Gasification vs. Incineration

Increasingly, gasification is being used to convert municipal solid waste, or MSW, into valuable forms of energy. While this type of waste has been burned, or incinerated, for decades to create heat and electricity, the gasification process represents significant advances over incineration.

In order to understand the advantages of gasification when compared to incineration, it's important to understand the significant differences between the two processes:

Incineration literally means to render to ash.

Incineration uses MSW as a fuel, burning it with high volumes of air to form carbon dioxide and heat. In a waste-to-energy plant that uses incineration, these hot gases are used to make steam, which is then used to generate electricity.

Gasification converts MSW to a usable synthesis gas, or syngas.

It is the production of this syngas which makes gasification so different from incineration. In the gasification process, the MSW is not a fuel, but a feedstock for a high temperature chemical conversion process. In the gasifier, the MSW reacts with little or no oxygen, breaking down the feedstock into simple molecules and converting them into syngas. Instead of making just heat and electricity, as is done in a waste-to-energy plant using incineration, the syngas produced by gasification can be turned into higher valuable commercial products such as transportation fuels, chemicals, and fertilizers.

In addition, one of the concerns with incineration of MSW is the formation and reformation of toxic dioxins and furans, especially from PVC-containing plastics and other materials that form dioxins and furans when they burn. These toxins end up in exhaust steams by three pathways:

- By decomposition, as smaller parts of larger molecules,
- By "re-forming" when smaller molecules combine together; and/or
- By simply passing through the incinerator without change.

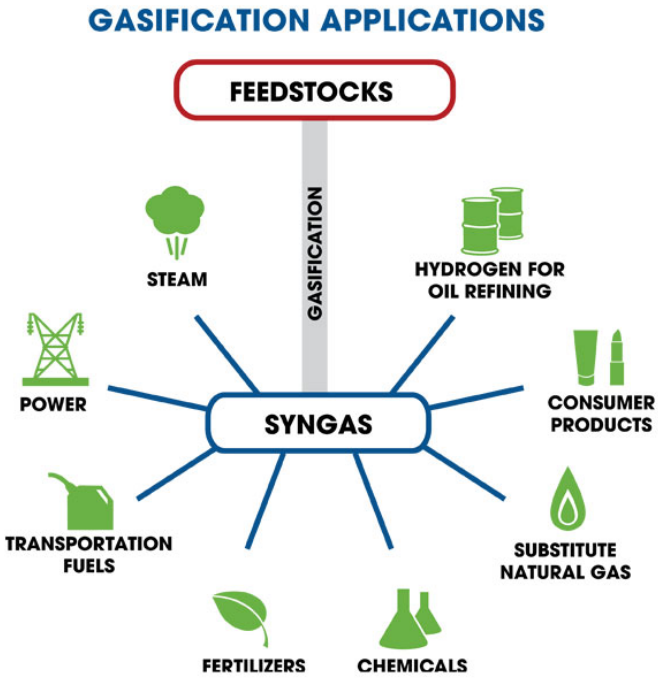
Incineration does not allow control of these processes, and all clean-up occurs after combustion.

Gasification is significantly different and cleaner than incineration:

- In the high temperature environment in gasification, larger molecules such as plastics are completely broken down into the components of syngas, which can be cleaned and processed before any further use,
- Dioxins and furans need sufficient oxygen to form or re-form, and the oxygen-deficient atmosphere in a gasifier does not provide the environment needed for dioxins and furans to form or reform,
- Dioxins need fine metal particulates in the exhaust to reform; syngas from gasification is typically cleaned of particulates before being used,

- In gasification facilities that use the syngas to produce downstream products like fuels, chemicals and fertilizers, the syngas is quickly quenched, so that there is not sufficient residence time in the temperature range where dioxins or furans could re-form; and
- When the syngas is primarily used as a fuel for making heat, it can be cleaned as necessary before combustion; this cannot occur in incineration.

The ash produced from gasification is different from what is produced from an incinerator. While incinerator ash is considered safe for use as alternative daily cover on landfills, there are concerns with its use in commercial products. In high-temperature gasification, the ash actually flows from the gasifier in a molten form, where it is quench-cooled, forming a glassy, non-leachable slag that can be used for making cement, roofing shingles, or used as an asphalt filler or for sandblasting. Some gasifiers are designed to recover melted metals in a separate stream, taking advantage of the ability of gasification technology to enhance recycling.



Combustion vs. Gasification

$C + O \rightarrow CO_2$

$C + \frac{1}{2} O_2 \rightarrow CO$

$C + CO_2 \rightarrow 2CO$

$C + H_2O \rightarrow CO + H_2$

A flame is present

Syngas is produced