Energy-Efficient Management of Pharma Waste

By Jose Capote
and Daniel Ripes
at PEAT International

Plasma Thermal Destruction and Recovery (PTDR) technology enables 100 per cent diversion of pharmaceutical waste, eliminating the need for landfill and/or further processing and generating synthetic gas to offset energy consumption.

With more stringent waste regulations in place and potential reclassifications forthcoming, along with additional environmental and 'cradle-to-grave' pressures, the pharmaceutical industry is starting to focus on emerging technologies to assist in the management of its waste issues. One of the most promising of these technologies is plasma gasification.

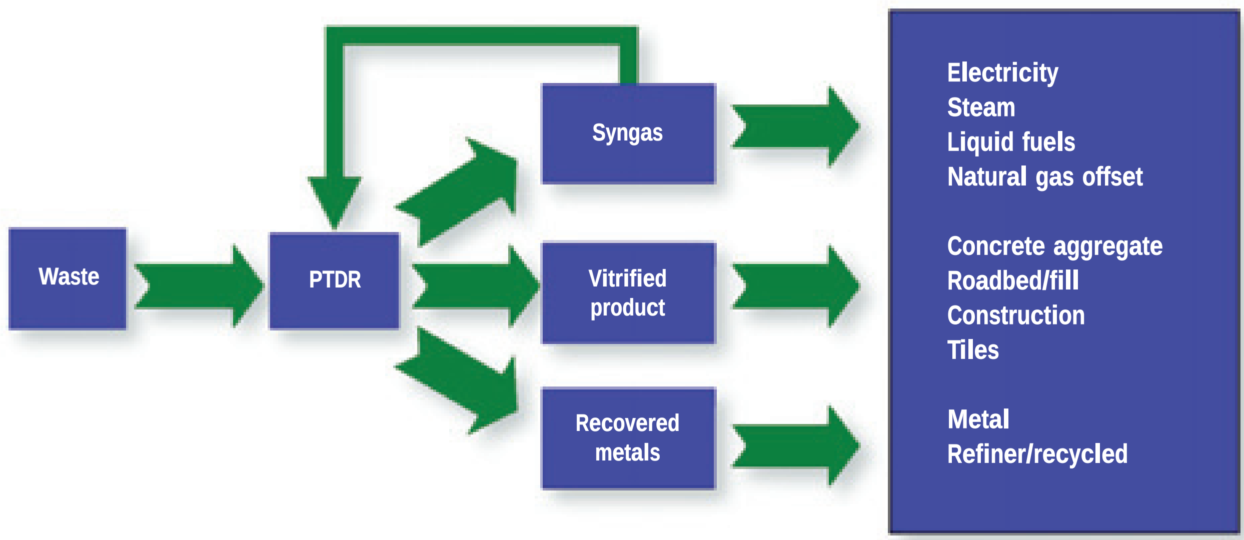
Plasma gasification uses extremely high temperatures, generated by plasma torches, to break up organic and inorganic waste streams; these are then turned into a synthetic gas (syngas) or an obsidian-like vitrified matrix that can be used in road construction as a concrete aggregate or for other commercial purposes. The syngas can be utilised to offset natural gas consumption in an existing boiler, to generate steam/electricity or to produce liquid fuels (ethanol). Metals in the feedstock are reduced in the oxygen-starved environment of the plasma reactor, and can be recovered as a mixture of metals or as alloys. All feedstock represents 100 per cent waste diversion, eliminating the need for landfills and/or further processing.

At PEAT International, we manufacture a plasma-based system called Plasma Thermal Destruction and Recovery (PTDR); the technology is offered through two system sizes suited for on-site applications – 130lbs per hour/60kg per hour (the PTDR-100) and 550lbs per hour/250kg per hour (the PTDR-500). The PTDR technology has been deployed in installations in Asia and the US and has received over ten permits and certifications from environmental agencies across the globe.

PLASMA THERMAL DESTRUCTION AND RECOVERY

The patented PTDR technology uses heat generated by plasma torches in an oxygen-starved, reducing environment to first pull apart (dissociate) the

Figure 1: Waste processing using PTDR technology



molecules that make up the organic portions of the waste; then – depending on the composition of the waste stream – a controlled (stoichiometric) amount of oxidant (either pure oxygen or steam) is added to reform the dissociated elements of the waste into the syngas, consisting mainly of carbon monoxide (CO) and hydrogen (H2) (see Figure 1).

When waste is heated to a very high temperature in the controlled atmosphere of the reducing plasma reactor, it undergoes predictable physical and chemical changes. This high temperature, over 1,000°C (1,800°F) prevents the formation of complex organic molecules and breaks down organics into a gas. These primary molecules are stable above 965°C (1,770°F). The formation of dioxins or furans is practically eliminated inside the plasma reactor due to its process features, including high uniform temperatures and a lack of excess oxygen within the system.

