Combustion Technology Issues

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Europeans have designed several pellet burning appliances specifically to deal with high ash biomass fuels that also contain significant quantities of problematic elements from a corrosion and/or emissions standpoint. There has been very little effort made to address these issues by North American combustion appliance manufacturers to-date. There are currently no incentives for manufacturers to consider investing R&D in this arena. Almost all North American appliances that can successfully burn grass pellets were designed specifically to burn corn grain. With the unexpected spike in corn grain prices, and the quickly declining sales of corn burners, there is some interest in investigating alternative biomass fuels.

Burning issues

Ash is more than an issue of convenience for the user. The composition and quantity of combustion residue are the primary factors determining whether or not a feedstock can be burned effectively in a particular appliance. The range in total ash content of grasses can be very large, from less than 1% to greater than 20%. Ash values significantly higher than 10% are most likely the result of excessive surface soil contamination. Mineral composition determines the melting point of ash, and also the potential for corrosion. These are the issues of primary concern when burning grass. Melting of ash into solid clinkers makes ash management problematic, and grasses generally have a considerably lower ash melting point than wood products. Silica is the largest component of ash and is found in much higher concentrations in the leaf and inflorescence, compared to the grass stem. Silica can combine with alkali metals to form silicates that melt at lower temperatures. Of the alkali metals, potassium is by far the most abundant in grasses. It will reduce the melting temperature and also contribute significantly to corrosion potential. Chlorine is a particularly damaging component of grasses, as it catalyzes corrosion reactions, a little goes a long way. Sulfur reacts with alkali metals to form deposits on heat transfer surfaces. Reduced concentration of all the above mentioned minerals in grass is highly desirable. Development of appliances that can address these problematic elements is also highly desirable.

Do we fit the grass to the combustion appliance or vice versa?

The primary technical stumbling block to for a grass combustion industry in the USA is the lack of residential-scale appliances specifically designed to burn high ash pellet fuels. Through management and breeding, grass biomass composition can be modified to minimize corrosion and clinkering. Although grass compositional improvements are worthwhile, a more robust solution is to modify appliances to be able to burn a diversity of feedstocks. Industrial sized ceramic-lined boilers (1 million BTU or more) are currently capable of burning grasses. These units can have cyclones of multi-cyclones attached to the exhaust stream to control emissions as completely as one needs to. Some light industrial sized boilers (500,000 BTU range) may be able to burn 100% grass, but almost certainly are able to burn fuel mixtures up to 75% grass or higher. Residential scale boilers from Europe with ceramic-lined combustion chambers, electronically controlled shaker grates, and auto de-ashing are capable of burning a least up to 75% grass in a fuel mixture, and may be able to burn 100% grass depending on composition.

Mixing grass with corn, wood or other biomass fuels will expand the number of suitable appliances for grass combustion.

European design to address all issues

One example of European engineering to address problematic fuels is the Guntamatic Power-Corn System, a fully automatic system. This boiler has automatic feeding from bulk storage and automatic ash removal from the combustion chamber. It has a moving step grate in the combustion chamber with self-cleaning primary air slots. It has secondary air supply to the combustion chamber, resulting in very high efficiency (exceeding 90%). Ceramic components in the combustion chamber help control corrosion in this chamber. It has a stainless steel "reaction tube" directly above the burn chamber that theoretically ties up problematic elements such as chlorine and potassium and neutralizes their corrosion potential. It has a counter-flow (flows downward) heat exchanger with self-cleaning spirals in each tube. If we had any incentives in North America, such appliances could be designed and available here.

Will North American appliances stand up to grass pellets?

We do not know the answer to this question for long-term use. Canadians (Elf Industries) have been burning flax shive pellets in their pellet stove for over a decade, and have been burning switchgrass pellets for several years. They acknowledge some corrosion (there is some corrosion with any burning process) but they consider corrosion a "non-issue" from their standpoint. The Hardy outdoor pellet boiler we have just started testing with grass pellets is "all" stainless steel. The person who designed this boiler is not sure what the long-term corrosion issues will be with this boiler burning grass pellets. There does not appear to be much interest in the corrosion issue among North American appliance manufacturers, they may be a bit naïve on the topic.

Summary

We currently have residential appliances that are capable of burning grass pellets and effectively managing the ash residue. This is typically done by either having some type of mixing device in the burn chamber, or by periodically dumping a portion or all of the burn chamber contents. We are not certain of their long-term durability when combusting problematic fuels. With some incentives, we could develop a set of considerably more robust appliances for problematic fuels.