Water 4.0: Knowing the data cycle can save you time

It is hard for a plant personnel to keep up with maintenance tasks such as inspection, data collection, review and analysis of field data to ensure reliability of the plant, and avoid losses and overconsumption of electricity and chemicals. Not keeping pace could result in noncompliance, fines, maintenance budget overages, disruption of water supply, or safety incidents. If you are like most people, you probably feel you have less time now as compared to a year ago. However, you can help yourself and your plant to keep up by using new technology. You learned about the water cycle in school. And now, you also need to know and understand the data cycle for digital transformation of your plant.

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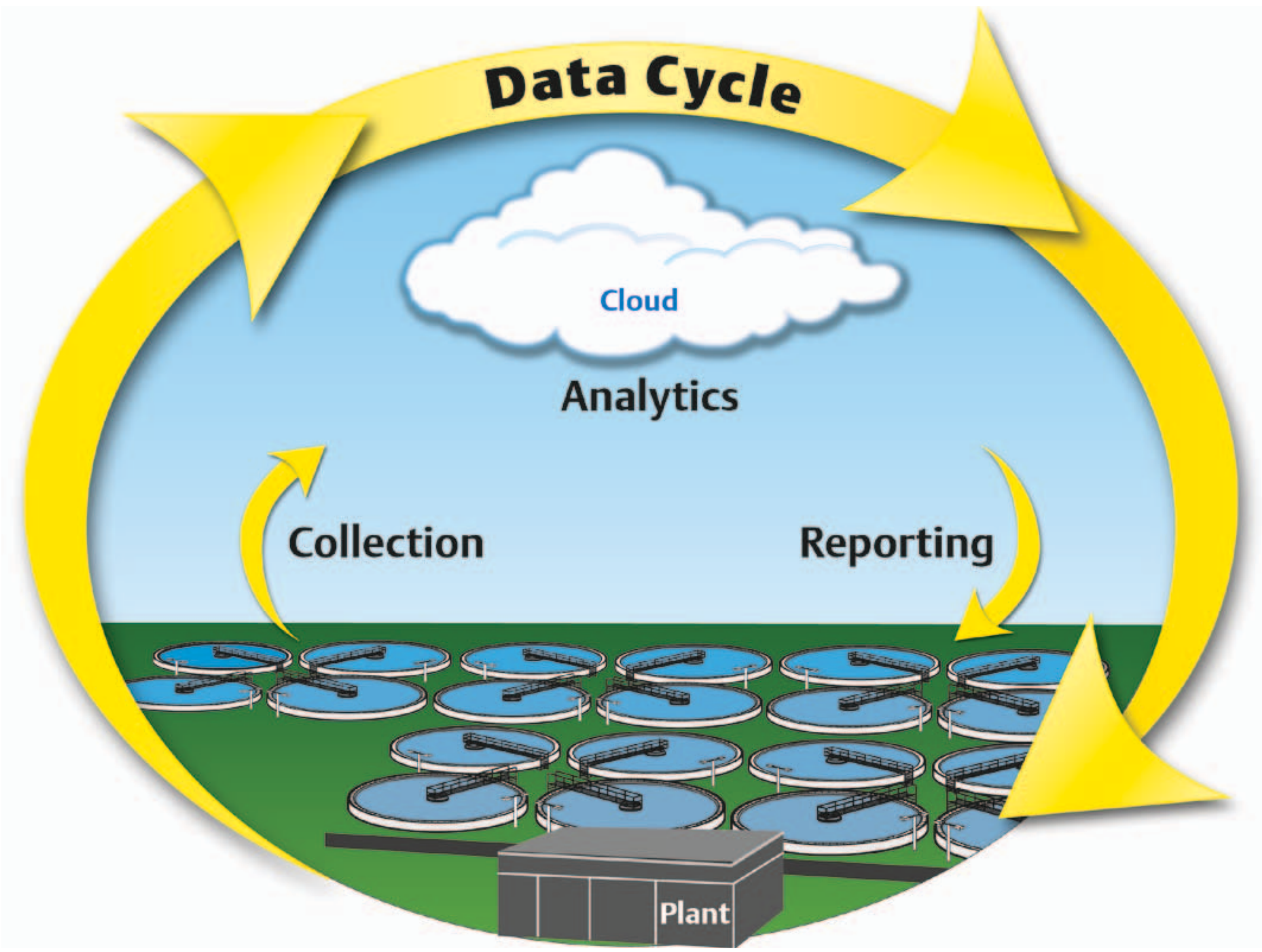


The Industrial Internet of Things (IIoT) can help water and wastewater treatment plants improve reliability, energy efficiency, and safety, while at the same time reduce emissions and maintenance costs.