This hot gas is then fed through a gas cleaning and conditioning system. (The gas that comes out of a plasma reactor has a trace of particulates, usually in the form of unreacted carbon particles, compared with huge quantities in an incinerator.) Here it is rapidly cooled and cleaned to remove any entrained particulate and/or acid gases prior to potential re-use.

Any inorganic constituents of the waste are melted (vitrified) into an environmentally safe, leach resistant glass matrix at the bottom of the basin within the PTDR plasma reactor. The glass and metal layers are removed through controllable tap ports into a glass maxtrix/metal collection system. The taps are connected to the slag handling system to allow automated removal of the glass maxtrix upon operator command. Removal of the molten glass requires no special tools and does not disrupt the operating process. The metal layer – below the molten glass – is tapped as necessary, depending on the metal content of the waste stream.

PTDR systems are driven by proprietary, state-of-the-art instrumentation and computerised control systems.

VALUABLE END PRODUCTS GENERATED

The syngas has approximately one-third to one-quarter of the heat value of natural gas and can be utilised as a substitute for fossil fuels (natural gas) in boiler systems, an input for liquid fuel/steam generation or utilised directly in gas engines to generate electricity. As the cost of natural gas fluctuates, the economic benefits associated with the use of waste-generated syngas become more valuable.

At one PTDR-100 system being installed in the western part of the US, we are integrating a gas engine designed to operate on the syngas. Based on this successful deployment, we intend to offer future commercial PTDR-100 systems with the option of utilising an integrated 50-kWe engine. The integration of such a feature would provide approximately two-thirds of the electricity for the system when processing pharmaceutical waste. It is worth noting that some utility consumption rates – including electricity – vary depending on the waste feedstock being processed. Also, PTDR systems generally result in a net reduction of greenhouse gases, and thus carbon credits may also be generated.

For PTDR-500 systems, our current projects have called for the syngas to be utilised in a number of different ways: to generate steam or to offset the use of fossil fuels in an existing boiler, as well as the production of electric power. We are in the process of undertaking the development work to integrate a larger gas engine (around 250kWe) to directly generate electricity in a similar fashion to the PTDR-100 system.

With PTDR-500 systems, the syngas can also be used as a fuel source in a simple steam-cycle configuration (using the syngas in a conventional boiler/steam generator and then using the steam in a conventional steam turbine to produce electric power). The electric power produced (approximately 210KWe from a steam cycle or approximately 250KWe from a gas engine) would offset the system's electricity consumption (approximately 180KWe), thereby generating excess power that would be available for sale.

The vitrified product can be used in a variety of commercial applications including concrete aggregate,

Figure 2: Financial overview of the PDTR-100 and -500 systems

* US market assumed; however, this could be reduced in other countries as labour and electricity rates fluctuate according to market. Also includes offset of natural gas at $7 per MMBTU
** Assumes pharmaceutical-based waste stream

System	Average capacity	Application	Sales price range	O&M cost	Number of base operators required	Syngas generation (BTU/hr) **	Estimated payback period
PTDR-100	60kg (130lbs)/hr	On-site	US$600-700,000	US$0.58/kg ($0.20/lb)	1	1,250,000	Less than two years
PTDR-500	350kg (770lbs)/hrUS	On-site centralised	$3.0-3.2 million	US$0.30/kg ($0.14/lb)	2	4,500,000	Less than one year

Figure 3: PTDR-100 system commissioned to process a wide range of solid waste streams, including medical waste, industrial process waste (organic and inorganic) and pharmaceutical industry waste

insulation and roadbed construction. The metal layer can contain relatively pure amounts of iron, copper and aluminium.

The composition of end products varies on the basis of waste composition. Processing pharmaceutical waste, with high percentages of carbon, produces meaningful levels of syngas, and lesser amounts of the vitrified matrix. Conversely, processing e-wastes or light bulbs produces lower amounts of syngas and relatively more vitrified product and recovered metal alloys.

Economics and Operations

With regard to operations and variable costs, PTDR-100 or -500 systems require labour, electricity, water, caustic for the gas cleaning and conditioning system, and plasma electrodes. The wastewater discharge – less than three per cent salt – is safe enough to release into any local sewer.

The automated process control system allows PTDR systems to be operated by a single trained operator. One auxiliary employee (two for the PTDR-500) may be required to assist with materials handling (waste receiving/feeding and end-product collection).

The two dominant waste treatment solutions – incineration and landfill – continue to fall out of favour with regulators and the general public for a myriad of reasons: pollution, advancing regulations, minimal recycling, and so on. However, as climate change challenges increase and waste continues to be generated, alternative solutions are gaining traction.

