DEVELOP YOUR WASTEWATER TREATMENT STRATEGY CONCURRENTLY WITH COMMERCIAL PROCESS DEVELOPMENT: DON'T LET WASTEWATER TREATMENT DERAIL YOUR PROJECT

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By Bob Hickey, PhD

Typically, the development of a new commercial process occurs in a linear fashion; develop the commercial process and once that is complete, look at how to manage the process residuals, including waste solids and wastewater. This model has been successfully used for decades, but is it the optimal way? Increasingly, commercial process development includes a minimal water footprint and sustainability. There is a strong case to develop the water management system in conjunction with the commercial process. It makes good economic sense compared to the typical linear process development approach.

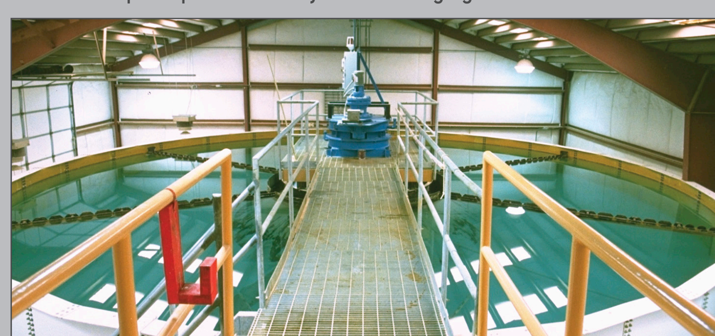
The cost of managing water, solid and gaseous "discharges" from a greenfield industrial facility can be on the order of 10% to 25% of the overall capital cost and a significant portion of the overall facility operating costs. As will be discussed, using a linear approach can result in missed opportunities to develop a more economical and overall sustainable plant.

For the linear model approach, the process development team defines the process and passes the information on the composition and flow rates of the effluent streams that need to be treated to the team developing the wastewater treatment facility. There is no opportunity to integrate wastewater treatment considerations into the commercial process, with the potential to reduce the cost and perhaps complexity of the wastewater treatment plant. Conversely, the concurrent development model, or holistic approach, allows the wastewater development team to understand the commercial development process and offer input on everything from materials used in the manufacturing process to how to improve water management.

Many companies, especially start-ups, do not have or can afford to have an in-house environmental staff; they rely on engineering consultants to provide this function. This should not pose any issue to doing concurrent development. By developing a partnership with the consulting entity, which includes the necessary protection of intellectual property, consulting firms can readily be part of the overall team developing the commercial process and wastewater treatment facility.

As a hypothetical example, let's examine a company developing a fermentation technology that is a large water consumer. There is a strong interest in reducing the water footprint due to scarcity and/or cost of water, or the company's internal desire to be more environmentally responsible due or stakeholder and/or shareholder pressure. In a typical linear plant design, the effluent of the fermentation and product separation and purification is discharged to wastewater treatment. Water reuse is talked about, maybe even assumed, but only in the context of further processing treated wastewater to the quality required to send back for use within the fermentation process. Once any stream is blended with all the other streams being discharged to the wastewater treatment plant, any value this stream had (i.e., potential reuse of a portion of this stream) is lost. However, if the team that will be responsible for wastewater management is actively involved in the fermentation process design, they can offer ways to consider recycle of some of these streams (i.e., membrane treatment of suspended solids) that could result in significant water savings and perhaps a reduction in the chemical costs of operation because the value of nutrients in the stream are recycled and captured.

Proposed options could be tested as a part of process development; knowledge is gained on how effective these concepts can be. The best approach to incorporate wastewater treatment into the commercial process can be analyzed in real-time, along with cost-benefit analysis to compare and contrast options. If one or more modifications make sense, the net result is reduced water consumption for the commercial process and less water to be treated at the wastewater treatment plant. If these streams were just discharged, the size and capacity and cost of the WWTP will be larger than necessary and any system installed to recycle treated wastewater perhaps more costly and challenging.



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Another example where the environmental and/or sustainability objectives can be best addressed with concurrent process development might be something as simple as selection of the chemicals used in the commercial system. For this hypothetical example let's focus on the selection of the nitrogen source used in fermentation. In fermentation system design there is always a push to keep chloride levels as low as possible to reduce the potential for corrosion in the fermenters and more importantly in downstream unit operations, such as distillation, that operate at higher temperatures (and so have greater risk of chloride corrosion). So instead of using ammonium chloride as the N source, ammonium sulfate, another highly soluble nitrogen source, might be selected and qualified for use in the commercial process. If we assume the process effluent has a moderate to high chemical oxygen demand, and, therefore, represents a potential source for energy recovery by using anaerobic treatment (where the organics can be converted into biogas that can be used as supplemental fuel to help off-set natural gas or other fuel costs or converted to RNG and sent onto the natural gas pipeline), the concentration of sulfate in the wastewater can have a significant impact on the wastewater treatment system, particularly managing the produced biogas. This is because the sulfate in the wastewater will be converted to hydrogen sulfide under anaerobic conditions. Most of the sulfide will be in the biogas produced. In order to use the biogas, sulfide needs to be reduced to ~100 ppmv for use in boilers and essential nil for use as renewable natural gas (RNG) that is sent to the pipeline. In the linear development case, the wastewater team will simply take the information on the wastewater and design the appropriate biogas cleanup system (and associated residuals management system, such as elemental sulfur that is produced by many of the sulfur removal processes)

For the concurrent development approach, knowledge of the consequence of using ammonium sulfate could be fed back to the commercial process development team and they could look for an alternative, which might be urea. Urea has no chloride or sulfate to deal with so there is no need to have more expensive materials of construction in the commercial plant to deal with chlorides. By making this simple switch, the capital cost associated with biogas cleanup system could be greatly reduced.

Now it is possible, in the case of linear development approach, once the size and cost of the biogas management system is understood, to play detective and go back and identify the source of the elevated sulfate level. However, this is more cumbersome and costly than having the environmental/sustainability goals identified and aligned with the process development from the outset.

Hopefully these simple examples illustrate how employing a more holistic approach involving the wastewater treatment team in the development of the commercial process can offer significant benefits towards achieving a less costly and more sustainable overall facility.

About the Author

Dr. Hickey has over 43 years of experience in the water, wastewater treatment and renewable energy and biochemical fields in the areas of applied research, development, demonstration and commercial application. Dr. Hickey also has extensive experience in full-scale system design, start-up, operations and troubleshooting of conventional and innovative biological treatment systems for anaerobic and aerobic treatment of industrial wastes and wastewaters, industrial water, groundwater and solid-waste streams. More recently he has applied the same skill set for developing biological based renewable fuels and energy systems. He has been successful in translating laboratory and pilot scale research and development into full-scale application. He is author of 50 refereed publications and over 20 patents with a number of patents pending. Dr. Hickey is an active member of several professional environmental organizations including working as a committee member, providing technical reviews and assisting in preparation of technical manuals of practice. Current interests include development of sustainable waste management systems for industry, and development of bio based renewable fuel and energy systems.