Industrial waste, biomimicry and the circular economy

Peter Middleton

COMMENT

In this month's Innovative Engineering feature, Claire Janisch of biomimicrySA presents the case for adopting a more 'life-friendly' approach to business and industry, one that does not result in dumped toxic waste materials and contaminated land, air and water resources.

"We can make almost everything in chemical engineering in ways that are nourishing to life. Almost every functional material or process has a counterpart in nature that uses life-friendly materials, low energy processes and continuously cycles all the materials used, including water and carbon," she says in introducing the concept of biomimicry.

Industrial processes, she argues, tend to be massively energy intensive compared to natural processes, which have evolved over millions of years to be amazingly efficient and very resilient.

Industrial processes, if the cost to the environment is fully accounted for, also prove economically unviable. Citing an Ecosystems and Biodiversity (TEEB) programme sponsored by the United Nations Environmental Program, Janisch notes that none of the world's top industries would be profitable if they paid for the natural capital they use. The TEEB programme calculated the total unpriced natural capital consumed by the 1 000-plus industries studied to be US$7.3-trillion per year, equivalent to 13% of global GDP in 2009.

"In comparison, naturally evolved processes integrate all externalities, yielding system-level efficiencies," she points out. Ecosystems such as forests, grasslands and coral reefs survive for centuries, cycling all materials, building soil, cleaning water and generating only the gases that support life.

"Using biomimicry as a model, measure and mentor, it is possible to emulate nature's ecosystems in many ways, which is why biomimicry and the circular economy go so well together. This is simply a better and more logical way to design and manage our systems to emulate the nourishing systems that support all life," says Janisch, before citing several examples of how this has already been done.

When applied to how we humans use natural resources in industrial processes to satisfy our ever expanding 'needs', the circular economy is a development model that strives to use the waste from one process as the raw material of another. Our SAIChE IChemE member profile in this issue follows the career of John Bewsey who, in recent years, has been exploring ways of applying this principle to water treatment, including acid mine drainage (AMD), industrial wastewater and domestic effluent.

Bewsey's patented treatment systems are built around the idea of transforming the inorganic salts polluting treated AMD, domestic sewage, industrial wastewaters and underground 'brakwater' into high-value fertilisers, while leaving the water completely demineralised.

"Sodium salts are particularly hazardous," says Bewsey, because clay particles absorb sodium ions, which makes the soil impermeable and causes the flora and the soil beneath it to die.

His ion-exchange treatment process uses two lines of stirred tanks with the contaminated water and the ion exchange resins flowing in opposite directions to each other. This process produces demineralised water, but the resins become contaminated, one with the positive salt ions (cations) and the other with the negative anions.

By regenerating the CATEX and ANEX resins with nitrate and ammonia, respectively, Bewsey's process produces a nitrate blend. Sodium carbonate is then added, which enables ions such as calcium to be removed, leaving a sodium nitrate solution. This is mixed with potassium chloride and evaporated, which enables the dangerous sodium chloride to be removed from the water, leaving a potassium nitrate (KNO_3) solution, which is dried into granules to give "a valuable fertiliser with global demand".

By beneficiating almost all of the contaminants in the water, the water treatment itself can become a profitable process rather than a grudge expense. More importantly, though, harmful pollutants in the water are transformed into valuable fertilisers.

A few months ago, we published the story of OMV Gypsum, which reprocesses waste gypsum from a phosphate fertiliser plants to make very high quality finishing plasters for the building industry. Some fertiliser plants still pump their waste into the ocean, but with the OMV initiative "we can now solve this problem by creating a genuine zero waste value chain from agricultural fertilisers all the way to high quality, modern building materials," says the company's MD, Oscar Goudriaan.

Bewsey tells a story from his early career about a milling technique he developed to improve the efficiency of a pharmaceutical ingredient. It was deemed too expensive by the company directors however, so he found a secondary use for the investment, grinding fire extinguisher powder. The company directors were horrified: "a pharmaceutical company cannot make fire extinguisher powder!"

Yes they can, and if more industries realised this and adopted circular economy and life-friendly approaches, their businesses, our lives and the environment would be better for it. ❑