Energy Answers International
Processed Refuse Fuel™ (PRF) Technology

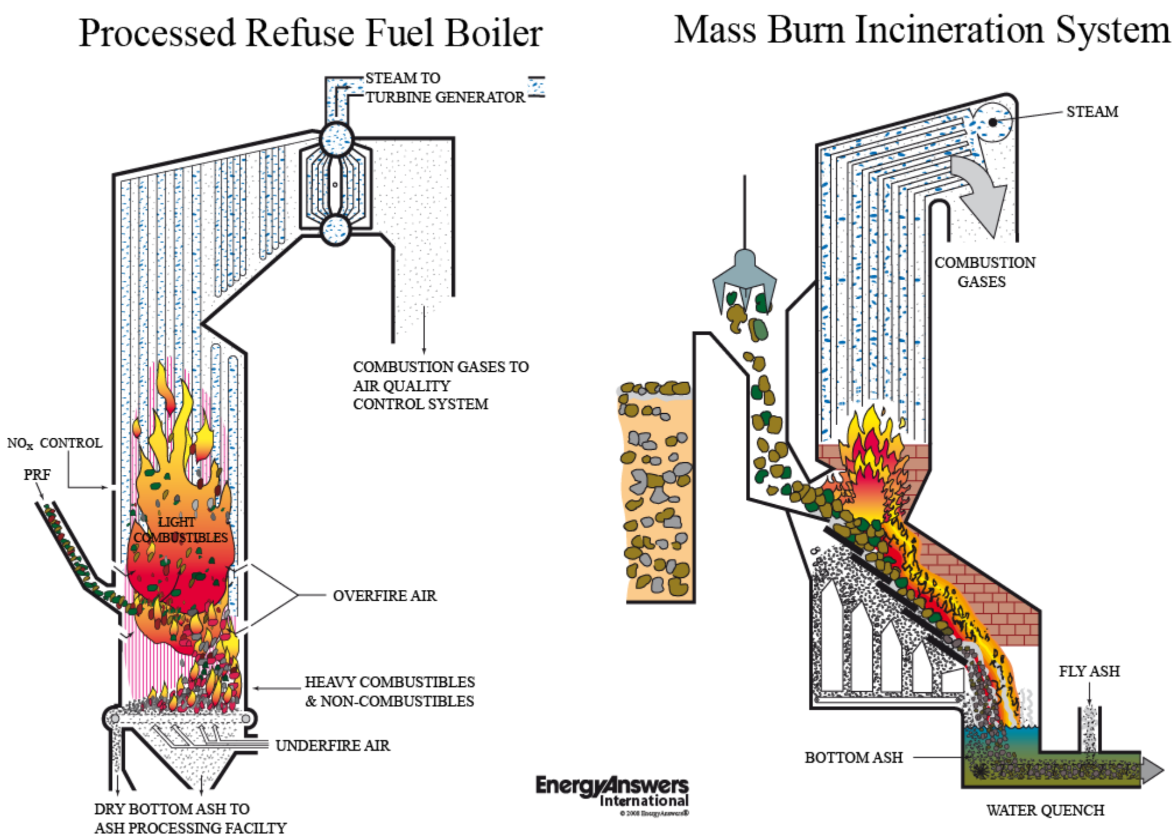
Energy Answers is in the business of developing, owning, and operating facilities that maximize the recovery of resources from waste, including energy and materials. Since its formation, Energy Answers has continually assessed the technological alternatives available for achieving this goal. The predominant technology available for recovering energy (but not materials) from waste at the time Energy Answers was making its initial formative assessment of alternatives was what is commonly referred to as mass burn incineration, the technology that still is used predominantly in waste-to-energy facilities around the world. This discussion addresses the differences between mass burn incineration and the Processed Refuse Fuel™ (PRF) technology developed by Energy Answers.

PRF is created by shredding MSW into a finer, easier to handle, and more efficiently combustible fuel. Shredding makes it possible to combust the PRF largely in suspension, which results in a high energy recovery rate and a high quality bottom ash from which valuable materials can be recovered and recycled. Mass burn incineration does not include shredding or any other form of fuel preparation.

The figure below compares PRF combustion and mass burn incineration systems. The PRF technology evolved from solid fuel steam boiler technology where the efficient generation of energy was the primary purpose and utilizes a semi-suspension combustion, spreader-stoker boiler instead of the more traditional mass burn incinerator and heat recovery boiler which is designed with the primary purpose of reducing waste volumes. As with other solid fuels (i.e., pulverized coal, sawdust, etc.), by extracting non-combustible and reducing the fuel particle size, the combustion efficiency is increased and ash quantities are decreased. Post recycling residual MSW is shredded into small particles (i.e., PRF less than 4 inches in size) ferrous metals are magnetically removed and the PRF is fed into the combustor. PRF increases the available surface area relative to raw solid waste for combustion, thereby increasing combustion efficiency and energy generation. The amount of electricity generated is indicative of the efficiency with which the system converts PRF into electrical power. The PRF technology, because of the shredding and suspension firing utilized and lower excess air required for combustion, generates significantly more steam and electricity per ton of waste than mass burn incineration.

