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MSW GASIFICATION – UNDERSTANDING THE CHALLENGES

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There has been a tremendous amount of discussion in recent years about alternative technologies for the thermal processing of municipal solid waste (MSW). These technologies try to differentiate themselves from combustion and claim environmental benefits. While these technologies may be technically feasible, and may have a place in the future processing of MSW, their processes and equipment need to be developed and scaled-up to define their economics, and they have a long way to go before being considered commercially proven and reliable. Covanta is actively evaluating emerging gasification technologies and is committed to identifying and developing the most promising processes.

MSW is a very complex material, both in its physical and chemical properties. After decades of operating energy from waste (EfW) facilities, we have repeatedly learned that empirical experience far outweighs the theoretical when dealing with MSW. From a chemical perspective, MSW is a very corrosive fuel due to its high chlorine content, and the presence of many volatile inorganic compounds. Although we have been operating EfW facilities for many years, the complex mix of inorganic elements that react with chlorine makes it very difficult to accurately predict corrosion and fouling in EfW boilers. Only through years of experience are we able to effectively manage corrosion and fouling, and maintain high reliability. This corrosion and fouling will also exist in gasification processes, and it will take years of development to identify and solve the specific challenges of each process, and design and scale-up reliable equipment.

From a physical perspective, MSW is a very heterogeneous material. In the mid-1980's, many thought that pre-processing and shredding MSW would improve its combustibility, leading to higher efficiency cycles. Although we continue to successfully operate several RDF-fired facilities, the very high cost of handling and pre-processing MSW has been well established, and far exceeds any minimal benefit, if any, that can be achieved from combusting RDF. Following from this, mass-burn has been established throughout the world as the most reliable, economical, and environmentally sound way to recover energy from waste. But this was a slow lesson learned through experience. Most gasification processes require some pre-processing of the MSW. This will come at a high cost; a cost that designers who do not have experience operating EfW facilities always seem to significantly underestimate.

Gasification is a family of chemical processes that generally involves the partial oxidation of the organic fraction of the MSW, leading to a "syngas" that contains carbon monoxide, hydrogen and some methane, in addition to the typical combustion products of carbon dioxide and water vapor. Syngas, if purified, can be used for the production of a variety of chemical products, including hydrogen, ammonia, and methanol. However, if the syngas contains any significant impurities, it can only be used for its fuel value.

Gasification technologies can generally be divided into three categories:

- **Low Temperature Gasifiers** are air-blown processes that operate below the melting temperature of the ash. As a result of fairly low operating temperatures, the syngas product will contain many heavy hydrocarbon impurities that make it impractical for clean-up. Therefore, the syngas is combusted immediately following the gasifier, and energy is recovered from the flue gas using a standard boiler and Rankine steam cycle.

- **High Temperature Slagging Gasifiers** are typically air-blown processes that include the addition of external energy to melt or vitrify the bottom ash. They often use coke, which results in increased greenhouse gas emissions. These processes have been developed and commercialized in Japan, at a very high cost, to ensure that the bottom ash could be reused. Like Low Temperature Gasifiers, the syngas is typically combusted immediately following the gasifier, and energy is recovered using a standard boiler and Rankine steam cycle.

- **Plasma Gasifiers** are typically oxygen-blown processes that involve the very high temperatures of an ionized gas or plasma. If the waste is effectively exposed to these high temperatures, the syngas has the potential of being very pure, with minimal content of hydrocarbons heavier than methane. There are many plasma gasification processes on the market, but successful commercialization has yet to be achieved on MSW. There is one commercial plasma gasification plant in Japan for processed MSW and auto shredder residue. But this facility has had many problems, and the technology is no longer marketed by the Japanese company that developed the project. Plasma melting of ash from EfW facilities is commercial in Japan with many installations, but this is very different from MSW gasification.

Gasification of MSW can certainly be accomplished, but the cost and benefits relative to EfW have yet to be defined at a commercial scale. There are many gasification processes on the market and a few small commercial scale projects under development. These projects will undoubtedly experience process and equipment challenges, and solutions will likely be developed, all contributing to the understanding of the cost and reliability of these technologies. As this development and commercialization continues, the cost components, including feed processing, high temperature equipment corrosion and fouling, syngas clean-up, and power generation will become better defined. Covanta is committed to understanding these costs for selected processes that we feel offer the best chance for commercial success. Whether these technologies ultimately find a commercial market will be determined by many factors, but what is certain, is that they are not ready today for large-scale commercial projects in the U.S.

Presenter Information

Stephen Goff is Vice President of Research & Development for Covanta Energy Group, Inc. He joined Covanta in 2005 with the acquisition of American Ref-Fuel Company, where he had worked since 1987, most recently as Director of Engineering. He has more than 20 years of industrial experience in Energy from Waste and other high-temperature process industries.

Mr. Goff earned his B.S. in Chemical Engineering from Villanova University, and his M.S. in Chemical Engineering from Lehigh University. He holds seven patents in the fields of waste combustion, ash treatment, and gas separations. He has also co-authored or presented ten technical papers in the fields of waste management, petrochemicals, and industrial gas production.