its new water management system because of the high utilization of its existing coolant facility. In test benches for combustion engines, water cooling is essential for operating the heat exchanger of the main cooling system and the eddy current brake. Closed or semi-closed cooling cycles reduce water consumption and increase economic efficiency. However, in semi-closed systems, additives and particles evaporate more slowly than water, causing the water's impurity and electrical conductivity to increase. At certain levels of conductivity, some water has to be replaced by conditioned water (desalination).

Cooling systems, such as micro controller-equipped units for softening or conductivity control, are widely spread throughout the facility. However, these stand-alone solutions will not act together sufficiently. Therefore, an innovative, overall control setup was designed that meets the given demands.

The new system

FieldPoint 2000 was selected to ensure high reliability and expandability of the controlling unit, and because it offered a short code development time. Each bank consists of one dual-channel terminal base with 4x PT100, 4x 4-20mA, and 2x 0-10V input channels, and one 16x digital output module. The user can save data locally on the control unit, provid-

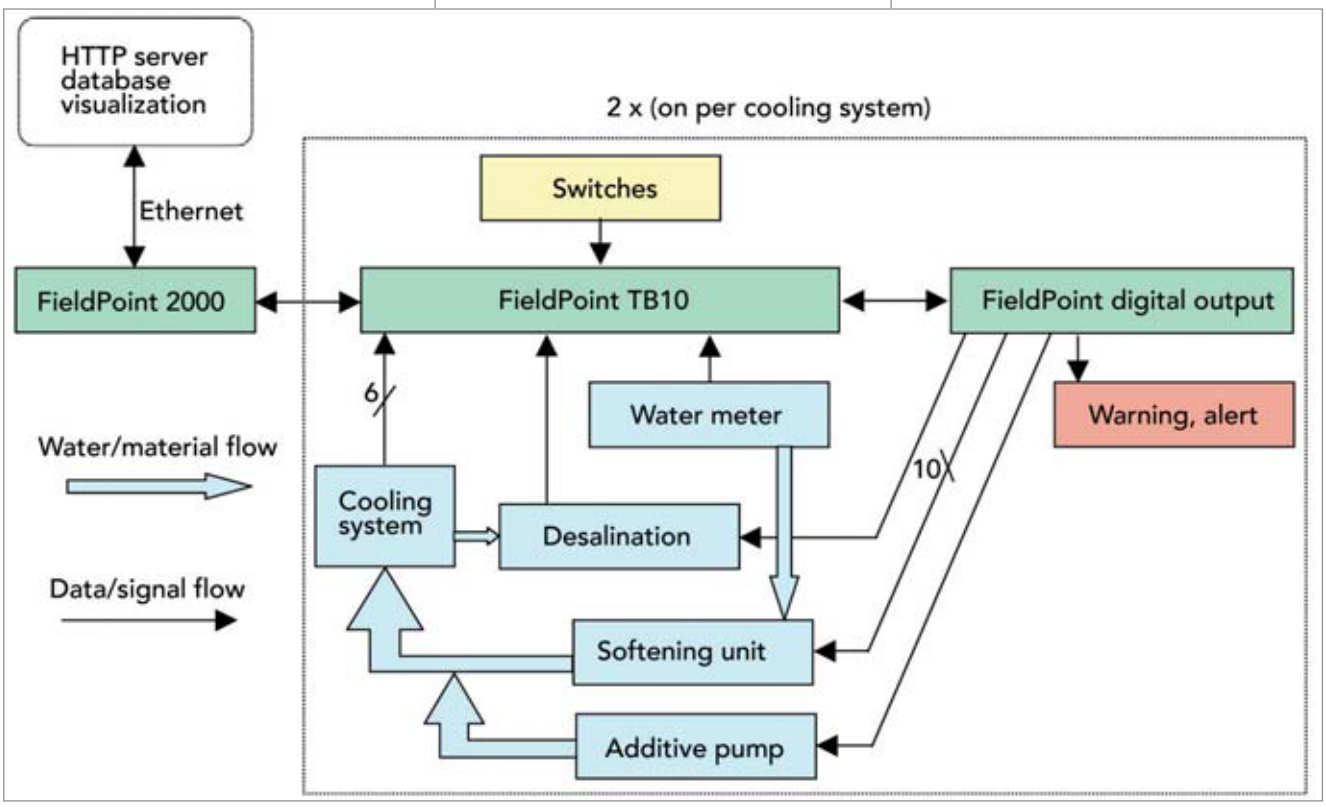

FIG. 1: Block diagram of the water management system.

ing an easy data upload to a local server. A user interface runs on the local server to provide information about the current and historical status, and can be used to request an upload or download of data. Figure 1 shows the block diagram of the setup.

