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Utilization of pellet fuels for industrial boilers

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For the first time in 20 years, the addition of new renewable electrical capacity will decline. The contributing factor can be most closely traced to the Covid-19 pandemic, resulting in both delay's with construction and in new development of projects. Despite this decline, global concern continues with the use of fossil-based fuels as an energy source for utility electric generators and industrial facilities. This includes the long-term acceptance of natural gas as a "clean fuel source".

Industrial facilities relating to the forest products industries have been operating on self-generated woody biomass composed of bark and chips for 80+ years. Similar to the forest products industry, the cane sugar industry has been powering their steam and power needs with bagasse for just as many years. These industries along with certain other agricultural processing facilities generate all or a portion of their renewable fuel requirements. However, those facilities having to purchase fuels have long been operating with coal, natural gas, or fuel oil as the primary fuel sources. With the exception of natural gas, users of coal and fuel oil are looking to minimize or fully remove use of these fuels. For industrial facilities this is related to fuel costs and environmental/sustainability reasons. Natural gas continues to have low costs and is forecasted to remain low for another 6-10 years. Therefore, a number of solid fuel fired



Figure 1: Coal & Biomass Briquette.

installations have or are currently performing retrofits or entirely replacing units for 100% natural gas firing. There remains however, a number of facilities that do not have access to a natural gas supply and are intent on mitigating the amount of fossil fuels utilized.

In order to facilitate these conversions, potential biomass fuels have to be reviewed in order to establish costs, availability, and suitability. Pellets/briquettes certainly offer potential to many owners, along with some unconventional fuels that were previously considered unsuitable or unsustainable.

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Detroit Pellet and Briquette Experiences

Detroit's experience with engineered fuels began in the late 1960's. It was initiated by North American coal mining companies who were looking to use finely sized coal particles combined with limestone in a pellet form. The commercial concept was to utilize a by-product that had few prospective buyers/users and add limestone to help provide a level of SO₂ reduction.

In the 1980's Detroit began to see pellets, again formed primarily from coal with biomass (Generally softwood sawdust) added to the coal at percentages of 10% by thermal

input. An example of this type of pellet is displayed in Figure 1.

In the last decade, the more prevalent pellet utilized by Detroit's grate system installations has been an engineered fuel pellet containing 60-80%Wt cellulose fiber content and the remainder composed of polymer/plastic content. Figure 2 illustrates a pellet/engineered fuel.

A number of grate fired clients are co-firing this type of pellet in combination with coal. Advantages include the pellet being made from industrial by-products, therefore a lower cost feed stock, translating to a lower cost fuel than traditional wood pellets. With the addition of the high calorific polymer/plastic portion, the calorific value better approaches that of the base coal fuels at approximately 22.36MJ/kg LHV (10,500 Btu/lb. HHV) and minimizing boiler design considerations that would historically result in de-rating of the unit.

Wood Pellet Experience

Until recently the larger industrial clients have not considered utilizing the traditional white wood pellets that



Figure 2: Engineered Pellets (courtesy of Convergen Energy).

have dominated the residential and small industry market for heating requirements. In the past 5 - 8 years, client interest with the white and/or higher calorific value black pellets is increasing. This is due to proposed

and existing facilities located on islands or remote locations that do not have the ability to generate or obtain a consistent supply of woody biomass. The primary interest is to reduce or eliminate imported coal or oil for environmental impact reasons. Secondly, these areas often have higher overall energy costs and requirements, therefore utilization of a non-fossil fuel source is better justified.

Detroit has found that inquiries related to conversion of predominantly coal fired facilities to biomass continue to increase. Wood pellets are now increasingly the fuel for consideration. As a result, Detroit began R&D activities focusing on the metering and delivery of wood pellets to the combustion system along with combustion characteristics.

Initial development was to establish baseline data utilizing mechanical feeders (distributors), primarily used for coal and some pellet applications in the past. Figure 3 illustrates a Detroit Underthrow type coal distributor.

