POULTRY WASTE GASIFICATION

IMPACTS ON THE ENVIRONMENT AND PUBLIC HEALTH

A TECHNICAL REPORT PUBLISHED BY

The Blue Ridge Environmental Defense League

Preface

WASTE GASIFICATION: Impacts on the Environment and Public Health was first published by the Blue Ridge Environmental Defense League in 2002 and updated in 2009. In the same fashion, the purpose of this special report—*Poultry Waste Gasification*—is to inform community leaders, government officials and public policy makers about the environmental and health impacts of the thermal destruction specific to poultry waste products. The report is intended for both the technical reader and the layperson. The investigation and documentation presented utilize generally available sources and techniques. The data and analyses are current as of the cover date. Revisions will continue to be done as necessary. Readers who note inactive or changed websites are encouraged to contact us.

Mission Statement

The Blue Ridge Environmental Defense League is a regional, community-based non-profit environmental organization whose founding principles are earth stewardship, environmental democracy, social justice, and community empowerment. BREDL encourages government agencies and citizens to take responsibility for conserving and protecting our natural resources. BREDL advocates grassroots involvement to empower whole communities in environmental issues. BREDL also functions as a "watchdog" of the environment, monitoring issues and holding government officials accountable for their actions.

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Overview: Pyrolysis and Thermal Gasification of Poultry Waste

Gasification and pyrolysis are similar processes; both decompose organic materials by exposing them to high temperatures. Both processes limit the amount of oxygen present during decomposition; gasification allows a small amount of oxygen, pyrolysis allows none. In other words, gasification and pyrolysis limit or prevent oxidation. In this report we use the term "gasification" to include both starved air gasification and pyrolysis. Plasma arc gasification uses electrically generated plasma torches to converting organic material into gas and byproducts.

In the presence of air, heat causes organic materials to burn. Burning or oxidation is what typical incinerators do. The burning of waste in incinerators causes well-known negative environmental and public health effects. Incinerators emit nitrogen oxides, sulfur dioxide, particulate matter, carbon monoxide, carbon dioxide, acid gases, heavy metals and organic pollutants into the atmosphere.

Gasification facilities produce a synthetic gas—primarily carbon monoxide and hydrogen (85%)—plus hydrocarbon oils, char and ash. Poultry gasification plants' air emissions would also include nitrogen oxides, sulfur dioxide, particulate matter, carbon monoxide, carbon dioxide, hydrogen chloride, ammonia, arsenic, dioxins and furans.

Poultry manure gasification facilities would share the same environmental problems associated with incinerators and others including:

- Air pollution
- Water pollution
- Disposal of ash and other by-products
- Consumption of water for cooling purposes
- Health, safety, and odor impacts
- Diversion of organic fertilizer

The ash which remains after gasification, 8% to 15% of the original volume, presents special problems. It is a poor fertilizer because most of the nitrogen is burned off as nitrogen oxides. Because of its low pH, leaching of toxic metals such as arsenic occurs more rapidly, resulting in contaminated groundwater.

The economics of gas transport require power generation units burning the gas to locate at or near gasification facilities; multiple smoke stacks in an area bring larger air pollution problems.

The Gasification Process

Gasification is a process that chemically and physically changes biomass through the addition of heat in an oxygen-starved environment. The end products of gasification include solids, ash and slag, liquids and synthesis gas, or syngas. The gas has a calorific value, or potential heat content, equivalent to 25% that of natural gas if ambient air is used or 40% if oxygen-enriched air is used.[1] See Figure 1 on page 4.

An industry trade association monograph describes the starved air combustion process as follows: [2]

> This type of incineration consists of two chambers: the primary is operated at below the stochiometric air requirement and the second operated under excess air conditions. The waste is fed into the primary chamber and semi-pyrolysed, releasing moisture and volatile components. The heat is provided by the controlled combustion of fixed carbon within the waste. The syngas that is driven off contains a high calorific value and can act as a feedstock for the secondary chamber. Importantly, combustion air is then added to the syngas making it highly combustible and prone to self-ignition. The secondary chamber is equipped with a conventional burner to maintain operating temperature at all times. The combined gases are combusted in the secondary chamber.

