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I can only speak based on my experience with medical waste. In the case of medical waste incineration, US EPA promulgated emission limits for incinerators that were not based on protecting health but rather based on the capabilities of pollution control technologies available at that time. Hence, we now have dioxin emission limits in the US that are 4.6 to 18 times less stringent than those used in Europe or even in developing countries. Today, we know that people living near incinerators have a higher risk of lung, stomach, colorectal, laryngeal and other cancers; a higher risk of birth defects; a higher risk of heart disease; or that workers and residents living near incinerators have higher levels of mercury, lead, cadmium, dioxins, furans, and other toxic substances in their bodies. Today we know that incinerators are a major source of dioxins and mercury in the global environment.

My concern is that we may repeat the same mistake with some of the conversion technologies being proposed—promoting the deployment across the state of technologies that operate above life temperatures even though little is known about their overall emissions under real-world conditions nor about their long-term environmental and public health impacts.

The proposed definitions in the draft Conversion Technology (CT) regulations describe CT as noncombustion processing of materials which produces, among others, electricity. In practice, however, many proposals for electric generation involve the combustion of the resulting product gas and therefore, the emission of combustion byproducts as pollutants. Pyrolysis is defined as a CT in which solid waste is degraded in the absence of oxygen. In practice, oxygen will always be present in any residual air in the feed material as well as in the chemical composition of the solid waste itself. In gasification, amounts of air or oxygen are added. In any case, some combustion will be involved and hence, there will be combustion products. For this reason, the European Union defines pyrolysis, gasification and plasma systems as incinerators.

What are the potential types of products produced? The products depend on the composition of the waste, the temperatures, and reaction times, among others. The fast pyrolysis of wood, for example, results in significant concentrations of toxic substances such as formic acid, formaldehyde, phenol, furans, methanol, etc. as well as lower concentrations of such carcinogens as benzene and benzo[a]pyrene.

Can chlorinated dioxins and furans be produced during pyrolysis or gasification? The answer is yes. Studies in 2001 showed that considerable amounts of dioxins and furans are formed during pyrolysis, with higher amounts of furans than dioxins, in wastes that contained chlorine and copper. A study of a German gasification plant in 1997 showed that pyrolysis of household waste, while resulting in lower dioxins, generated 3 to 4 times higher furans, resulting in a net increase in the toxic equivalent. The levels were particularly high in the liquid residues.

Organic pollutants are not the only concern. Toxic metals are also released by high temperature conversion technologies, metals such as mercury and lead. Because of its physical properties, mercury is especially difficult to remove from the gas stream.

One analysis based on EPA data estimated that a gasification plant processing 100 tons per day under reduced air conditions could release into the air about 200 lbs of mercury, 100 pounds of lead, 118,000 pounds of SO₂, 115,000 pounds of NO_x and about 11,000 pounds of CO per year if emissions are uncontrolled. Therefore, like incineration, the high temperature conversion technologies could potentially release acid gases, toxic metals, particulate matter, and organic contaminants. The addition of baghouse filters, scrubbers, electrostatic precipitators and other pollution control devices would merely concentrate and transfer many of these pollutants to the filter cakes, scrubber wastewater or other environmental medium.

The solid residues could also be a problem due to the presence of toxic metals and organics. Studies of incineration, for example, show that as much as 70% of all the dioxin formed during incineration could end up in the bottom ash or slag. Depending on the design and operating conditions, the solid residues from the high-temperature conversion technologies may also contain dioxins. Unfortunately, EPA's Toxicity Characteristic Leaching Procedure or TCLP does *not* test for dioxin.

In the past, the focus has been on stack emissions but we need to look carefully at the overall releases to *all* environmental media.

Some engineering issues are also worth noting. Explosions due to leakage of combustible gases as well as accidental release of pyrolysis gas have been reported in the past. The high temperatures and presence of acid gases create problems of corrosion and degradation of refractories, which could significantly impact operating costs. In the case of plasma systems, the high temperatures and operating conditions place a limit on the life of electrodes or torches, another significant cost. A plasma system evaluated by the Department of Defense had issues with the regulation of hazardous byproducts, process control, and problems in reliability. Process control is important when the waste feed is not be homogeneous as in the case of municipal waste. Tar contamination of electric generators has also been a concern. Furthermore, I would recommend close scrutiny of the energy balance. Pyrolysis by its nature is endothermic, that is, it requires considerable input of energy for pyrolysis to take place.

In the absence of comprehensive data and analysis of *all* emissions, waste streams and residues for the presence of harmful constituents such as persistent organic pollutants and persistent toxic substances, one should employ the precautionary principle. My concern is that the limited data I have seen regarding pyrolysis, gasification and plasma systems point to serious environmental questions similar to those that were raised for years about incineration. I believe we are much wiser now about incineration. I hope we do not make the same mistakes about these high-temperature conversion technologies.