SCADA Control and Monitoring Of Groundwater Remediation Facilities: Past, Present and Planning For the Future

Speakers:

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• **Kevin Fleming** is the founder and President of Carolina Automation Systems with over 25 years of experience in Control, Automation and Instrumentation. Kevin has worked with a wide variety of clients such as Water and Wastewater facilities, Pharmaceutical, Food and Beverage, Mining, Energy among others providing clients with practical, cost-effective state-of-the-art solutions.
Presentation Overview

- Groundwater Remediation: Definition and Need
- Groundwater Remediation Processes:
  - Extraction
  - Treatment
  - Discharge
- Automation in Groundwater Remediation Facilities
- Remediation and SCADA
- SCADA Past, Present and Planning for Future
- Planning New/Upgrades for Ground Remediation Facilities
**Remediation- Definition and Need**

**Definition:** Groundwater remediation is the process where water below the ground surface is extracted for the purpose of treatment and thereafter used or discharged back to the ground.

**Need:** Groundwater becomes contaminated for human use when in proximity to areas such as landfills, industrial sites (contamination from spills), farming lands where pesticides and fertilizers are used, domestic sources and many others.

- **Landfill**
  - Ref: swamplot.com

- **Industrial spill**
  - Ref: kdheks.com

- **Urban runoff**
  - Ref: wikipedia.com

- **Crop dusting**
  - Ref: breakfornews.com
Remediation - Processes

- There are various types of contaminants and standards list them by concentration in water. For example in NC the standards list 147 contaminants! (Ref: NC reports in 15A NCAC 02L .0202)
- Groundwater remediation is thus a unique process that provides treatment in various ways- biological, physical, chemical and/or natural. This water can further be used or discharged back to the ground.
Remediation - Processes

- Extraction
- Treatment
- Discharge

Biological
Chemical
Physical
Natural

Discharge back to ground or to reuse storage
Remediation - Automation & SCADA

Automation provides a viable link between these processes.

Extraction

Treatment

Automation

Discharge
Remediation and SCADA
## SCADA Past, Present and Future

<table>
<thead>
<tr>
<th>ITEM</th>
<th>PAST</th>
<th>PRESENT</th>
<th>FUTURE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Communication between field devices and the PLC</td>
<td>Wired</td>
<td>Wired/Wireless</td>
<td>Wired/Wireless with a higher % leaning to wireless</td>
</tr>
<tr>
<td></td>
<td>Slower communication-from instruments to PLC, then from PLC to HMI</td>
<td>More communication-such as from instruments to both PLC and HMI</td>
<td>Higher levels of communication-such as from instruments to both PLC and HMI wireless</td>
</tr>
</tbody>
</table>
## SCADA Past, Present and Future

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</thead>
<tbody>
<tr>
<td>Panel Cabinets</td>
<td>Much use of Panel cabinets</td>
<td>Reduced use of Panel cabinets</td>
<td>Much reduced use of Panel cabinets</td>
</tr>
<tr>
<td></td>
<td>Fully wired control cabinets- wiring to I/O modules from PLC</td>
<td>Partially wired control cabinets- wiring to I/O modules reduced with use of networking systems</td>
<td>Trend towards less direct wiring of I/O points and more toward secure wireless network transmission</td>
</tr>
<tr>
<td></td>
<td>Large panel sizes with screw-in large footprint devices</td>
<td>Medium panel sizes with DIN- rail mountable small footprint devices</td>
<td>Smaller panel sizes with DIN- rail mountable smaller footprint devices</td>
</tr>
</tbody>
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<tbody>
<tr>
<td>Input/ Output (I/O)</td>
<td>Standard Modules- only inputs, only outputs</td>
<td>Split I/O- Inputs and Outputs shared on the same module, rise of machine –mount I/O</td>
<td>More use of split I/O with less footprint and more of machine – mount I/O with wireless web capability</td>
</tr>
<tr>
<td>PLC Modules</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Automation Program</td>
<td>Downtime when making program changes</td>
<td>Some have the ability to make program changes without downtime</td>
<td>Full ability to make program changes without downtime</td>
</tr>
<tr>
<td>Design Changes</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Control Capability</td>
<td>Control of plant sections/units</td>
<td>Control of entire plant</td>
<td>Control of multiple plants</td>
</tr>
</tbody>
</table>