The industry monograph describes pyrolysis as a similar process but with no oxygen present in the first combustion chamber: "Materials are heated in the absence of Oxygen to about 800^{o}C. Hydrocarbons are converted to simple gases leaving a residue of carbon char, inert materials and heavy metals." Plasma arc furnaces replace the fossil-fuel heat source with an electric arc.

Similarly, the gasification process at a poultry operation is described as follows:

> Gasification is a staged oxidation process. The reactions take place in a refractory lined primary gasification chamber and an oxidation/temp control chamber. Coaltec has the U.S. marketing rights for the Westwood Energy Systems, Inc. gasifiers. A WESI-36 is used at Frye Poultry. It is a two-stage system consisting of a reaction bed area including a propane start-up burner; an ash removal section and standard removal conveyor; and an oxidizer/temperature control section complete with another propane start-up burner. The propane burners are used to heat the fuel bed during initial start up and also to prevent smoking from the stack as the system is getting up to operating temperature.
>
> The target fuel is gasified into producer gas in the primary gasification chamber. It is an oxygen starved (fuel rich) chamber that promotes the production of CO, CH4 and H2 at a relatively low temperature, typically ranging from 1,000 to 1,400°F. A small amount of CO2 is created in the chamber to provide energy for the gasification process. As the amount of moisture increases in the fuel, additional CO2 has to be produced to maintain the target temperatures. This balance is accurately maintained by controlling the air/fuel ratio in the primary chamber. The resulting "producer gas" is ducted to the oxidation chamber where high temperature oxidation and combustion of the gases.[3]

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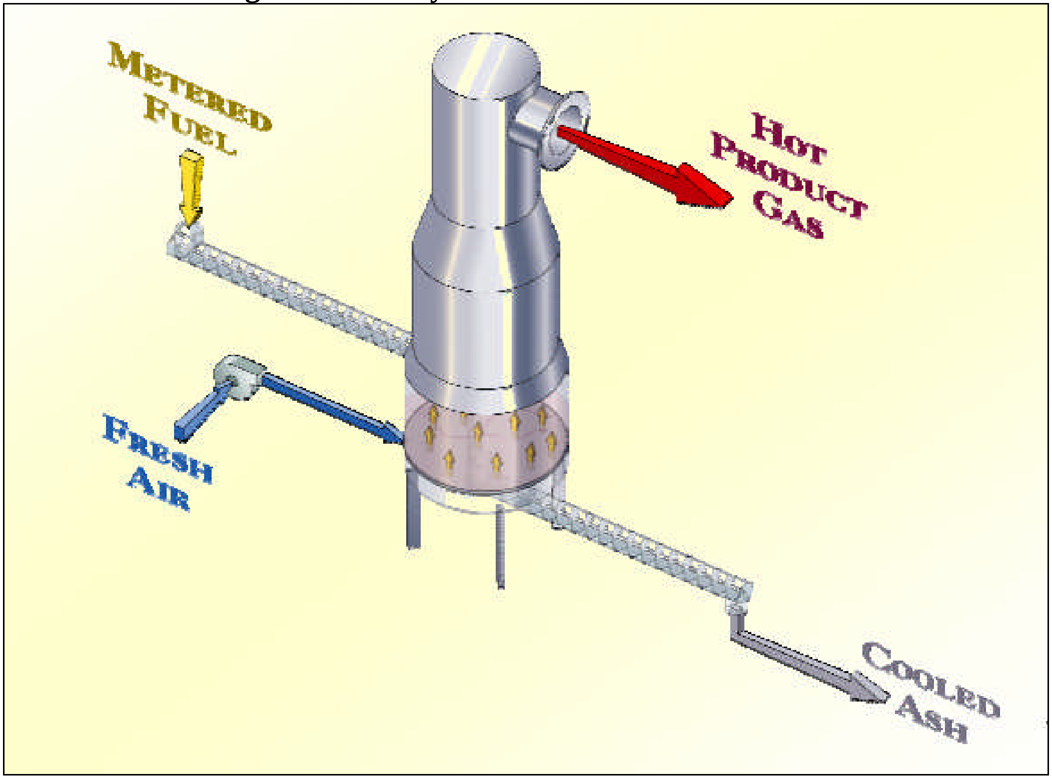
[1] "Update on Pyrolysis," monograph, Health Care Without Harm, March 19, 2002, downloaded February 3, 2009 from http://www.noharm.org/details.cfm?type=document&id=623