Ultimately the commercial success of the PTDR technology lies in its ability to generate a favourable net-present value based on existing market prices, industry dynamics and metrics. Using a conservative price point for pharmaceutical waste at $0.50 per pound, important financial benefits can be seen. Both PTDR systems have the ability to process feedstock on a continuous basis, feeding 21 hours a day with three hours reserved for maintenance and inorganic vitrification/pre-heating. Using 340 days per year, this indicates 8,165 operational hours per year. The chart in Figure 2 provides a financial overview

PTDR 100 and 500 systems are provided on a turnkey/joint-venture basis and are sized to accommodate large industrial manufacturing facilities to mid-size regional hospitals.

NEW CHALLENGES REQUIRE INNOVATIVE SOLUTIONS

The two dominant waste treatment solutions – incineration and landfill – continue to fall out of favour with regulators and the general public for a myriad of reasons: pollution, advancing regulations, minimal recycling, and so on. However, as climate change challenges increase and waste continues to be generated, alternative solutions are gaining traction.

With stringent regulations in place and new ones always being introduced, waste industries throughout the world are focused on newer technologies that improve the process of managing pharmaceutical waste. In addition to being environmentally friendly, PTDR systems can process inorganic and organic feedstocks together, thus minimising or even eliminating any pre-processing or staging costs. Further, wastes with little or no calorific value can be effectively treated.

Finally, unlike incineration or metal-bearing waste stabilisation, the PTDR process does not create any secondary solid wastes that would require further treatment or landfilling. For example, incinerators produce large quantities of bottom and fly ash that are toxic in nature and require further treatment (with stabilisation agents); the resulting post-treated materials (whose volume may have increased significantly) will also require final disposal, sometimes in specially designed hazardous waste landfills. With a PTDR system, all feedstock represents 100 per cent waste

Figure 4: Plasma torch in operation

diversion, which eliminates the need for landfill disposal and/or further processing.

INSTALLATIONS AND GOVERNMENT APPROVALS

One research and development facility and four proof-of-concept facilities have been constructed to date. An R&D facility in Huntsville, Alabama, built in the 1990s and operated until 2003, successfully completed numerous campaigns on a wide range of waste streams, including hazardous/toxic, medical and infectious, and military. As to the proof-of-concept facilities, in 2000 PEAT Inc (the predecessor to PEAT International, Inc) constructed a 350kg/hour (770lbs/hour) facility in Lorton, Virginia, for use by the US Army to treat agriculture blast media and regulated medical waste.

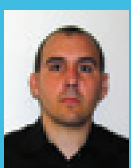
At the National Cheng Kung University in Taiwan, we completed the construction of a 200 kg/hour (440 lbs/hr) system to process incinerator fly ash, medical and hazardous waste in January 2005. In early 2007, we finished work on a 20kg/hr (45lbs/hr) system at Fooyin University (Southern Taiwan), that has applications for mobile system deployment. In February 2008, we commissioned a PTDR-100 system to process a wide range of solid waste streams, including medical waste, industrial process waste (organic and inorganic) and pharmaceutical industry waste (see Figure 3).

At present, we are installing our first PTDR-100 in the US; this is scheduled to be operating early in the second quarter of 2009. The PTDR technology has already received numerous approvals from regulatory authorities throughout the globe, including:

- Taiwanese Environmental Protection Agency
- Taiwan Ministry of Education
- Kaohsiung Department of Environmental Protection
- Virginia Department of Environmental Quality
- Alabama Department of Environmental Management
- City of Huntsville Natural Resources Division
- San Diego Air Pollution Control District
- Indiana Department of Environmental Management
- Michigan Department of Environmental Quality
- California Department of Public Health

Waste treatment and alternative energy generation are two of the most difficult challenges facing many industries today. An ever-increasing global output, coupled with the rapid industrialisation seen in many developing countries, is forcing the world to not only rethink how it handles waste, but how it views waste as a resource. Plasma gasification – and specifically the PTDR technology – allows companies to do just that.

Jose Capote is Chief Technical Officer PEAT International. He has over 20 years' experience in engineering, project development and project management, in the environmental, nuclear and conventional energy, and industrial sectors. As senior executive with several US companies, Jose was involved in a wide range of energy, environmental, waste management and energy projects. In his varied assignments, he was responsible for projects involving 'Superfund 'clean-ups, facility de-commissioning and re-industrialisations, and waste-to-energy and conventional energy production projects. Jose graduated from Columbia University (New York, NY) with a degree in Nuclear Engineering. Email: ???



Daniel Ripes is Corporate Finance and Business Development Manager at PEAT International. Prior to joining PEAT, was the Corporate Communications Manager for CGI International, where his responsibilities included the coordination of all corporate communication aspects for a pre-IPO/public company. Daniel holds a Bachelors of Arts Degree in Communications from the University of Illinois Urbana-Champaign, and is a Masters of Business Administration Candidate at the University of Illinois-Chicago, Liautaud School of Business. Email: ???