Experiences of refuse derived fuels preparation and handling

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During the era of the 1970's and 1980's, Detroit Stoker Company was involved in an increasing number of waste to energy projects that changed the idea of waste/refuse disposal from traditional landfilling or simple incineration processes to utilizing the continuous production of municipal solid waste (MSW) and processing it into a refuse fuel used to produce thermal energy for electrical production by steam turbine generators.

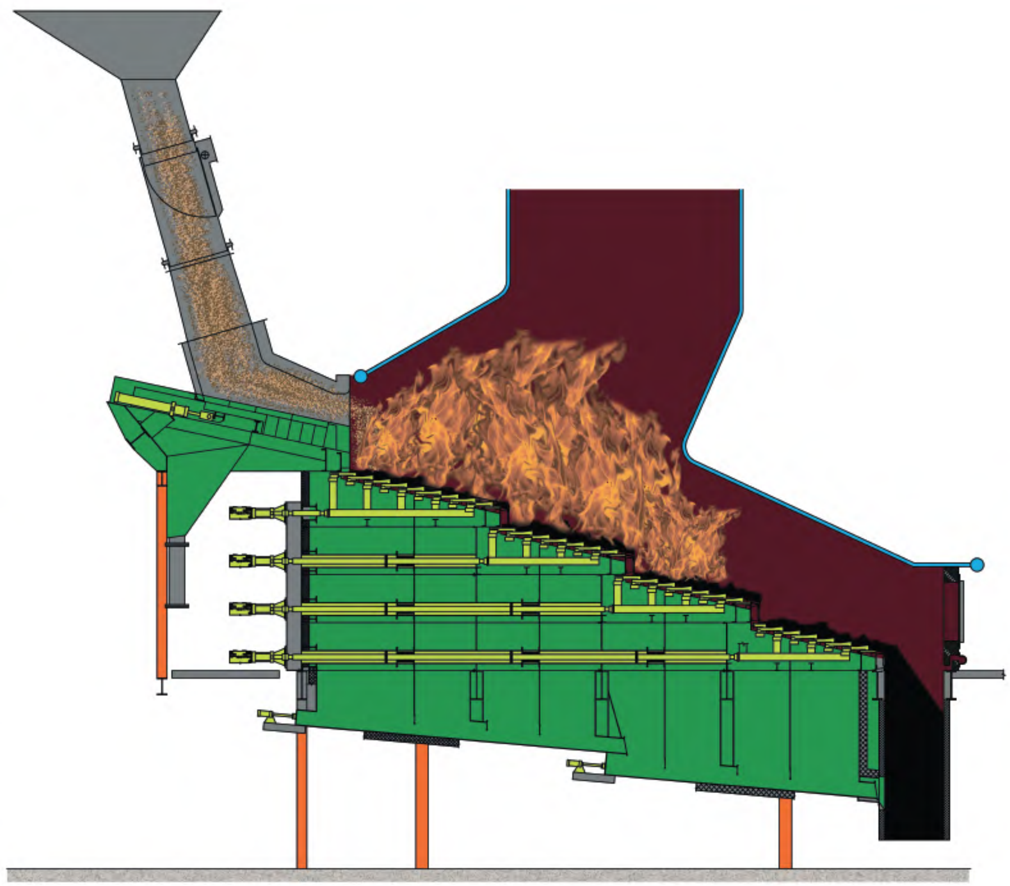

Figure 1: MSW – Mass Fired Waste to Energy Combustion System.

The resulting fuel and firing method was noted as being refuse derived fuel (RDF) and spreader fired. MSW fired facilities were also being developed with the same goal of providing useful electrical energy. The main technology for MSW combustion technology was and continues to be mass fed grate systems similar to that illustrated in Figure 1. By processing MSW into RDF, the final fuel results in lower amounts of inert material, specifically metals and lower moisture content as a result of both the processing and final RDF storage/fuel management. Lower ash and fuel moisture contents combine for an overall improvement of the fuel calorific values.

The interest in RDF firing waned in the 1990's but the number of projects utilizing construction and demolition debris (C&D) increased, specifically in Western Europe. Due to Detroit's experiences with RDF, the processing and combustion of C&D was easily addressed with established equipment selections and the environmental constraints of utilizing biomass fuels that often include small amounts of volatile metals including lead and mercury which are common difficulties. Since 2010, there is a resurgence of inquires with RDF; particularly in island nations or large municipalities worldwide.

Facilities burning MSW are mass-fired units and burn MSW just as it is received from individual homeowners and businesses with no processing or size reduction.

