



## A Water Roadmap for Chemical Engineers

Water is one of the most important resources in the chemical process industries (CPI) — presenting both opportunities as well as compliance obligations. It is involved in a broad range of operations, including separations, product recovery, wastewater treatment, and disinfection, to name a few. Because of its pervasiveness, water requires a new engineering lens through which chemical and biological engineers view their study and work. This new engineer is analogous to the subset of process engineers who have specialized expertise and experience in developing and running unit operations.

To refine this lens and bring focus to water engineering, the International Society for Water Solutions (ISWS) is developing roadmaps for water topics that relate to the CPI. A roadmap, as the name implies, consists of a starting point, an endpoint, and routes or pathways to connect the two points. The roadmaps for water engineering will identify pathways to bridge the gap between the existing state of water technologies (starting point) and an envisioned state for the future (endpoint).

For illustrative purposes, consider separations — a ubiquitous process in the CPI. Separation processes are used across many industries, from the oil and gas sector to biorefining to primary metals production. Some of the issues related to water separations include the difficult separation of substances that form azeotropes (such as water and ethanol), the high energy input required for purifying fracking water, and the removal of water (*i.e.*, drying),



▲ Roadmapping provides a structured and focused method to carve out a space within the broad topic of water processing where chemical and bio-related engineers can play a role.

which is one of the most common separation processes used in the production of specialty chemicals, pharmaceuticals, and bio-based products.

To create a roadmap for water separations, ISWS is looking to key stakeholders across a broad range of industries, academia, and government agencies to work together to answer the following questions: What are the challenges with existing water-separation processes and technologies? What metrics are used to measure the performance of water separations? What is an ideal future state for water-separation processes? What innovations could address the existing challenges and move the industry closer to the envisioned future state?

ISWS plans to develop roadmaps for several water topics. The roadmaps will also identify where and when it makes sense to apply modular chemical process intensification to close the gaps between identified issues. Some issues may be best addressed with process intensification, some with modular and distributed processing solutions, and others with centralized processing that capitalizes on economies of scale.

The issues related to both process intensification and modular distributed processing are of particular importance for the Rapid Advancement in Process Intensification Deployment (RAPID) Manufacturing Institute. The RAPID Manufacturing Institute has identified water as an issue — and potential opportunity — across all of its six focus areas, which span chemical and commodity processing, natural gas production, renewable bioproducts, and several fundamental cross-cutting areas, including modeling and simulation. The Manufacturing Institute's roadmaps highlight water management as an area with a large potential impact. Applications range from product recovery and inhibitor removal in biological processing systems to process water purification and management across the chemical and commodity processing space, as well as wastewater management in unconventional gas production.

ISWS will combine the roadmaps for the various water topics into an overall roadmap, which will identify major issues with existing water technologies and potential solutions for these issues. In a sense, the roadmap will provide a picture of water engineering and how it fits into the fields of chemical and biological engineering. Just as a process engineer must master a subset of engineering concepts, water engineers will need to gain expertise in certain topics and concepts.

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