field report

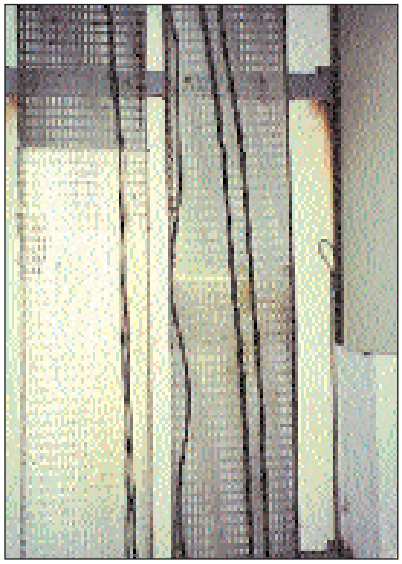
BY DAVID RIZZO

Turnkey automation comes to the water industry

IMAGINE THAT YOU ARE IN THE FINAL STAGES OF CONSTRUCTING A 10-FILTER WATER TREATMENT PLANT. STARTUP FOR THE FILTER CONTROL SYSTEM ALONE REQUIRES THE CONTRACTOR TO COORDINATE WITH REPRESENTATIVES FROM THE VALVE SUPPLIER, ACTUATOR SUPPLIER, INSTRUMENT SUPPLIER, FILTER CONSOLE SUPPLIER, THE ELECTRICIAN, AND THE INTEGRATOR TO PUT TOGETHER A SYSTEM THAT IS SUPPOSED TO WORK AS ONE COMPLETE UNIT.

Now imagine the additional complications of a controls upgrade project in which older, existing equipment must be integrated with a new control system. These headache-inducing scenarios are the norm in the water industry—but they may be a thing of the past. The first complete turnkey automation system for filter operations is here.

Although the basic components of any filtration system include the filter console, the communications link, the actuators, and the instrumentation, it is the turnkey integration of these components into a prepackaged, preengineered—and even preprogrammed—system that marks this as a major step forward. Combined with the use of pneumatically operated actuators, the "total solution" can reduce installation costs by 30–40%, ensure reliability, reduce maintenance, and increase safety. In addition, a single-source system ensures a single point of responsibility for installation and support.



These before (left) and after (right) pictures show how Filter Magic® eliminates extra enclosures, conduit, and wiring.

A SOLUTION WHOSE TIME HAS COME

The Safe Drinking Water Act mandates strict control of turbidity levels that can only be achieved through exacting control of filter operations. As a result, new facilities must incorporate state-of-the-art equipment, and many older plants must undergo controls upgrading. This complicated process often leaves plant managers searching for an easy place to start.

"On a typical filter control project, the control system designer has to start from scratch," says Patrick Moorman, an instrumentation and control specialist of nearly 30 years with Black & Veatch Corp. "You have to buy this piece from one vendor and then another piece from another—and then you have to have a contractor put it all together. Then, hopefully, you find a system integrator who can program the software, troubleshoot it, and make it all work."

As a solution to the challenge, many vendors have offered their own, increasingly sophisticated elements—control console, networking, sensors, actuators, and valves. However, a piecemeal approach to upgrading can sometimes result in increased complexity and heightened vulnerability.

"As a result of the necessary control, there's a lot of electrical instrumentation within the filter pipe gallery," notes

Willard Jordan, a professional engineer from Longview, Texas. Jordan's company, Electrical Expertise, specializes in engineering the instrumentation and supervisory control and data acquisition (SCADA) system design for water and wastewater treatment plants. "But all this extra wiring creates its own problems. You have a myriad of boxes and conduit and wires that look like a bowl of spaghetti. I've had installations where we've had to go back and replace wire trays and conduit because they actually rotted off the wall after several years of operation. That [kind of a job] is really time-consuming because you can only do it one filter at a time."

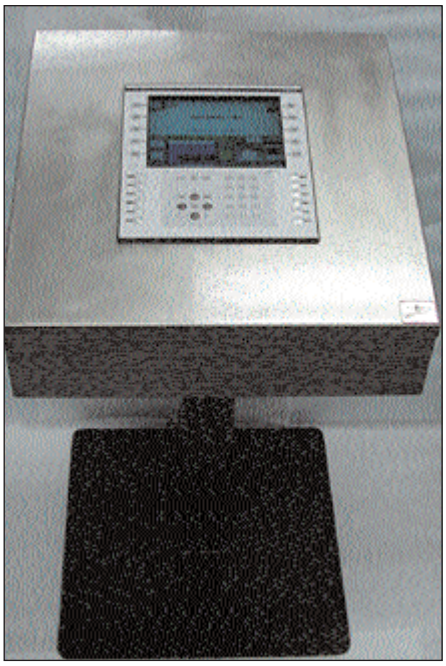
Some solutions have focused solely on the collection of data from the sensors as a means of simplifying the process. Although these higher-level field-buses provide improved performance, they do so at a much higher cost.