The Data Cycle

Imagine not having to collect data manually, especially on days when it's cold and icy, rainy and windy, or hot and humid. Imagine not having to analyse a huge backlog of vibration spectrums. Imagine simply receiving reports pinpointing where maintenance is required, automatically.

Across all industries, plants are now deploying additional sensors to monitor online the condition and performance of a broader scope of equipment ("things") such as pumps, compressors, blowers, and valves around the site from a central location. Sensors are also added to computerise energy management and improve situational awareness, including for pressure, flow, fluid level, valve position, vibration, temperature, acoustic noise, corrosion, pipe wall thickness, and electric power consumption and more, depending on the application. These transmitters are often wireless as it is the easiest way to add more sensors to an existing plant. If the site uses digital fieldbus, it also makes it simple to integrate additional devices. By automating data collection, plants become more productive as time is saved gathering data that then frees up personnel to perform more value-added activities like fixing small issues detected before they turn into big problems. As the data is up-to-date, up to the minute or hour instead of weekly or monthly, maintenance becomes much more predictive too.

Some plants prefer the local maintenance team to monitor the equipment "on-prem" while others prefer the equipment to be monitored by a pool of company experts from a corporate central engineering office. These experts are responsible for the reliability and performance of multiple plants in a municipality or across a country. Other plants prefer a third-party company to monitor the equipment as a connected service for a monthly subscription fee, which reduces the burden on the site personnel. For connected services, the sensor data is transmitted to the cloud with a few methods available to securely transfer the data to the cloud. But many plants already have a Demilitarized Zone (DMZ) connection to the Internet with back-to-back firewalls, and cloud connection may already be provided by the plant's historian. A third option is to have Industrial IoT as a completely separate system not connected to the plant control system while a fourth option is to use a data diode, which as the name suggests, is a network appliance that only allows selected data to leave the plant. As there is no path to receive data, it prevents attacks on the control system through this connection. Note that water quality is controlled from within the plant. The connected services are for asset monitoring.

In the cloud, which is nothing but a virtually unlimited number of servers with massive computing and storage capacity connected to the internet, software "apps" are running to analyse the raw data from the sensors in the plant. These software apps specialise in task at hand, such as monitoring the condition and performance of equipment like pumps, compressors, blowers, valves, and more. The beauty of cloud computing is they can be accessed from anywhere in the world, the server machines need not be physically present in the plant, so they take up no space, and you do not need your IT department to maintain them. The apps generate reports listing which equipment is in good condition and performing well, and which equipment needs attention.

The reports are reviewed by service provider's experts for correctness and completeness before they are sent to the plant. Plant personnel act upon the recommendations, such as replacing, repairing, and adjusting equipment thus closing the loop by improving equipment condition and performance.

Reliability Apps

Reliability apps are pre-built analytic software which can be integrated with the plant's historian or can be web-based using HTML5 graphics; enabling them to be displayed in a web browser on a computer, tablet, or smart phone from anywhere. The maintenance personnel could be in the canteen, in a meeting, or on the way home and still be able to access equipment health information instantly.

The apps use graphical representation in the form of colour-coded dial gauges and trend charts, which includes health for the overall population of each type of equipment; how many of them have critical issues, warnings, or are in good condition.

