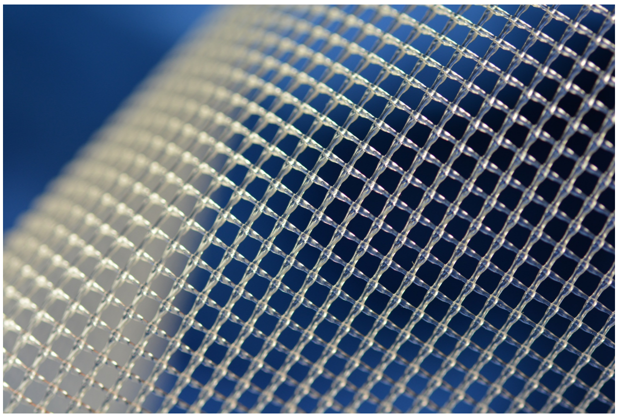
Conwed sees potential in reverse osmosis

09 April 2015

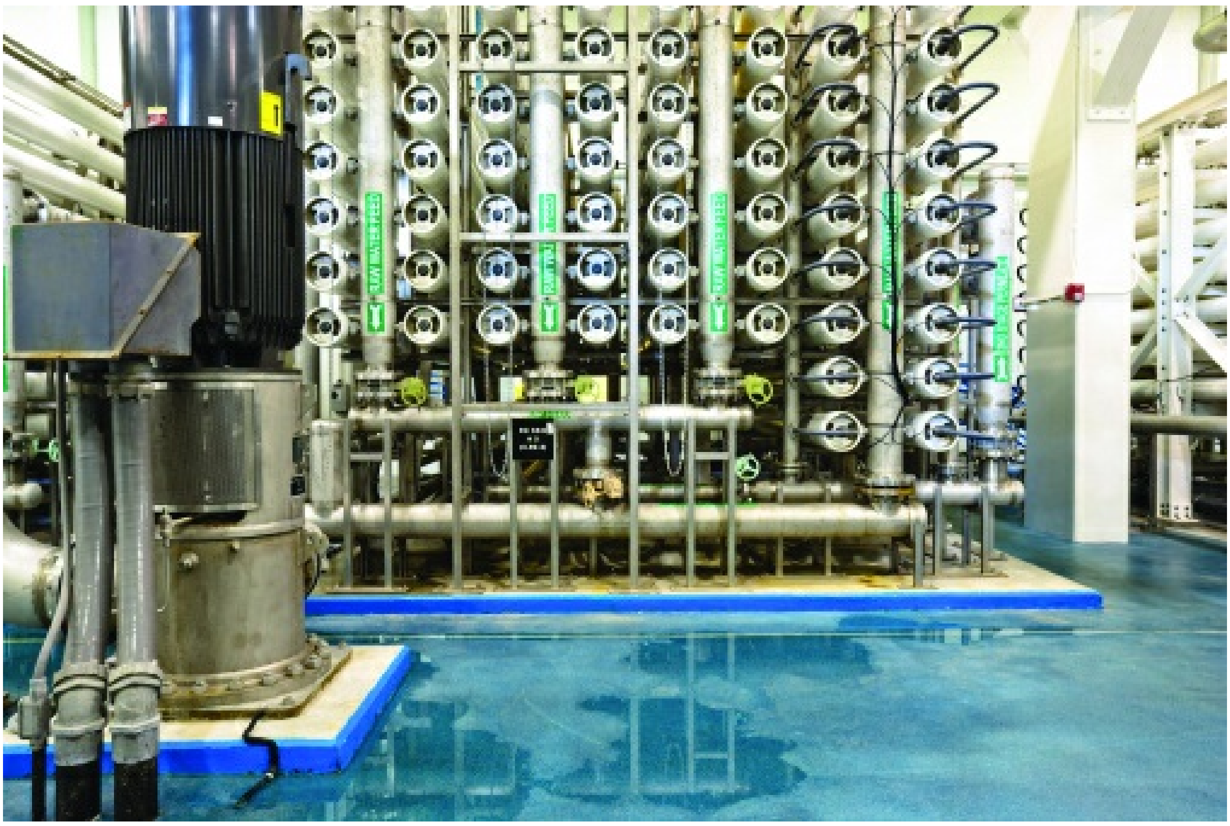
Conwed have been developing netting solutions for more than

45 years.