The control unit that was developed performs several tasks, including monitoring of water level, temperature, pump pressure, conductivity, the supply of softened water, water hardness control, and regeneration of the softening unit. The same master unit controls both of the independent cooling cycles, and in case of emergency, each water treatment unit can supply both cooling systems. All relevant measurement data is logged automatically, which enables the deduction of important trends like the connection between water consumption and temperature.

Each cooling unit is equipped with sensors for conductivity, water consumption, water level (ultrasonic), temperature, and pressure. Additional sensors (e.g., hardness and pH-value) can be embedded easily.

To guarantee high-quality refill water, each facility uses a twin tank alternating softening system. If one tank is substantially depleted after dispensing the specified water volume, it is switched to a regeneration status while the other tank continues to supply water. Since the required amount of refill water varies with cooling power, temperature, and so on, the capacity of the softening unit must consider even peak requirements. By using a new innovative controlling system, the unit can be scaled down to cover the average need.

Unlike many of the conventional controlling units, the new system enables subsequent regeneration only if the brine is ready. If a sufficient amount of time isn't provided for regeneration of the brine, hard water will enter the system, causing fatal consequences such as calcification of the pipes and hot surfaces on the breaks and heat exchangers. Settings for either one or two brine barrels provide the fastest regeneration without any risk of overrunning the system. The required hardness of feedwater can be achieved through calculating the overall water hardness and operating a bypass valve accordingly.

Software features

A watchdog function periodically checks the regeneration process and valves. If a measurement channel provides out-of-range data, a warning or error condition arises. In this case, a snapshot of all parameters is stored and an alarm (flashing light and horn) is activated. The optical/acoustical signal is latched until it is acknowledged. To prevent loss of information due to a power failure, important data like regeneration phase or valve positions are periodically stored in a

