Circular Economy and Waste Conversion

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The increasing amount of waste is one of the most demanding problems facing the world, which creates global environmental challenges. Worldwide, 2.12 billion tons of waste are generated annually, and it is expected to rise at the current trend [1]. Most of the trash ends up in landfills emitting harmful pollutants into our air, water, and soil. Therefore, waste reduction in a circular economy is vital for climate change mitigation and sustainable economic growth. The circular economy is not only based on simple recycling and reuse of the produced waste. In a circular economy, waste materials are redesigned or converted into forms retaining as high value as possible. Garbage can be converted into high-value products by mechanical/physical, thermochemical, and biochemical processes. Consequently, a circular economy should include the use of the effective waste conversion technologies based on thermochemical and biochemical processes (e.g., Waste-to-Energy, Waste-to-Gas, and Gas-to-Liquids technologies) to produce usable products. However, a circular economy should not be limited to recycling and conventional technologies, such as incineration and anaerobic digestion.

Many waste products as contaminated plastic, paper, diapers, medical waste, waste biomass, anaerobic digestion and industrial byproducts are very difficult to recycle.

Incineration is a wasteful use of resources – providing low energy conversion efficiency. In addition to thermal energy, products of the incineration process include bottom ash, fly ash, and flue gas, in which a number of regulated pollutants (e.g., mercury, lead, cadmium, etc.) are found**.** The produced flue gas significantly diluted and increased in volume by the nitrogen content of the excess air use. Combustion of waste is a significant source of furans and dioxins, which are highly toxic and carcinogenic pollutants. Also, the typical gaseous pollutants in the flue gas are carbon dioxide, nitrogen oxides, sulfur oxides [2].

On the other hand, anaerobic digestion has a limit in the waste conversion. It is only suitable for the treatment of the biodegradable organic portion of waste feedstock. Non-biodegradable material – digestate remains after processing waste by anaerobic digestion. The produced digestate can be contaminated with toxic heavy metal compounds from municipal solid waste (MSW) and sewage sludge. Therefore, the by-products of the anaerobic digestion often cannot be reused without environmental contamination. The produced biogas and landfill gas are contaminated by sulfur gases (e.g., hydrogen sulfide, methyl mercaptan), siloxanes, halogenated hydrocarbons, and ammonia, which can be sources of air pollution after burning [2].

The circular economy can be based on emerging waste conversion technologies, such as steam reformation, gasification, pyrolysis, and other [2, 3]. An appropriate Waste-to-Energy technology can convert both biodegradable and also non-biodegradable carbonaceous waste contents into the higher value of clean/renewable energy products, recover materials for reuse, and divert waste from landfills to prevent contamination of air, water, and land. Higher value liquid synthetic fuels can be produced from waste materials by a combination of a Waste-to-Gas technology with a Gas-to-Liquids technology. The waste feedstock can be a cost-effective and environmentally sound supply of clean energy source and replace a portion of fossil fuels. Potentially, garbage can be transformed into various forms of clean and sustainable products, such as electricity, hydrogen, liquid synthetic fuels, "green" chemicals, and food-based products. The produced product composition depends on the type of waste feedstocks and reactants, and the applied processing conditions [2, 4]. The used waste conversion technologies should be efficient and combined with a reliable scrubbing/cleaning system to remove contaminants in order to generate clean/ renewable energy and other sustainable products, and prevent pollution of the surrounding environment. In a circular economy, effective waste conversion technology applications can play a key role to find a solution for waste disposal, clean energy and sustainable product regeneration.

References

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About the Author

Dr. Zoltan Kish has a Ph.D. in Chemistry with over 25 years of diverse industrial and academic experience and contributed to more than 70 scientific publications. He has developed and managed complex research and development programs related to alternative/renewable energy, clean technologies, GHG, sustainability, and advanced materials applications, such as solar energy technology, ceramic engine & cutting tool components, materials processing, and electronics. Dr. Kish was the Director of Research & Development at two major Canadian alternative energy companies where he focused on R&D and commercialization of unique Waste-to-Energy technologies and reliable scrubbing/ cleaning systems to produce clean and sustainable energy products. In response to global environmental challenges and the need for scientific evaluations of new technologies and advanced materials applications, he has established a consulting company - Quasar ScienceTech (www.quasarsciencetech.com) to provide multidisciplinary science and technology consulting in the areas of Natural & Applied Sciences, Clean Technologies & Energy, Waste Conversion, Technical Due Diligence, Climate Change Mitigation, Circular Economy, Sustainability, Innovation, and Advanced Materials Applications.