"There [have] been newer data-highway systems around for a while now," notes Jordan, "but they usually are high-dollar, proprietary protocol like Honeywell or Allen Bradley."

In the face of diminishing federal, state, and local revenues, most water treatment facilities enjoy little leeway in expanding their installation costs. If anything, decreased expense and complexity are sought at all levels, especially at the control console.

"With some of the older systems, all of the data signals from the sensors would come up to this large instrument control panel on the top of the filter gallery and then go through a series of relay switches to handle the signals for opening and closing all the valves," says Patrick Moseley, a senior engineer who heads up the electrical SCADA department for Chiang, Patel & Yerby Inc. of Dallas, Texas. "It can get quite complicated."

Ultimately the price paid for attacking the problem of improved data access and control in a hodgepodge fashion comes in the form of diluted



The system uses a menu-driven operational control console (above) and a two-wire data and control bus.

responsibility. "Typically the mechanical guys install the valves and actuators, the electrical guys wire it up, and the instrumentation guys apply the instruments and control panel," observes Moseley. "But when a problem crops up with the filter, you have all these subcontractors and the general contractor pointing fingers at each other."

The system is configured around what Filter Magic calls "the loop," which consists of four elements.

The demand for unified systems and single-point responsibility has already been demonstrated by the recent popularity of a product that includes the underdrain, media, and control system. But this isn't much help for those treatment plants that already have a satisfactory filter bed or those that require a new data acquisition and control system.

THE INTEGRATED FILTER CONTROL SYSTEM

Filter Magic® of Dallas, Texas, has designed and engineered the industry's first water and wastewater filter control system that uses a menu-driven operational control console and a two-wire data and control bus to simplify and guarantee backwashes that comply with federal turbidity levels. Filter Magic is a division of Controls International Inc., a leading manufacturer of filter control systems and high-performance components for the water industry for more than 30 years.

The system is configured around what Filter Magic calls "the loop," which consists of four elements—the central console, the communications link, the actuators, and the instrumentation. Although these elements individually compose the basic components of any filtration system, it is the turnkey integration of these components at very low voltage, the intuitive human–machine interface, the complete automation, and the simplicity with which these tasks are accomplished that merit its classification as a major step forward.

The console. Engineers at Filter Magic have created menu-driven software and graphics of the filter, recognizing that not every operator is sufficiently trained to perform a backwash operation. The detailed graphic changes with each command to demonstrate that the command entered per the menu was successfully completed. Each filter has its own programmable logic computer, completely sidestepping the need for a PC. Limit switches on all valves act as permissives to also prove that the commands were completed as well as acting as safeguards against performing an improper command that could put the filter in operational jeopardy.

The console includes a complete hands-off control sequence that derives input from the sensors to determine when and how the backwash process should take place. The system also offers three other levels of control that allow increasing operator input to the point of complete manual control. The menu directs the operator to perform the exact sequence of backwash operations. Still, a plant operator has some latitude to configure parameters, such as filter basin water levels, air scour time, and low/high backwash durations. On the other hand, safeguards built into the code prevent unwarranted deviations from the process sequence so that the clearwell cannot be accidentally contaminated. Redundant power supplies automatically switch in the event of a failure, and a battery-powered UPS keeps the entire system powered for a minimum of 10 minutes. Even in the event of a failure, all programming is permanently stored in the nonvolatile memory.

The communication link. Filter Magic engineers opted for the proven, open architecture AS-i network. Supported by more than 100 vendors worldwide, it allows a low, and thus failsafe, level of automation. This two-wire, 24 VDC bus carries both the network communications signal and the power needed for the peripheral devices by way of a redundant (in case of a line break) ring topology. The AS-i interface is ideally suited to the needs of devices, such as sensors and actuators, where low connection cost per node is critical and simplicity is paramount.

Jordan explains the Filter Magic arrangement from his perspective as an electrical engineer. "The loop wires carry the control signal, which is multiplexed at a proprietary frequency. The DC power flows on the same two wires. At each sensor or actuator, you have a potted electronic device—with its own address—that acts as the interface. These fit into a standard screw-covered junction box. The device accepts the signal coming in and converts it to a contact closure to open and close the valve. If you need valve status, it takes the same contact closure status and converts it into a signal to go back to the console."