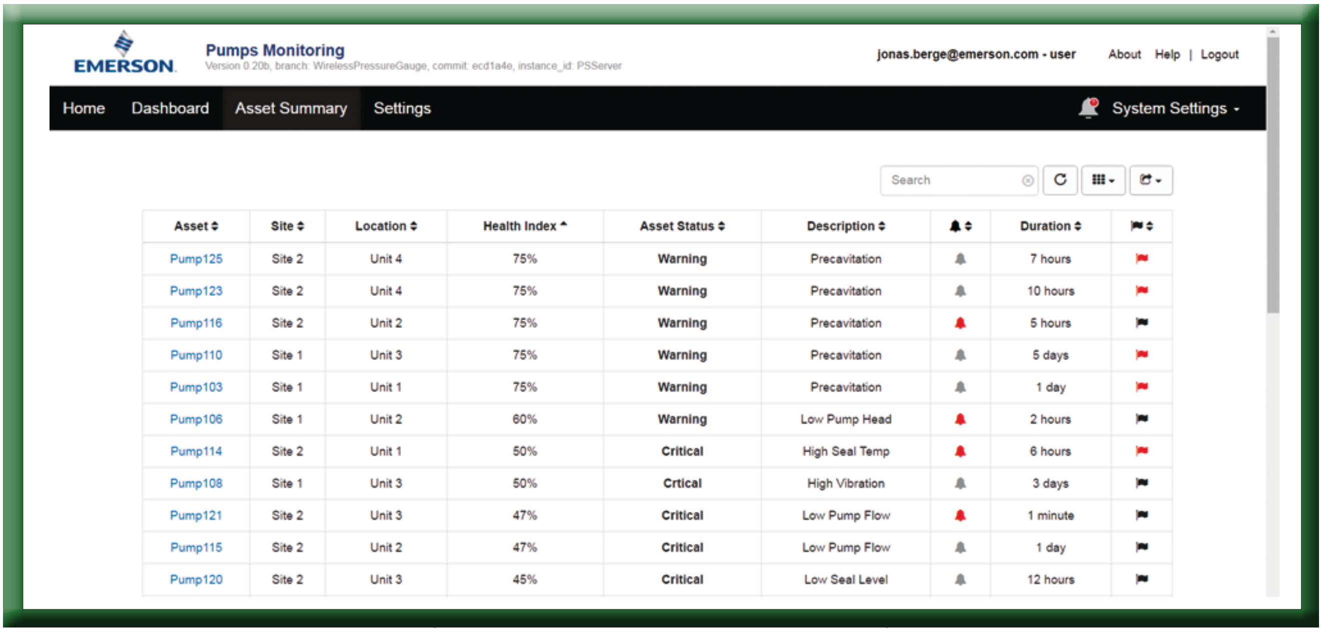
The data cycle describes how data moves through the plant; connecting the plant, cloud, and third-party services providers. Condition and performance data are collected by sensors in the plant, transmitted to the cloud, analysed, and sent back to the plant in the form of information reports to be acted upon - improving equipment condition and performance.

Figure 1 Equipment dashboard shows an at-a-glance view of the health of pumps in the plant

Equipment like pumps are identified by tag and location and specific tags can be sorted and searched. The list shows status, health index, problem description, alarm condition, and the length of time the equipment has been in this condition. The apps also provide plain text problem descriptions. There is no need to interpret complex 3D scatter plots or spectrums, and early warning is given about developing problems, which allows maintenance personnel to intervene to prevent equipment failure. This health information can be used for risk-based inspection planning to prioritise and schedule daily maintenance and turnaround activities. By not spending time on routine inspection of equipment which is in good condition, it allows focusing of resources on the equipment that really needs attention.

The equipment health summary can be exported to Excel to be compiled into reports for use in meetings and more, again saving valuable maintenance management time. The type of problems detected by the diagnostics algorithm depends on the type of equipment and how it has been instrumented. For a pump, this may include pre-cavitation, low head, high seal temperature, high vibration, and low flow. A compound health index is also computed for each type of equipment for easy prioritisation and optimisation of maintenance activities based on a predefined weightage of each type of problem a piece of equipment has.

A trend chart of the health index and other pertinent information for each piece of equipment makes it easy to visualise if its condition is deteriorating significantly, and how fast. As the user interface is very intuitive, days of training are not required to operate the software and there is certainly no need to be a data scientist with a degree in analytics. The apps are designed for maintenance and reliability personnel. Compressors, blowers, and other equipment will be managed the same way as pumps. Digital transformation of work processes means maintenance and reliability personnel now check the software first before going to the field, while in the past they would always go to the field to first check what is going on. With the information from the app, maintenance engineers can quickly decide what action needs to be taken.



