Profiles in Wastewater: Jiří Wanner

Playing Darwin with the microbes of sludge

The people of Pilsen care deeply for beer.

As the birthplace of Pilsner pale lager, in 1842, this Czech Republic town lent the root of its name to the world's popular brew. The cultural heritage, anchored by the Pilsner Urquell brewery, means locals also care deeply about the ingredient that makes up 90 percent of beer: water.

All this makes the Pilsen municipal wastewater treatment plant an ideal showcase for Jiří Wanner's process, known as bio-augmentation in situ. It represents just one of the ways he gets to play Darwin as a consultant to builders of wastewater plants.

A professor at the Institute of Water and Environmental Technology of Prague University of Chemistry and Technology, Wanner has a teacher's knack for breaking down complex concepts into understandable parts– just as bio-augmentation helps break apart bad stuff from good stuff.

Several dozen plants in the Czech Republic use bio-augmentation in situ and other processes devised or perfected by Wanner to favour the survival of "good" bacteria over "bad" inside treatment centres. This "unnatural selection" serves to improve plant efficiency, thereby saving time and money while resulting in cleaner effluent.

Effluent from the Pilsner plant contains just 1 milligramme per litre of ammonium, for example. "Very nice for a municipal wastewater plant," says Wanner.

Bio-augmentation involves creating optimal conditions for bacteria that are good at oxidising ammonium and, by extension, resolving concerns about nitrogen. Nitrogen is present in municipal wastewater mostly as ammonium-nitrogen from urine.

The bacteria are good at what they do, but they are extremely sensitive. To sustain their numbers, Wanner has developed a small basin that sits astride the flow of sludge stream that is about to be reintroduced into the plant as part of the cleansing cycle. While in the basin, the bacteria-rich wastewater gets extra oxygen in addition to a regenerating charge of ammonia from reject water sent from the anaerobic digesters.

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Plants around the world buy bacteria to mimic that process, but all too often they quickly lose their effectiveness. "They are not used to the specific conditions of your plant," says Wanner. "They were cultivated somewhere else. They are usually very quickly shocked. If they are born in the system, in situ, they are accustomed to the conditions in your plant from the beginning."

Wanner uses another trick to help bio-augmentation in situ: his molecular tools identify the components of activated sludge. "The nitrification bacteria are small balls," he says. "They cannot be identified under a microscope."

Bio-augmentation in situ runs parallel to Wanner's other work on separation in activated sludge. In this case, the 'good guys' are floc-forming organisms. They aggregate and settle well. The 'bad guys' are filamentous organisms that, as their name implies, encourage the growth of filaments that keep sludge particles from globing together. Floc-forming organisms help sludge blobs become larger, heavier and more compact. Filamentous organisms take longer to settle, costing more time and money.

In this "mixed culture of organisms," the two kinds of organisms compete under "very strong selective pressure," says Wanner. Without outside intervention, the bad guys all too often win. "You have to provide the conditions."

To tip the scales, for example, the concentration of the organic carbon in the substrate can be altered. "This gradient helps the floc-forming bacteria overcome the filaments," he explains. Or oxygen may briefly be sucked out of the system, mixing wastewater with activated sludge in non-aerated basins. "They create the conditions for the growth of floc-forming bacteria," says Wanner.

After striving so hard to clean up wastewater, Wanner wants to make the most of it: to clean streets or other productive uses, building resilience against droughts like the Czech Republic suffered in 2015. "To discharge it without an economic use is nonsense," he adds.

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