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The main attraction of MSW firing is that the refuse fuel can be burned without any processing, preparation or sizing. Traditional RDF fuel is prepared from MSW and processed to better obtain a more uniformly consistent fuel sizing and for reduction of metals and inert material content from MSW. Burning unprocessed fuel is the major advantage of MSW firing over RDF firing, which requires considerable fuel preparation, shredding and storage. By its nature, MSW is widely variable. A typical North American MSW fuel contains approximately 20% non-combustibles or residue, approximately 20% moisture and nominal higher heating value of 4,500 BTU/lb. (10,467 kJ/kg). Unfortunately, the ranges in these values are quite large, particular as seen in the world wide market. Non-combustible content can range from 5-30%. The moisture content can range from 5-50% and the heating value varies between 3,000 BTU/lb. (6,978 kJ/kg) to 6,500 BTU/lb (15,119 kJ/kg). These variations can be accounted for, in part, by the mixtures of residential and commercial waste and by weather conditions. A period of high rainfall can result in increased moisture content in the MSW. Also, in certain areas, spring and fall yard waste makes up almost half of the refuse being delivered to the plant and this yard waste contains up to 70% moisture. It is clear that the quantity of high moisture fuel will have a dramatic effect on the average analysis of the waste being delivered to the plant. Because of these variations, proper fuel management is essential in the storage pit to help provide a homogeneous fuel mixture.

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From the perspective of RDF, the MSW particle sizes have to be dramatically reduced in order to be suitable for non-mass fed combustion systems. For spreader type grate fired systems, reference Figure 2; the majority of the larger particles need to be less than 24" (610 mm) in the three dimensions and 54" (1372 mm) is the longest acceptable length. It is recommended to remove as much of the oversized tramp material and abrasive fines as possible. The most practical method of accomplishing this separation is by screening, utilizing either trommel or disc screens. Magnetic separation should also be utilized to eliminate ferrous metals and use of an Eddy Current Separator is recommended for removal of non-ferrous metals, specifically aluminum.

Screens can be arranged so that the first stage of screening allows the fines to pass through and all remaining material continues on to a second screening process

