SIMPLIFICATION OF DESIGN, OPERATIONS & MAINTENANCE

Outline

Many digital transformation initiatives arise from pain points, business/innovation needs on the customer (experience) side of business. Addressing these pain points results in better design, as well as in easier and more straightforward operations and maintenance of water treatment equipment. This would lead to a clear benefit for De Nora's **customers**, who would obtain better systems and services, but also advantages for the **community**, which would experience much fewer issues of interruption of service, and for the **environment**, given the increased safety and control.

In the following, the main stages of De Nora's product sales, engineering, after-sales, and technical assistance are outlined to show areas to be further investigated for digitally driven innovation.

Technology selection

With all the many water treatment technologies available in the industry, customers are often challenged in understanding which one is most effective to address their specific needs.

The starting point is the identification of the contaminant(s) of concern: the customer may be interested in treating ammonia, arsenic, chlorate, fluoride, nitrates, biofilm, etc., or a combination thereof. This narrows down all the available treatment methods (e.g., oxidative, biological, adsorption-based, membrane-based, etc.) to a subset.

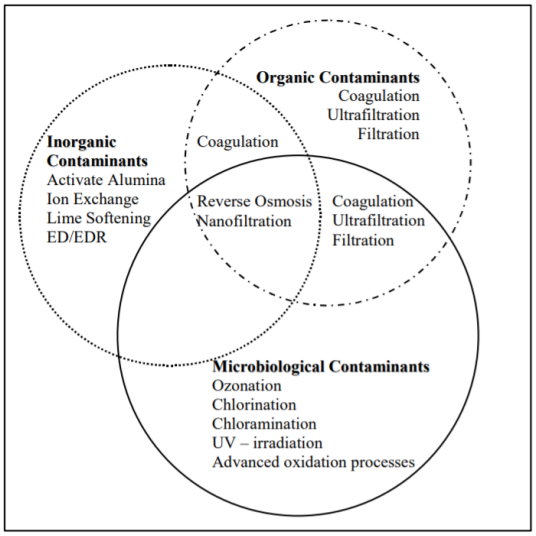

Figure 1 - Selection of contaminant specific treatment technologies.

For instance, in the case of disinfection, one may use chlorine gas, vacuum-operated solution feed systems, commercial sodium hypochlorite, on-site hypochlorite generation (OSHG), on-site chlorine generation (OSCG), ozone,[1] ultraviolet light, calcium hypochlorite tablets or chloramines.[2]

For each method, several different types of equipment are then available in the market. Each equipment has advantages and disadvantages with regards to capital and operating expenses, operational degree of difficulty, safety issues, control strategy and treatment by-products. Other requirements may include hydraulics, energy and environmental footprint, and climate conditions. Given all these factors, plant operators and supervisors look for the best available, most cost-effective, and most user-friendly alternative.[3]

In summary, water treatment technology selection problem is a multi-criteria problem, which requires considerations beyond exact numerical technical evaluations. Thus, the process followed to select a set of technology or equipment can benefit from software-based solutions such as **equipment selection tools** that guide the customers in the definition of the requirements and helps them evaluate the pros and cons of one treatment solution verses another. Eventually, a configurator may help the customer explore the standard solutions by themselves, on their schedule, with the possibility to customize the product according to their needs and flexibility.

Proposal design, engineering and deployment

Once a treatment solution has been identified, De Nora's customers purchase either an off-the-shelf product from our catalogue, like Capital Control® Ozone Generators, or a custom solution for treating water, which can include several pieces of core technology and ancillaries, such as piping, valves and pumps.

In the former case, the customers further specify their requirements, such as the water flow rate and the concentration of contaminant. Currently, this happens through standardized

[1] https://blog.denora.com/ozone-fundamentals
[2] https://blog.denora.com/choosing-the-right-water-disinfection-miox
[3] https://www.wateronline.com/doc/wastewater-treatment-the-art-of-technology-selection-0001

questionnaires, typically exchanged via email. Then, there is limited effort for the internal design and engineering team because products are standardized and several standard drawings with different sizes are available.

In the latter case, the design and engineering effort is higher. For instance, besides upstream and downstream water quality and flow rate, the customer must share information on the layout of the plant building, current infrastructure, and equipment.

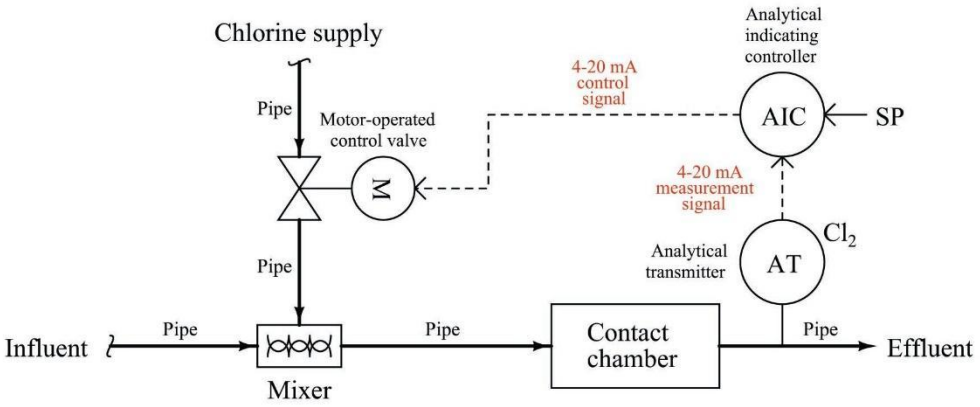

Figure 2 – An example of P&ID for a chlorination control system.[4]

Once that all requirements are collected, the De Nora team prepares a technical offer that contains the definition of the largest pieces of equipment (e.g., electrochemical cells, inverter, rectifier, …) and balance of plant (e.g., valves, piping, …). After negotiation and acceptance of the proposal, a team of mechanical, automation, electrical, and process engineers, coordinated by a project manager, generates a detailed and comprehensive P&ID (process & instrumentation diagram) for customer's final approval.