Asset	Site	Location	Health Index	Asset Status	Description		Duration	
Pump125	Site 2	Unit 4	75%	Warning	Precavitation		7 hours	
Pump123	Site 2	Unit 4	75%	Warning	Precavitation		10 hours	
Pump116	Site 2	Unit 2	75%	Warning	Precavitation		5 hours	
Pump110	Site 1	Unit 3	75%	Warning	Precavitation		5 days	
Pump103	Site 1	Unit 1	75%	Warning	Precavitation		1 day	
Pump106	Site 1	Unit 2	60%	Warning	Low Pump Head		2 hours	
Pump114	Site 2	Unit 1	50%	Critical	High Seal Temp		6 hours	
Pump108	Site 1	Unit 3	50%	Crtical	High Vibration		3 days	
Pump121	Site 2	Unit 3	47%	Critical	Low Pump Flow		1 minute	
Pump115	Site 2	Unit 2	47%	Critical	Low Pump Flow		1 day	
Pump120	Site 2	Unit 3	45%	Critical	Low Seal Level		12 hours	

Figure 2 Summary page lists problem equipment with description

Reports and Experts

If the plant is using connected services, then it doesn't really matter what the analytics software application looks like or how easy it is to use because the plant's maintenance personnel need not use the application themselves – they simply get periodic reports or text messages from the equipment monitoring service provider telling them what actions are required. In the case of connected services, it is the clarity of the reports which matter.

The report's executive summary uses graphical pie and trend charts for the health of the overall population. The particular type of equipment can be viewed at a glance, for example, how many pumps are in good condition and how many have critical issues or just a warning. Other sections of the report list problem pumps and other equipment by tag including location information, health index, problem description, and how long the condition has persisted. The information in the report is used to prioritise and schedule daily maintenance as well as for turnaround planning including workforce planning. The actions that come out of the report could be as simple as checking with operations if there is a closed valve obstructing flow causing pump cavitation; a reminder to fill up lube oil; or to schedule replacement of a bearing. The plant maintenance and reliability teams save time by reducing routine inspection. It also frees up expert resources, such as vibration analysts, to focus their effort on more critical equipment.

Thanks to cloud connectivity, personnel in multiple locations and departments can access the information at the same time, enabling new levels of collaboration between teams such as technicians at site, subject matter experts at a corporate center of excellence, third-party service providers, and original equipment vendors to discuss problems and plan solutions. Cloud connectivity also enables visibility of equipment in multiple sites in one central location to coordinate deployment of maintenance personnel to the site.

Note that the data now collected automatically by the system and sent to the cloud is the same data, which in the past was collected manually for maintenance purposes, often by external parties taking it to their office for manual analysis. This type of data leaving the plant is not new, just very much more up to date and easier to use.

Energy Efficiency Apps

Energy management information system (EMIS) software is integrated with the plant's historian to support efficient use of energy and chemicals. The EMIS software also uses colour-coded dial gauges and trend charts, but in this case illustrating below target, on target, or overconsumption of each energy stream such as electricity, air, or chlorine gas. These consumption targets are computed dynamically by the equipment performance models in the software and from historical energy utilisation patterns.

Figure 3 Detail page shows equipment history and trend along with all pertinent information

For instance, based on the current water production the models could predict what the consumption of air, electricity, chlorine, and other chemicals should be in real-time. Alarms are triggered on overconsumption. These alarms make it easy to detect when equipment like motors that are not in use are left running or run faster than required. Leaking aeration systems and valves left open when not producing are targeted. Depending on the level of additional instrumentation deployed in the plant, the energy manager can drill deeper down into the plant hierarchy to see consumption for each plant area, unit and individual pieces of equipment. Such equipment includes pumps, air compressors, blowers, and sludge dewatering centrifuges. This allows operators to pinpoint the source of the overconsumption with finer granularity to help troubleshooting. For plants adopting ISO 50001 energy management practices to reduce and sustain energy consumption, EMIS software saves a tremendous amount of time.

Digital Transformation to Keep Up

Existing water and wastewater treatment plants can be modernised with instrumentation and analytics software to improve reliability and energy efficiency, reducing maintenance costs, as well as saving people's time and enabling them to keep up with their work load. Monitoring can either be on-site or as a connected service provided by a corporate engineering center or third-party. Starting on the path towards digital transformation begins with an operational certainty discovery session to uncover latent needs and gaps making the plant ready for IIoT and Industry 4.0. **WWA**

About the Author

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