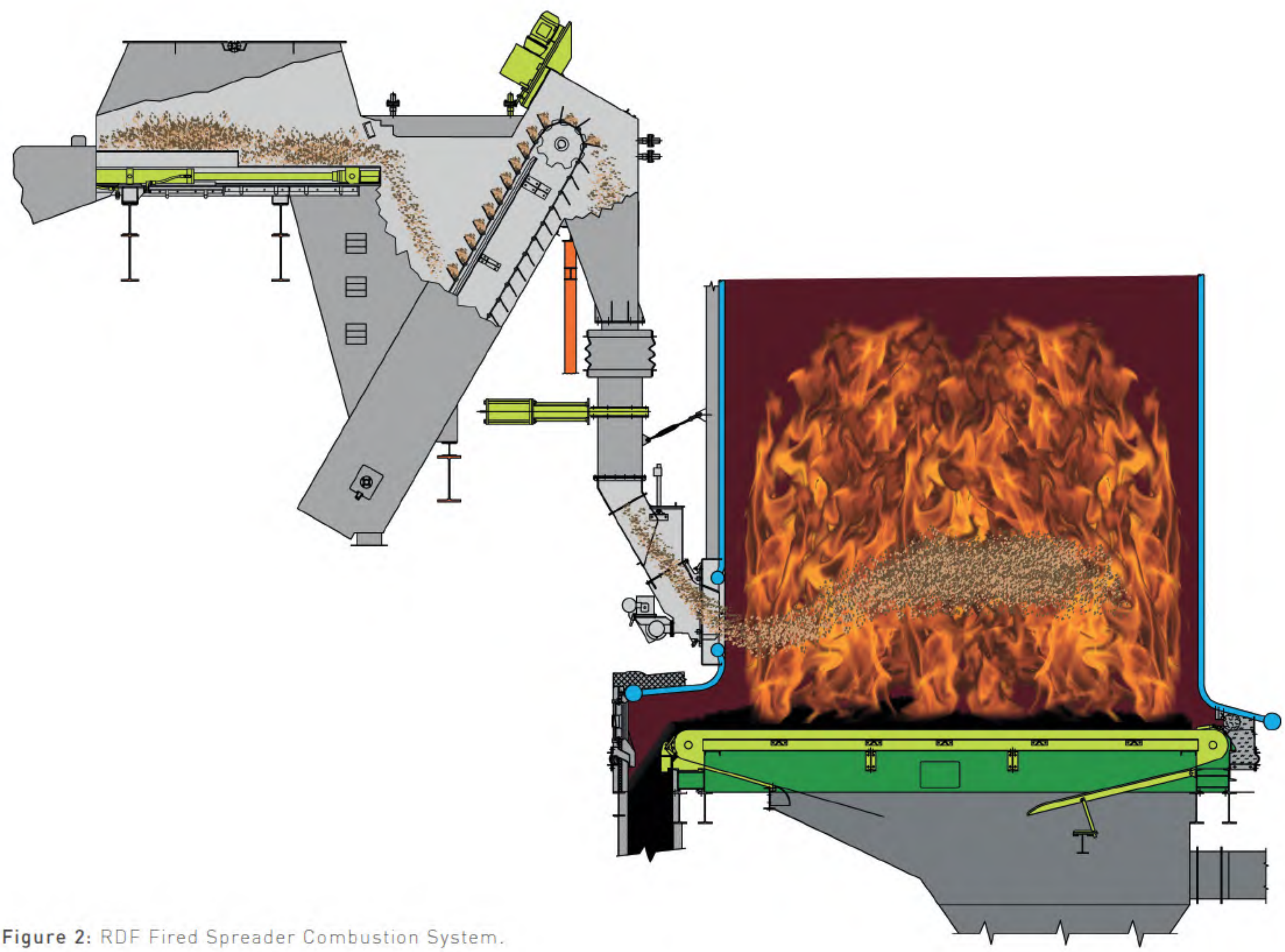

Figure 2: RDF Fired Spreader Combustion System.

arranged so that material passing through the secondary screens is considered RDF fuel and the oversized material is discharged off the end. This oversized materi can either be discarded or returne for re-shredding. Experiences demonstrate the effectiveness of screening for the elimination of fir abrasive materials. Installation of secondary disk screens resulted i removal of +55% of particle sizes ≤2.4 mm. Fuel analyses determin approximate reduction in ash content of 45-50 and the higher heating value of the RDF increase 18-22%.

Investigations and fuel analyses of RDF from installations that utilized shred¬ding but no screeni resulted in ash content reduction 5-10% due to the shredding proc producing a fine abrasive fraction from glass as well as the natural gritty, fine, non-combustibles four in municipal waste.

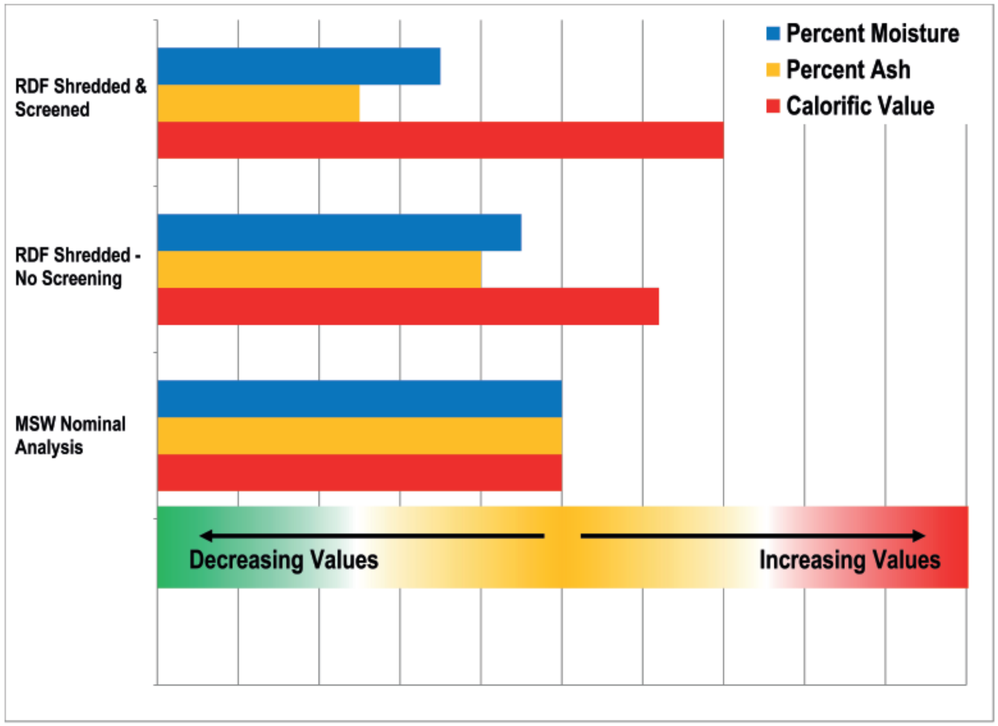

Figure 3: Comparison of MSW and RDF Fuel Constituents.