Once the purchase is completed, all the necessary parts are purchased and partially assembled if needed. After a Factory Acceptance Test (FAT) at De Nora's facility, the assembled equipment and loose items are shipped at customers' site.

De Nora may then offer on-site support for the installation and supervision of the start-up. A few days' training on site usually follows to explain to the end users how the system works. Then, it is time for the Site Acceptance Test (SAT), which often unlocks the final payment from the customer. The SAT protocol, which contains all the activities to be done, is typically shared beforehand, and some information/data needs to be input during the test. When successful, the final documents are then signed as soon as possible, to avoid any loss of information that may cause future litigations. After this stage, De Nora's equipment is deemed fully functional.

Operations and maintenance

When customers make any capital investment, they need to know how to implement measures to protect that investment. The most effective way to protect an equipment purchase is to follow manufacturer-recommended maintenance and service procedures and schedules, which is not always straightforward for the end-user.

[4] https://control.com/textbook/introduction-to-industrial-instrumentation/example-wastewater-disinfection/

Water and wastewater system operators play an essential role in ensuring the reliability and performance of equipment. Proper operation and maintenance of water and wastewater treatment equipment depend greatly on the operators and the training they have received. For example, operators are trained to perform the daily, weekly, monthly, quarterly, and annual maintenance required to ensure operation at optimum levels.

Following these manufacturer-recommended maintenance and service schedules will help to maintain the same efficiency levels, ensure compliance with warranty requirements, and provide economic benefits to the end-user.

This may not always be the case, for instance when the customer hires incoming operators who lack proper skills for maintaining. Tools for supporting the customer with trainings throughout the equipment lifecycle may be truly beneficial.

Some other common deficiencies affecting customers' ability to follow manufacturer-recommended procedures and schedules include lack of maintenance equipment; poor record-keeping; missing information in the Operations and Maintenance (O&M) manuals; lack of regular maintenance; the absence of replacement parts on-site.[5]

When something goes wrong, the customer usually seeks assistance through De Nora's service portal or via email. Examples of issues can be over-heating of the power supply unit, a broken pipe, or a malfunction of the control unit. In many cases, the answer is to provide customers with a way to figure things out by themselves, for example by looking at the O&M manual, currently provided as a paper and/or PDF document.

Interactive, visual, and smart ways to get information about the machines and their operations and maintenance may help the customers quickly identify the solution with the clear benefit of minimizing downtime. For instance, the end-user may get such indications directly from the equipment user interface or, maybe, through a dedicated software (e.g., a smartphone app or a web-based platform) accessible from everywhere.

In addition to making the information from the O&Ms more accessible, software tools may be used to visualize the status of the equipment, look for deviation, notify failures, and keep track of regular maintenance tasks. In this case, the preliminary condition is to connect the equipment to the internet through IoT devices, giving rise to the challenges about integration, data privacy and cybersecurity described in Challenge 3 – Digitally enhanced Water Treatment.

Nonetheless, the integration of data driven alarms or trigger-based indications to help customers know, for instance, when to proactively replace parts before potential failures occur, are both a timesaving and cost-saving value.

Another useful feature for the customers would be the simplification of the procurement of spare parts. More fluidity and accessibility of parts through the procurement tool would lead to better is customer experience and higher active sales of parts.

[5] https://blog.denora.com/maintaining-your-capital-equipment-miox

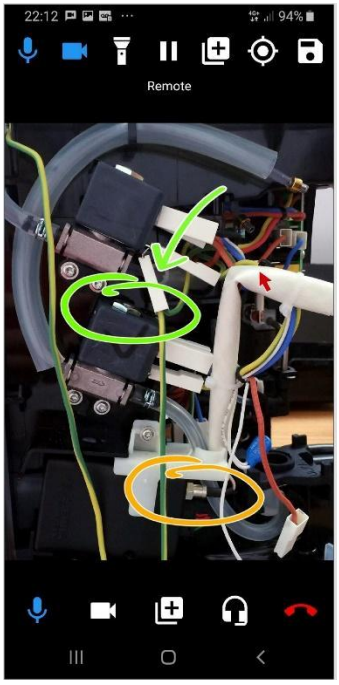

Figure 3 – Screenshot of De Nora VIA™ application from customer side.

Finally, digital tools can improve the collaboration between De Nora's experts and the customers. In pre-COVID times, De Nora's experts used to go onsite for checking the equipment status, looking for deviation, and help the customer solve issues. These visits had also the advantage of increasing aftermarket opportunities. However, in the challenging travel times caused by COVID-19, it is more difficult to support business operations where water equipment is located. Remote collaborations tools as well as remote monitoring and inspection capabilities can effectively support the customers and improve their satisfaction. Some examples of application of artificial intelligence to proactive asset management are available from the IWA.[6]

In this regard, De Nora recently launched the DE NORA VIA™ Remote Support Services, which connects De Nora technicians with on-site customers in real time using live video and inspections.[7]

This application supports capabilities like voice and text communication, document share, and augmented reality to provide a fast and easy response to equipment concerns. For more information, watch here De Nora's webinar on Digitalization.

[6] https://iwa-network.org/wp-content/uploads/2020/08/IWA_2020_Artificial_Intelligence_SCREEN.pdf
[7] https://www.denora.com/products/brands/DE-NORA-VIA-Remote-Support-Service.html