[2] "Methods of waste treatment," monograph, Sanitary Medical Disposal Services Association, downloaded February 3, 2009 from http://www.smdsa.com

[3] "Gasifier Closes Energy Loop at Poultry Farm," *BioCycle* September 2007, Vol. 48, No. 9, p. 51, Barbara Gaume

Figure 1. Poultry Waste Gasification Process [4]



Emission of Air Pollutants

Gasification shares many characteristics with incineration. At high temperatures used in incineration and gasification, toxic metals including arsenic, acid gases including hydrochloric and sulfuric acids, and ozone-forming nitrogen oxides are released. Also, dioxins and furans are created in the cooling process following the burning of chlorinated compounds and cellulose. These poisons are dangerous at extremely low levels and modern pollution control devices do a poor job of reducing these emissions into the atmosphere. Some including dioxin are persistent and bioaccumulative; they resist breakdown in the environment and are concentrated in the food chain.

Many gaseous chemical compounds created in the heating process are harmful to the environment when emitted to the atmosphere and to the gasification unit itself:

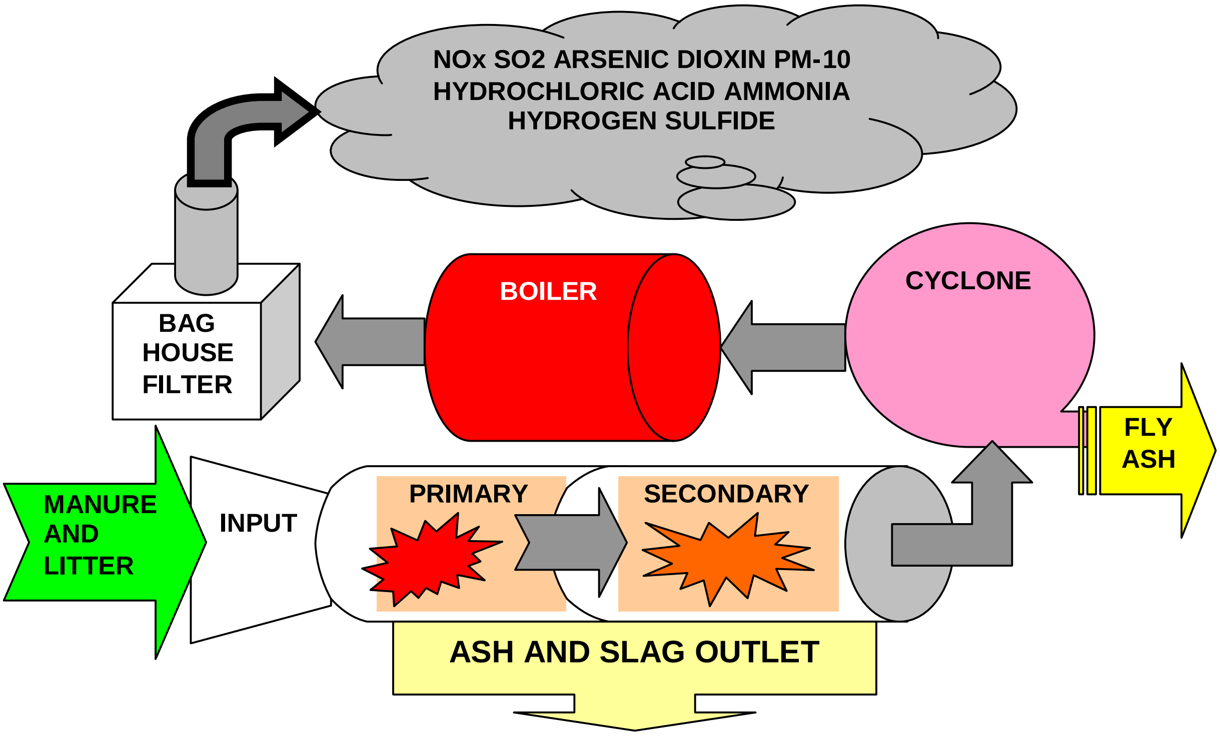
> Gasification of poultry litter will produce increased levels of inorganic nitrogen and sulfur product gases compared to wood gasification. The result is that poultry litter fuel produces certain levels of NOx, ammonia, acid gas, and hydrogen sulfide, which will