If a facility has preexisting protocols, both the console and the AS-i network can be designed with gateways to communicate with other options such as plant SCADA, Allen-Bradley, Modicon, GE, Siemens, Profibus, RS232C, 422, 485, Modbus+, Device Net, or Ethernet TCP/IP.

Valve actuation. The loop encompasses control of all necessary valves: influent, effluent, backwash, airwash, filter-to-waste, and drain. Filter Magic supplies the actuators, which are pneumatically operated and capitalize on a simple "rotary vane" design using only one moving part. This design ensures accurate, incremental control, and eliminates hysteresis. Each actuator is assigned a default setting in the event a power grid goes down. The actuator holds its respective valve in the open or closed position until power is restored, thus preventing the flooding of filter galleries and protecting treated water.

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Capable of carrying up to 8 amps VDC, the AS-i wire loop supplies sufficient power to open and close the solenoid on each pneumatically operated actuator. The system also works with plants that rely on electric actuators.

"You do not have to switch over to pneumatic actuators, " says Fred Underwood, developer of the Filter Magic system. "In plants that already have electric actuators, the address on the network bus will point to a transformer that converts our 24 V to the 125 V on an electric actuator. In such cases, the actual 480 VAC required to power the actuator/valve movement is usually already wired into the pipe gallery.

The instrumentation. The loop includes the high-quality sensors required for metering any water filtering application: level transmitter, head loss transmitter, turbidimeter, and an effluent flow transmitter. Each sensor is sized, selected, and calibrated for optimum performance within the prescribed application. All instruments return data back to the console via the AS-i bus. Incoming data are checked by the receiver for possible faults by comparing the parity bit and several other independent values to ensure accurate and reliable feedback.

Installation. The Filter Magic loop comes preengineered specifically for each filtration plant. At the factory, each component is addressed and configured with the AS-i communications network and the console, then tagged appropriately for ease of installation. After factory testing, the entire system is shipped as a "kit," including wiring harnesses. Onsite operator training follows installation with documentation including operation and maintenance manuals.

MULTIPLE BENEFITS MOVE THE MARKET TOWARD TURNKEY SOLUTIONS

"The real advantage of the Filter Magic system is that its provides a prepackaged, preengineered scheme and even develops preprogrammed software, " observes Moorman. "The possible best niche for this system is a retrofit job because a lot of the legwork—the design and fabrication—is already thought out. The bottom line is that they should be able to deliver this product a little more competitively."

For example, the elimination of redundant wiring turns out to be a strong suit of such turnkey systems. Specifically, the AS-i bus reduces the size of cabinets and cable ducts while eliminating terminating resistors and

excessive connectors, bridges, terminal housings, and distributing clamps. This translates into less installation time and reduced maintenance. According to the AS-i technical forum, typical cost savings range from 15–40% compared with traditional cabling methods.

"This system has eliminated all of the extra enclosures, conduit, and wiring," reiterates Jordan. "Now you only need to run one 0.5 in. (13 mm) conduit with a couple of number 12 wires to as many as six filters, and you're in business. This eliminates about 90% of the previously required wiring."

These efficiencies are also manifested at the control console. "We are now able to eliminate all of those relays and switches up at the control panel," points out Moseley. "Because they are supplying you with a panel that is already preprogrammed and field-tested, this product definitely simplifies the wiring and programming. When it arrives on the job site, it's ready to go."

Equally important, low voltage architectures help improve safety conditions for plant workers. "If you go with a pneumatic actuating system, the advantage is that you eliminate the 480-power voltage and also the 125-V control voltage," says Underwood. "There is a tremendous safety issue there. Everybody is concerned about flooding and subsequent short circuits. At the very least, once you get one of these electric actuators filled with water, they're history."

PREPACKAGED, FULLY AUTOMATED SYSTEMS ARE THE WAVE OF THE FUTURE

Water treatment plant operators are already eagerly incorporating turnkey solutions, such as for the underdrain. This trend promises to accelerate with the offering of a complete filtration instrumentation and control system.

"One of our clients asked us to consider this route," says Moorman. "We looked at it and agreed that it is a viable scheme. We then proceeded to the design, based on the use of the Filter Magic system."

—This article was written by David Rizzo, a freelance technical writer who works out of Torrance, Calif. For more information, contact Filter Magic at 10410 Vista Park Rd., Dallas, TX 75238; (215) 343-0025; fax (214) 503-0736; e-mail info@filtermagic.com, or visit www.filtermagic.com.