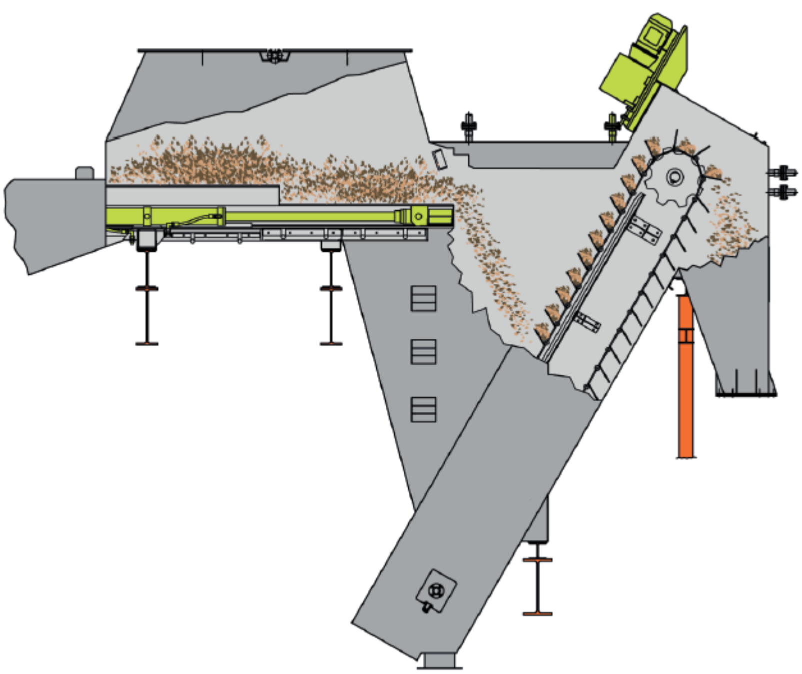

Figure 4: Detroit RDF Metering Feeder.

Because RDF fuels are often difficult to shred and trommel, Detroit designed and manufactures an RDF metering system specific for this fuel.

These analyses also indicated an improvement of higher heating values of 11-15%. Figure 3 notes a comparison of fuel quality changes from MSW, shredded RDF and shredded and screened RDF.

Final sizing requirements must satisfy the operational re¬quirements of the entire RDF material handling system and the combustion system. Maximum availability of all equipment is imperative. Materials which can cause breakdowns or high wear rates of mechanical equipment should be eliminated or in most cases have redundant fuel handling capabilities. The elimination of much of the fine, non¬combustible materials can minimize the tendency for slagging on the furnace walls and boiler heat transfer surfaces.

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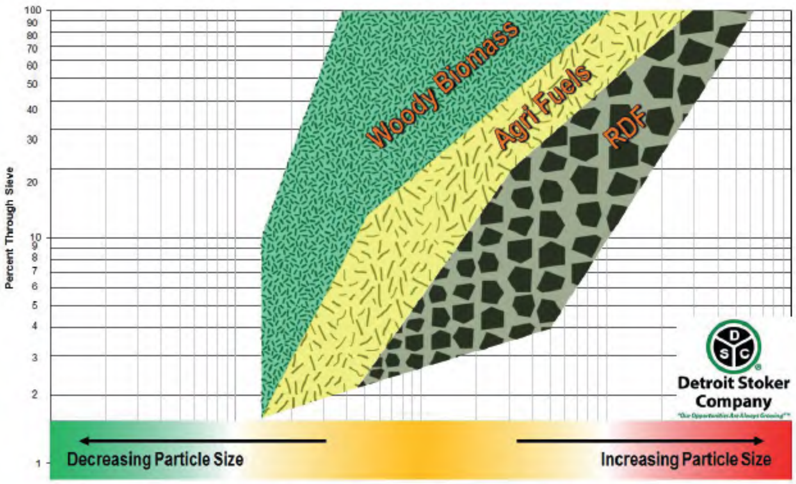

Recommended Fuel Particle Size of Distribution

Figure 5: Ranges of Recommended Fuel Distribution of Particle Sizes.

Figure 6: Biomass Capacity Metering Trials.

metering system specific for this fuel. Referencing Figure 4, the RDF metering feeder is a ram fed device using a special inclined apron conveyor to provide continuous "fluffing" of the fuel to avoid compaction experienced with screw type metering bins.

The experiences gained from the processing and combustion of RDF has proven successful in evaluating facilities now using fuel feed stocks that include traditional wood chips, bark, poultry litter, and agricultural residues such as olive and grape refuse. Outside of Europe, fuels continue to represent bagasse (refuse from cane sugar production), refuse from palm oil manufacturing and the refuse from lignin ethanol production.

Fuel particle size is an important aspect of a properly performing steam generator. Detroit's grate systems depend on a range of particle size distribution. This allows for flexibility utilizing a wider variety of fuel(s) having specific physical properties to be the fuel stock within the combustion system. Figure 5 illustrates recommended sizing ranges from RDF to traditional Hogged bark and wood chips fuels. Yet, all combustion system types have limitations to wide ranging fuel inputs.

In this regard, the proper management of fuels received and their preparation, handling, mixing and metering are an invaluable part of obtaining the performance required of an entire biomass facility. To address inquires on biomass fuels that have yet to be commercially established, Detroit continues to collect data and perform physical metering and fuel distribution testing on an annual basis as illustrated in Figure 6. Successful biomass power projects begin at fuel reception and continue through the processing, metering and combustion systems.