Making "Gold" from faecal waste: A Fairy Tale or A Reality?

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WIN-SA aims to capture the innovative work of people tackling real service delivery challenges. It also aims to stimulate learning and sharing around these challenges to support creative solutions. Most importantly, WIN-SA strengthens peer-to-peer learning within the water sector.

What we normally see as waste in toilets is actually gold. Dr Sudhir Pillay, a Sanitation Research Manager at the Water Research Commission (WRC) in Pretoria, South Africa takes us through the current practices of turning faecal waste to valuable products with economic value.

In 1812, the Brothers Grimm published "Children's and Household Tales", containing many of the well-known and famous fairy tales, such as Hansel and Gretel, The Frog Prince, and the fabled one of the long-haired Rapunzel. One of those stories was Rumpelstiltskin. The story was about a miller's daughter who could make gold from straw with the assistance of an imp-like creature. What do making gold from "nothing" and toilet waste have in common with this article? Dr Pillay explains the link between the two below.

Finding gold in toilet waste

According to Paul Westerhoff and co-workers from Arizona State University, there is actually gold and other precious metal contained with human sewerage flushed down the toilet. In a study that that they conducted and published in the scientific publication Environmental Science & Technology (Volume 49, pages 9479-9488) in 2015, they estimated for a community of 1 million people, the metals contained in the sludge generated from the wastewater treatment process had a value of around US$13 million. Further, a model they used to determine the relative potential for economic value from the sludge showed that there are 13 lucrative elements, including silver, copper and gold, with an estimated value around US$280/ton of sludge. With this scientific study showed that there are actually precious metals contained in toilet-derived waste, there is some way before we re-orientate our engineering processes to extract these resources.

From Wastewater to Resource Recovery Facilities

Dr Pillay further refers back to the 2nd International Resource Recovery Conference held at Columbia University, New York, U.S.A in August 2017. The conference was held over 3-days and aimed to showcase the latest developments in resource recovery from sewerage-derived and faecal sludge waste. Sewerage waste is basically moved through sewers, and can be from domestic sources, including clothes washing and toilet use, and / or industrial sources, for example, manufacturing.

Faecal sludge refers to waste that collects in on-site pit-type systems and includes septic tanks. The conference was not only focussed on technology; there was also a focus on the monetisation, financing and policy-making required to drive resource recovery in the form of energy and commercially valuable chemicals.

Among others, the conference focussed mostly on "waste" and their engineering systems; these systems called resource recovery facilities and the resource recovered have monetary value – hence Dr Pillay refers to "gold contained in shit".

Harvesting Valuable Commodities from Toilet Waste

Dr Pillay reminds us of a young engineer, named Dr Shashwat Vajpeyi, who attended the 2nd International Resource Recovery, a co-founder and CEO of a biotech start-up, named Carbocycle, the technology of which was developed through his post-graduate research at the Chandran laboratory at Columbia University and with funding support from the Bill & Melinda Gates Foundation. In conventional wastewater treatment processes, sludge produced from the wastewater

treatment process is often treated anaerobically – meaning in the absence of oxygen – through specialised micro-organisms which thrive when there is no oxygen. Through a cascade of reactions involving a consortium of micro-organisms, methane gas is ultimately produced.

Vajpeyi explained to the conference how methane produced from the anaerobic process can then be used to heating or could be converted into electrical energy. What Vajpeyi and his team have shown is that they do not have to convert all the carbon source in the waste to methane – they actually engineer their systems to produce organic acids and instead of taking this and further degrading ultimately into methane, they feed it to oil-producing yeasts. The oils produced are similar in composition to common vegetables oils, including palm oil, which are used in many manufacturing processes, including cosmetics and soaps. This process is not only confined to wastewater processes; but other so-called "waste industries" that have a lot of organics contained within them. In doing so, Vajpeyi and his team aim to establish a new industry based on converting readily-available organic "wastes" into usable chemicals thereby creating new material supply chains within cities. To see more of the patented system, see this video:

Pillay gives more tangible examples of how waste is being converted to valuable commodities with economic value. For example, in Ghana, the Columbia University team led by Prof. Kartik Chandran, partnered with a local university, Kwame Nkrumah University of Science and Technology, to adapt the process to make biodiesel from toilet waste. A pilot plant, guided by laboratory research conducted at Columbia University, was established in Kumasi and was fed with pit latrine waste. Like the rest of sub-Saharan Africa, full-sewered systems are not common in Ghana. Instead, pit toilets are used – these technologies usually rely on a hole in ground in which the faecal-origin waste collects and eventually needs to be emptied. This can be a costly process to the household and for service providers, who empty these toilets as part of their business, as profits are linked to affordability of their service to consumers and the cost of disposing waste in an environmentally safe manner.

A common challenge in the developing world is that this waste often ends up being disposed into the environment. "Thanks to Prof Chandran's team for showing us that through innovative engineering processes that toilet waste can be converted into valuable products with the further promise of off-setting costs into the sanitation supply chain, notes Dr Pillay. "This has the potential to reduce the cost of services to customers requiring emptying services and incentivising pit emptying businesses to bring the collected waste to these resource recovery facilities. Similar strategies are being explored elsewhere around the world", adds Pillay.
(see: http://pivotworks.co/pivot-fuel).

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