Reverse osmosis (RO) is a critical part of the world's water supply. The International Water Management Institute, a non-profit scientific research organization that focuses on sustainable water use in developing countries, estimates that by 2025 nearly 1 billion people will lack access to fresh, drinkable water.[1] It's clear that RO will play a major role in alleviating water scarcity, but there will be a strong push for greater efficiency and cutting energy costs while boosting product water output.

For most RO plants, the key word is energy. An RO plant typically needs at least 150 psi and can require as much as 1000 psi to efficiently operate its RO arrays. Pressure at those levels consumes a large amount of power. The change in pressure from feed water inlet to concentrate outlet is known as pressure drop. Pressure drop is a key measurement of the energy efficiency of an RO plant. Maintaining pressure, or having a low pressure drop, is often a vital concern for some RO plants. It is also expensive: high pressure is costly to achieve and maintain.



For most RO plants, the key word is energy.

Plants have different sources and prices for power, of course, but the overall cost for energy is trending up. Given the tremendous volume of water processed by RO plants as well as the extremely high energy costs, even small improvements in efficiency can translate into large savings or increased product water output. A great deal of research and innovation pursuing these goals has focused on membrane chemistry, including changes to the polymeric formulation and different methods of membrane production.

Plastic netting manufacturer Conwed believes that the next leaps in RO filtration efficiency could come from the feed spacer. The simple plastic netting doesn't have to be so simple anymore, and Conwed has launched an R&D project to innovate the next generation of feed spacers.

Feed spacer innovations

The Global Innovation and Technology team at Conwed, led by James Kidwell, is devising and testing new ideas and advances in feed spacers. "For more than 45 years, Conwed has been developing netting solutions for hundreds of products and applications in diverse industries," says Kidwell. "Our aim is to research the RO challenges prevalent in our industry and test innovative new feed spacer ideas that might help address those challenges."

Conwed began this investigation with a thorough review of academic literature. As Kidwell reviewed the research being conducted at universities around the world, one thing became clear: people who study the RO process think there is potential in the feed spacer to address some of the industry's most pressing issues. "That's often where new developments come from in any industry," says Kidwell. "Ideas start in academia and then bubble over into the commercial realm."

Kidwell then spent 18 months traveling the globe, searching not for answers but for problems. He visited the major players in the RO membrane industry, surveying them to identify their biggest operational challenges. Conwed typically sells its feed spacers to companies that manufacture RO elements. Their manufacturing process is generally known as spiral winding for the way membrane, feed spacer, and permeate spacer are wound tightly into an element, through which water is pushed and filtered. But Conwed didn't stop with just its own customers.

Kidwell also visited his customers' customers: the RO plants that use the elements as well as the industrial construction companies that build RO plants and design and install RO systems. Kidwell's approach was simple: he began the effort with no assumptions of his own, a clean slate, and asked everyone he spoke to, "What are your areas of greatest need? What causes you the most problems?" Their answers laid out the direction of the Innovation Team's research.

RO Challenges

There were three primary problems that resonated among the companies and people Kidwell talked to. These three problems came up repeatedly and at times overlapped as a concern for both the membrane manufacturers and the RO plant operators and builders. They were:

1. Pressure drop
2. Membrane damage
3. Biofouling and scaling

With their research targets now identified, the Global Innovation and Technology team at Conwed set out to design different feed spacers and test the impact that changing individual features could have on each of these problems. But the experiments required wide-open thinking as well as creativity. Conwed invested a substantial amount of time and dedicated R&D personnel to develop and test feed spacer designs. Says Kidwell,

"Our team can work on a specific idea and control selected steps of the process, so that the single characteristic I want to test is completely isolated and examined."