[4] "Poultry Litter to Energy: A Solution for the Watershed," Primenergy, LLC, Biomass Energy Conversion, 3172 N. Toledo, Tulsa, OK 74115 (918) 835-1011, sales@primenergy.com

> require gas treatment before combustion so that the life of an engine or furnace may be preserved and to minimize the need for downstream air pollution control equipment.[5]

Figure 2 illustrates the gasification process's twin combustion chambers, power boiler, pollution controls, and pollution by-products: bottom ash and slag, fly ash, and air emissions.

Figure 2. Poultry Waste Pollution



When vaporized, some of the chemical elements in chicken manure and litter contribute to problems when re-solidified in the gasification process:

> Some alkali metal vapors [VAM] are evolved inside a typical gasifier when utilizing poultry litter as a fuel. The presence of VAM's present a significant challenge to the design and optimization of a poultry litter gasifier because it can cause freezing of the post gasification ash and char inside the downdraft gasifier.[6]

In general, the elements of the alkali metals group include lithium, sodium, potassium and rubidium; in poultry manure from the southern states, potassium levels range from 1.69% to

[5] Reardon, J.P., Lilley, A., Browne, K., Beard, K., Wimberly, J., and Avens, J., "Demonstration of a Small Modular Biopower System Using Poultry Litter," Final Report submitted to the Department of Energy, 2001, DOE SBIR Phase-I, Final Report, http://www.osti.gov/bridge/servlets/purl/794292-6l279H/native/794292.pdf

[6] *Id*

1.85% on a dry weight basis.[7] Sodium levels in chicken litter range from 0.3–0.6%.[8]

Waste Gasification Adds Greenhouse Gases

In addition to the currently regulated air pollutants, gasification also adds greenhouse gases to the atmosphere. The biggest contributor to global warming, carbon dioxide, could soon be regulated as a pollutant by the US Environmental Protection Agency.

It is the release of carbon, carbon that has been locked up in fossil deposits for millions of years, that is driving global warming. However, carbon released into the atmosphere from burning or gasification also adds to greenhouse gas levels in the atmosphere. Over time some of this carbon is taken up again by new growth in forests, but in the short-term the damage is done.

Waste gasification adds both directly and indirectly to the build-up of greenhouse gases (GHG) in the earth's atmosphere. It is not a solution to global warming; it is instead part of the problem—a part that should be eliminated as a waste management option.

> *By destroying resources rather than conserving them, all incinerators, including mass burn, pyrolysis, plasma and gasification, cause significant and unnecessary lifecycle GHG emissions.*[9]

Conclusion

The false promise offered by gasification is that one single solution can solve all waste disposal problems. But poultry litter, similar to other waste products, cannot be dumped in a hopper and gassed out of existence.

Louis A. Zeller
Science Director June 24, 2011

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[7] Perkins HF, Parker MB, Walker ML, *Chicken Manure–its Production, Composition and Use as a Fertilizer*, University of Georgia College of Agriculture, Bulletin NS-123, December 1964

[8] "Feed From Animal Wastes-State of Knowledge," Nutrients in Livestock Wastes, Table 21, Food and Agriculture Organization of the United Nations, http://www.fao.org/DOCREP/004/X6518E/X6518E01.htm

[9] Brenda Platt and Eric Lombardi, "Stop Trashing the Climate," *BioCycle*, Vol. 49, No. 8, p. 24, August 2008