### Diagrams

- **Past**: A smaller control system with limited input/output capabilities.
- **Present**: An expanded control system with enhanced control capabilities.
- **Future**: A highly scalable and connected control system over a wide area.
## SCADA Past, Present and Future

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<tr>
<td>Data Acquisition</td>
<td>Data recording from instrumentation</td>
<td>Data from instrumentation to PLC through a wired/ radio system</td>
<td>Data from instrumentation to PLC through wireless system</td>
</tr>
<tr>
<td>Data Collection</td>
<td>Strip chart data collection-analog</td>
<td>Numerical/ digital Data collection</td>
<td>Numerical/ digital Data collection to the web</td>
</tr>
<tr>
<td>Data Processing</td>
<td>Data processing offsite- data has to be transferred to another system with different software for processing</td>
<td>Data processing onsite – at higher level controller (send data from remote collection to a central location for processing), also Smart processing that performs at local machine level.</td>
<td>Data processing onsite- advanced smart processing at Machine level</td>
</tr>
</tbody>
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# SCADA Past, Present and Future

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<tr>
<td>HMI Software and PLC</td>
<td>One development software brand per PLC brand</td>
<td>One software can work with a few different brands of PLC (has some 3rd party drivers)</td>
<td>One software can work with multiple brands of PLC and/or Multiple development software with multiple PLC brands or all common brands</td>
</tr>
<tr>
<td>PLC Design</td>
<td>Use of PLCs only</td>
<td>Use of PLC and pilot designs of PLC/PC hybrids</td>
<td>More use of PLC/PC hybrids to the extent that PLCs are replaced with servers on the network</td>
</tr>
</tbody>
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# SCADA Past, Present and Future

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<tr>
<td>HMI Design</td>
<td>Graphic P&amp;ID view with analog numbers, use of red/green for off/on conditions</td>
<td>Section-views with analog numbers, use of gray/green for off/on conditions</td>
<td>3-D views and Icons with more advanced color options to indicate off/on conditions</td>
</tr>
</tbody>
</table>

**past**

![Line 2 Overview](image1)

**present**

![Main View](image2)

**future trend**

![System A](image3)
SCADA Past, Present and Future

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<tr>
<td>HMI Functionality</td>
<td>Monitoring machine / process</td>
<td>Controlling, Monitoring machine /process, Program development Software on PC, Remote /mobile access Compatibility with diverse equipment and software-can be used with Microsoft Office products</td>
<td>Present functionality incorporating full PLC functionality.</td>
</tr>
<tr>
<td>Alarm systems</td>
<td>Physical indicators such as a loud horns go off and light indicators showing the area of alarm</td>
<td>HMI alarms integrated with communication aspects such as phone calls and emails alerts.</td>
<td>Advanced HMI alarms not only for system operation but plant diagnostics, controller system updates and patches</td>
</tr>
</tbody>
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<tr>
<td>Data Storage</td>
<td>Local on PC/Server</td>
<td>Storage on central PC or server with pilot designs for Cloud-storage</td>
<td>More inclination to Cloud storage</td>
</tr>
<tr>
<td>Databases</td>
<td>Duplication of Databases- one for HMI and one for PLC</td>
<td>Duplication of Databases- with pilot designs for centralization</td>
<td>Centralization of Databases and possibly web-based</td>
</tr>
<tr>
<td>SCADA Location</td>
<td>SCADA is local- local PC and SCADA software which is custom-unfriendly</td>
<td>SCADA is local, pilot designs for SCADA on the Cloud, SCADA software which is custom-friendly</td>
<td>More use of Cloud based SCADA systems and custom-friendly</td>
</tr>
</tbody>
</table>
Planning New/Upgrades for Ground Remediation Facilities