1. Pressure drop

As noted earlier, high pressures necessary for RO require commensurate levels of energy. Any increase in pressure drop represents a loss in applied feed pressure and hence a loss of efficiency — and of course energy, and money.
Any reduction in pressure drop represents a direct savings to the plant. In an RO plant, the applied pressure comes ideally as much as possible from high feed stream throughput, and not from overcoming feed spacer resistance. But a feed spacer with no resistance isn't the answer either, because RO elements require turbulence in the feed stream to work efficiently. That turbulence comes mostly from the water rushing across and through the feed spacer, and is important because it reduces salt buildup on the membrane.

To address the challenge of pressure drop, researchers at Conwed are experimenting with feed spacer configurations for optimum flow and lowest intrinsic resistance while still trying to maintain a sufficient degree of turbulence. Spacer configurations are created and tested to measure pressure drop across the feed spacer. While more testing remains to be done, Conwed believes the feed spacer may have a role to play in reducing pressure drop. As Conwed continues to examine different alternatives, the nature and scope of the impact the feed spacer has should become more evident.

2. Membrane damage

When RO membrane manufacturers roll their elements, they wind layers of membrane, feed spacer, and permeate spacer tightly into the cylindrical element so recognizable in the RO industry. The membranes themselves are susceptible to damage during the manufacturing process when they are tightly pressed against the feed spacer. As with many aspects of the RO process, winding the membranes and feed spacers involves tradeoffs.

The feed spacers need a high degree of dimensional stability, that is, stiffness, to maintain separation between the membranes. However, the stiffer the feed spacer, the more likely it is to damage the membrane. A softer feed spacer, for instance one made from resins other than polypropylene, is gentler on the membrane, but that in turn compromises some of the stiffness and stability.

RO membrane elements undergo extensive quality control checks before being shipped, including testing flux and rejection performance. Elements with membrane damage can't be repaired—they are discarded, and accrue to the membrane manufacturer's scrap rate, driving up costs. Research has suggested that changes to feed spacer resins might offer breakthroughs in terms of the tradeoff of structure and membrane damage. Ongoing testing indicates there might be gains to be made in feed spacer structure without causing membrane damage, but determining that requires an effective way to test the spacers to predict potential membrane damage.

As part of their research, the innovation team at Conwed is testing different chemical configurations and the impact they may have on RO membranes. This connects directly to their research concerning the effect different spacer configurations have on pressure drop, because unorthodox or novel feed spacers that may offer gains in pressure drop aren't viable if they cause excessive membrane damage.

"Right now there's not really a standard way to test membrane damage without winding an element," says Kidwell. Conwed is attempting to measure and predict what impact different feed spacers will have on membranes in the winding process. "We wanted to do this screening ourselves to understand potential improvement on our feed spacers," notes Kidwell. "That way the pressure—pardon the pun—wouldn't be on our customers to explore new ways to do this." The ultimate goal is to develop even higher quality feed spacers, with the potential impact on membranes tested, measured, and documented.

3. Biofouling

Biofouling occurs when unwanted microorganisms and algae grow on the feed spacer or membrane surfaces. Biofouling could happen in any RO desalination system and it causes two main problems for RO plants. First, the fouling material clogs the membrane and the feed spacer, leaving less of the membrane surface area permeable. This increases flow resistance and leads to higher pressure drop, so the RO plant has to pump water at a higher pressure to overcome resistance. Second, biofouling also impairs the quality of the permeate water.[2]

To address these problems, RO membrane elements have to be cleaned, which causes a reduction of available

RO membrane units for water production. All of these factors contribute to an increase in water production costs. With this in mind, Conwed is evaluating the impact different feed spacer configurations might have on biofouling. As with the experiments investigating pressure drop and membrane damage, the biofouling experiments suggest that further R&D is absolutely warranted.