Furthermore, the PRF suspension firing and thin bed of ash on the furnace grate assures that virtually any combustible material in the fuel will be burned. The amount of unburned materials found in the bottom ash (in the form of small unburned carbon bearing particles) is typically less than 1% of the bottom ash and ash quantities are 30% less than mass burn incineration due to the complete combustion of PRF.

In mass burn combustion, since no fuel preparation is undertaken, the waste is burned in its bulk, as-received state on a moving grate. As a result: (1) bulky waste frequently plugs the feed hoppers and ash extractors; and reduces availability; (2) waste burnout and energy recovery efficiencies are much lower; (3) since most of the heat of combustion is liberated at or near the grate, grate temperatures are high enough to melt glass and metals, making post combustion recovery of these materials very difficult and expensive; and (4) the high ash temperature and burning waste materials requires the ash to be quenched in water, further complicating and discouraging post combustion processing to remove valuable materials.



Comparison of PRF Combustion in a Spreader-Stoker Boiler and Mass Burn Incineration

With PRF technology, because most of the combustible portion of the PRF burns in suspension, less heat is liberated on the grate. Therefore, the temperature on the grate can be more carefully controlled to remain below the melting point of glass and metals, allowing all of the bottom ash to be removed from the furnace in a dry state, and to be recycled in the form of recovered metals and construction aggregate. This is a crucial difference between the PRF technology and mass burn incineration. The PRF technology is centered on efficient combustion and energy production, and the production of a recyclable ash; whereas mass burn incineration evolves from traditional incineration begun over one hundred years ago that was designed to simply reduce the volume of waste prior to landfilling.

The distinction is further evidenced by the fact that the spreader-stoker boiler used in the PRF technology has a power plant heritage. It was originally developed in the 1930s to improve the combustion of coal. Because the travelling grate in the spreader-stoker boiler is designed to have a material depth of no more than 8 to 10 inches, it cannot be used to combust raw MSW; it can only be used with a prepared, small particle size, fuel. On the other hand, the lower portion of the cross section of the mass burn incinerator shown in the figure above can be found depicted in engineering textbooks from the early 1900s, when incinerators (without heat recovery) were used simply to reduce the volume of waste. Heat recovery systems were only later added to these units when the cost of energy became higher.

From the point of view of material handling and combustion, the PRF technology has other advantages relative to mass burn incineration:

- PRF, like other solid fuels, can be easily transported on conveyors, a very reliable and low cost method of moving materials.

- Because of shredding, the characteristics of PRF are more homogenous than raw residual waste. In effect, shredding is a form of mixing that creates a fuel with more uniform moisture content and chemical characteristics. As a result, the combustion process can be more precisely controlled than with mass burn incineration, where, for instance, a load of very wet raw residual waste could be fed into the boiler followed by a very dry load. As with conventionally fueled power plants, the more precise combustion control afforded by the PRF technology provides for more uniform steam production (and electricity generation) as well as better operation of the air quality control equipment relative to mass burn incineration.

- The material which burns in mid-air is subject to an intimate mixture with the combustion air because the lighter and more volatile material in the PRF is floating in mid-air. Thus, the amount of excess air required when burning PRF is substantially less than that required for mass burn incineration. The lower excess air ratio results in smaller ducts, smaller air pollution control equipment, smaller induced draft fans and smaller stacks, and reduces the amount of hot air leaving the stack.

- Because most of the PRF burns in mid-air, the design criteria for grate size is based on a heat release of 750,000 Btu per square foot per hour. This value compares very favorably with the usual 250,000 Btu per square foot per hour used in mass burn systems. Hence, mass burn grates are three times the size of the grates in the PRF system resulting in a furnace footprint three times larger. Furthermore, because the only purpose of the grate in the PRF technology is to carry the non-combustibles and heavy combustibles while the combustibles are burned, there is no need for complicated and expensive mechanical systems used in mass burn incineration to tumble and stir the waste being burned. The PRF burning furnaces use a very simple slow-moving horizontal grate. The air blowing through the grate keeps the glass particles from melting so that the bottom ash consists of individual discreet particles, not an amalgam of slag as produced in mass burn incineration systems. This enables the easy separation of valuable materials in the bottom ash.

The efficiencies described above result in some distinct and measurable environmental and economic advantages including:

- Lower landfill disposal requirements (approaching zero disposal);
- Higher energy recovery efficiency;
- Higher quality combustion residues with low unburned carbon content (fly ash and bottom ash);
- Complete combustion and cleaner gasses going to the air pollution control system;
- Significantly higher materials recovery rates;
- Lower capital costs; and
- Lower total operating costs.

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