- Advanced Control features such as:
  - **Use of recipes** – a collection of parameters/setpoints for a certain operation and when the operation is called upon the parameters are made readily available for the system.
  - For example, setpoints for turning the treatment pumps on and off can be developed and set to be triggered by events such as season of high rainfall or floods.
  - **Operation scheduling** - available where for example in an air stripping system (with a 2 blowers and 3 pumps), a schedule may be set up with various configurations such as shown below:

<table>
<thead>
<tr>
<th>Week Schedule</th>
<th>Pump</th>
<th>Blower</th>
</tr>
</thead>
<tbody>
<tr>
<td>Week 1</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Week 2</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>Week 3</td>
<td>3</td>
<td>2</td>
</tr>
</tbody>
</table>
Planning New/Upgrades for Ground Remediation Facilities

• **Advanced Monitoring and Data Processing**-
  - Operation metrics through trends and data analyzing.
  - Video monitoring of field devices.
  - Data consolidation from multiple vendor systems is possible for expanding/merging facilities.

• **Increased Compatibility of SCADA with other tools**-
  - Microsoft products
  - Email communication
  - Advanced alarming devices.
Planning New/Upgrades for Ground Remediation Facilities

• **Ability to expand I/O modules rack** (this is beneficial when adding more devices to the system—such as adding new wells). More PLC brands also are been designed with the ability for program changes (such as auto-configuring new I/O modules) with less downtime.

• **Energy Conservation**—SCADA systems are being designed with more focus on energy conservation which translates to less costs.

• **Enhanced Alarm Management**—Alarms can be set into priorities/hierarchy whereby the most critical ones get faster attention and/or activate an auto dial to call the operator.
Planning New/Upgrades to Ground Remediation Facilities

• **PLC communication using Ethernet**-
  
  – Easier to add more applications such as remote and mobile access. This creates an added feature like remote diagnostics which can reduce plant costs.
  
  – For example being out the remote well and having a need to refresh/restart the central controller for purposes such as establishing communication with the well controller, with internet access, one can remote access the central controller and refresh without having any other operator assistance or having to travel to the control room.
Planning New/Upgrades for Ground Remediation Facilities

• **Reduced footprints of newer systems** - since a new SCADA system will have less space, the possibility of having 2 systems has been attainable.

• **Ability to meet new opportunities** - Other than discharge to the ground, meeting new opportunities such as Heat Exchange cooling for other processes and energy harvesting.
Planning New/Upgrades for Ground Remediation Facilities

Present day challenges are providing the thrust into the future. Some of the challenges include:

- Ethernet cabling issues
- Dealing with Ethernet multiple switch ports
- Driving wireless devices with low-life battery power
- Wireless network isolation from other networks
- Advancing security for Cloud usage.
Planning New/Upgrades for Ground Remediation Facilities

As more solutions become available for the current challenges, GRFs that would want to increase their automation capability will have more access to:

- Advanced Multi drop Ethernet reducing cabling issues.
- Enterprise-based SCADA functionality-whereby Data can be processed and is readily available and curtailed for all decision making levels. In case of multiple plants, management level is able to see the ‘global’ picture (operations of all plants).
Planning New/Upgrades for Ground Remediation Facilities

- Use of cloud technology for not only data storage and remote access but real time (cloud time) control-cloud based access to a controller.
- Multifunctional SCADA Hardware
- Advanced energy harvesting methods whereby the energy necessary for operating the wireless devices is derived from the remediation process itself.
- Real-time SCADA on Cloud without Internet limitations whereby real time data transfer and control is possible on the Cloud. This will also lead to cloud based access to the PLC which will be necessary for firmware updates etc., and with no downtime.
Conclusion

• With the advancement of technology the future holds out modern devices and advanced SCADA for Groundwater Remediation Facilities. These advances make the mission of the remediation process more attainable – where the process not only progresses in having a shorter ETD cycle, more water-volume handling but also minimal downtime- all this with lesser control space and providing enterprise-based control and monitoring.