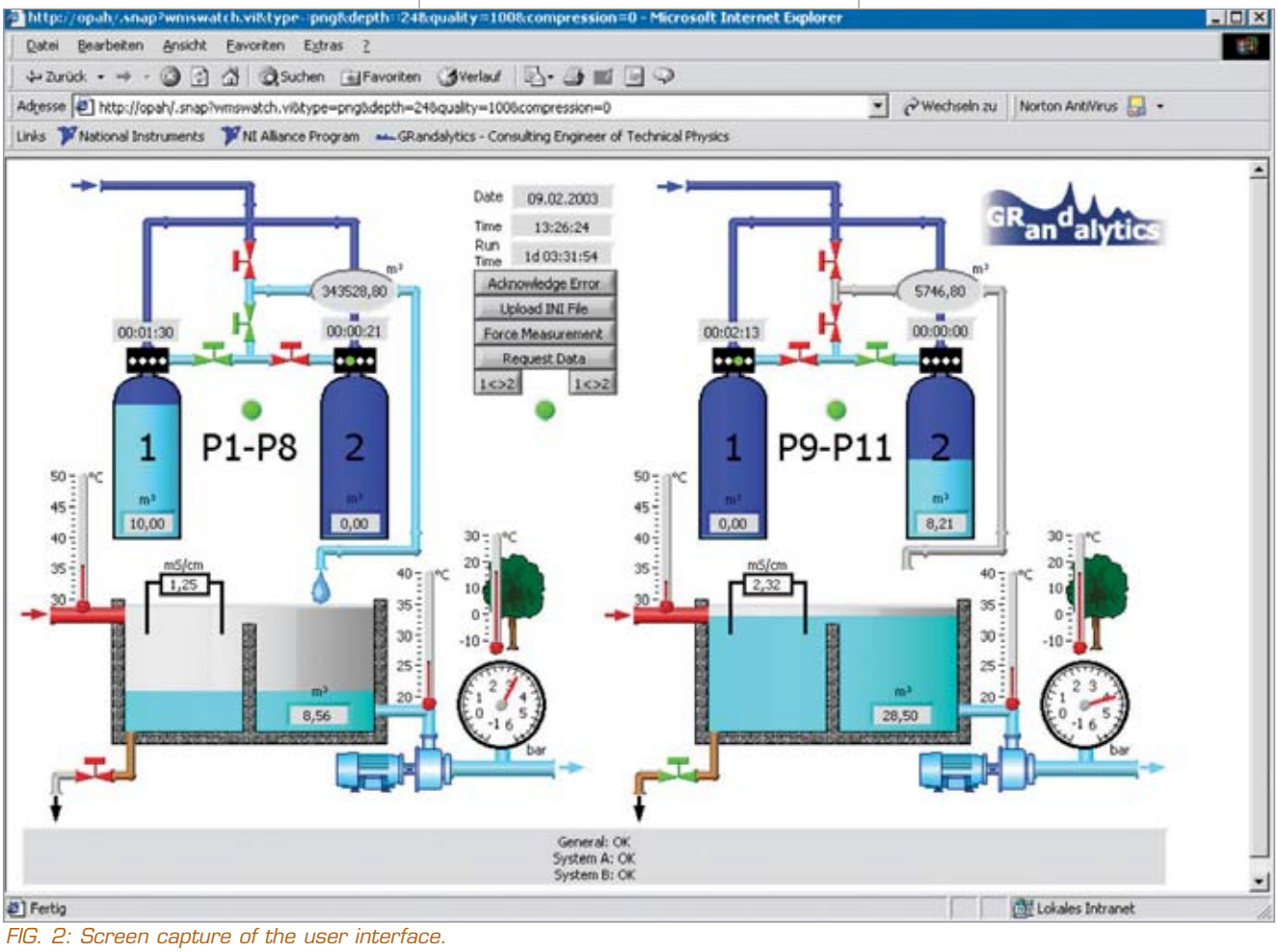

FIG. 2: Screen capture of the user interface.

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temporary file on the flash RAM of the controller. After the device has been rebooted, the temporary file supplies all the information to the controller, which continues operating at the point of interruption. The internal error is cleared after each software cycle.

The online user interface (Figure 2) enables monitoring of data, which is provided by the controller via DataSocket. In online mode, the interface shows the actual status of all channels, error messages, regeneration information, and valve status. In offline mode, it displays charts and trends of historical data stored in the database. By performing a request-for-data, the latest information is uploaded from the FieldPoint 2000 flash RAM to the database. Through the LabVIEW HTTP server and CGI, both interfaces can be operated by a Web browser at any workstation.

Several calibration parameters and limits are stored in an initialization file. Changes to settings are made at the local server; thereafter, the user can request a download of the new file to the controller. The controller sends a request-for-file with a local and remote file name to the server, which transfers the file via FTP, followed by an OK tag. The controller checks the file for validation and replaces the old initialization file, which allows a safe update without interrupting the controller. The upload of measurement data is done similarly. For convenience, a new file is created each month, and data compression and automatic size check prevent an out-of-memory on the controller.

An innovative solution

This new network-based water management system works well, and provides an innovative overall solution to replacing the previous noninteracting controllers. The reliability of the FieldPoint controller, together with software safety features, prevents system crashes that can cause a considerable loss of production time. Fully automated measurements make the operation much more convenient. In addition, they make it more time and cost effective by lowering personnel costs and downtime.

The new system supports higher water capacity at a good quality, reducing the number of shutdowns and fatal consequences caused by high water hardness. It also enhances flexibility as each water treatment unit can supply both cooling systems by cross switching. Water is saved because the new system prevents the complete draining of the cooling basins. Furthermore, the modular setup of the system allows future, low-cost expansion and adaptation with regard to other facilities. Considering all these factors, the user saves up to ten percent of total costs.