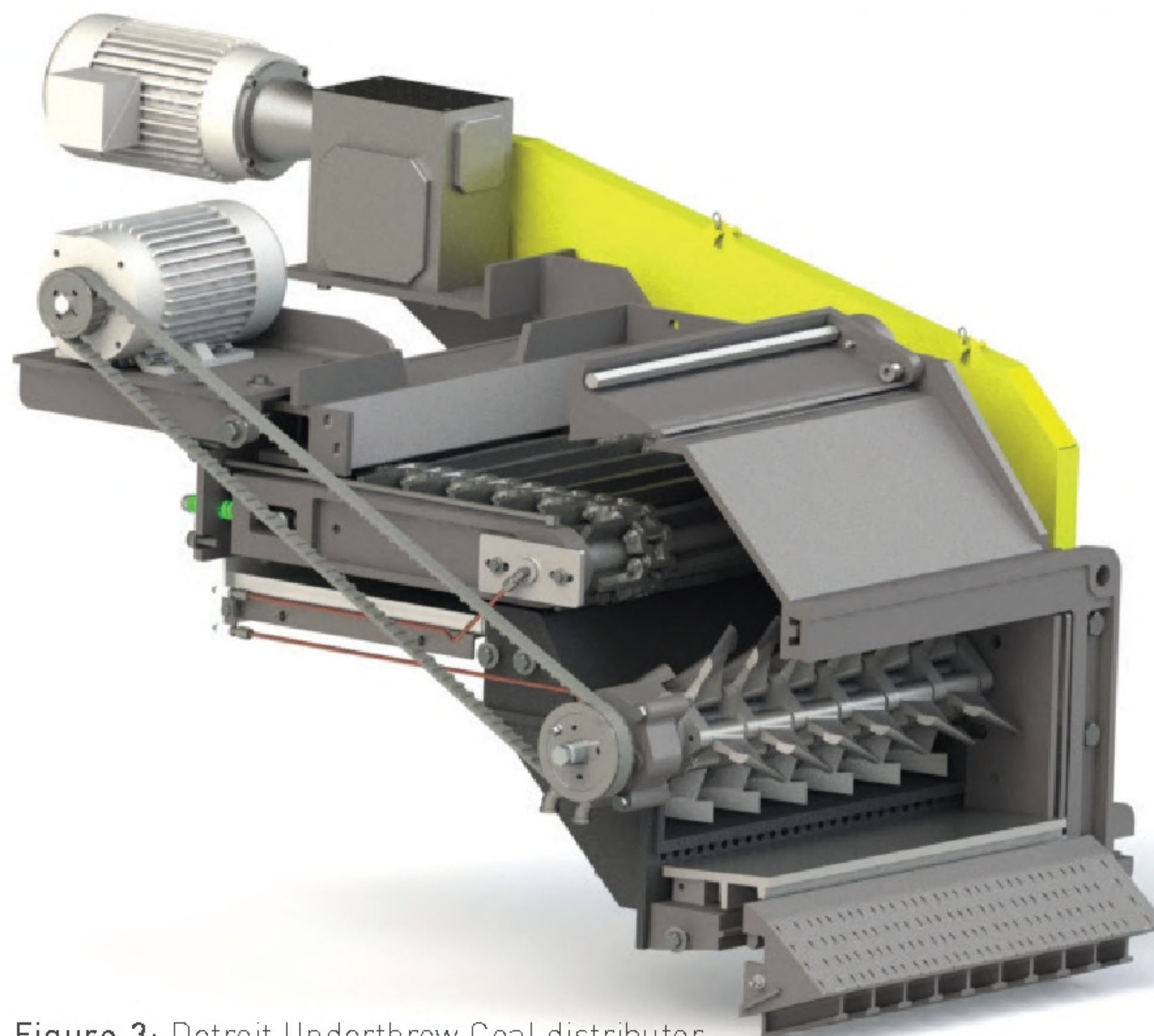


Figure 3: Detroit Underthrow Coal distributor.

Detroit has found that inquiries related to conversion of predominantly coal fired facilities to biomass continue to increase. Wood pellets are now increasingly the fuel for consideration.

Distribution testing of pellets when utilizing a mechanical distributor revealed that traditional wood pellets were nearly pulverized upon exit of the feeder. An attribute not welcomed with grate fired boilers when starting with a uniformly sized fuel on the lower end of standard sizing curves. Figure 4 illustrates the results.

Spreader type grate combustion systems depend on the solid fuels being utilized to have a specific distribution of sizing to allow for both suspension firing (finer fuel particles) and firing of fuels at or near the grate (larger fuel particles). A standard grate fired combustion system displayed in Figure 5.

Based on the characteristics of spreader type combustion, Detroit has a long history of developing recommended fuel size distribution curves to address particles sizes based on fuel type. Figures 6 and 7 illustrate recommended particle size curves for bagasse & coal; and bagasse & pellets.



Figure 4: Pellet degradation.

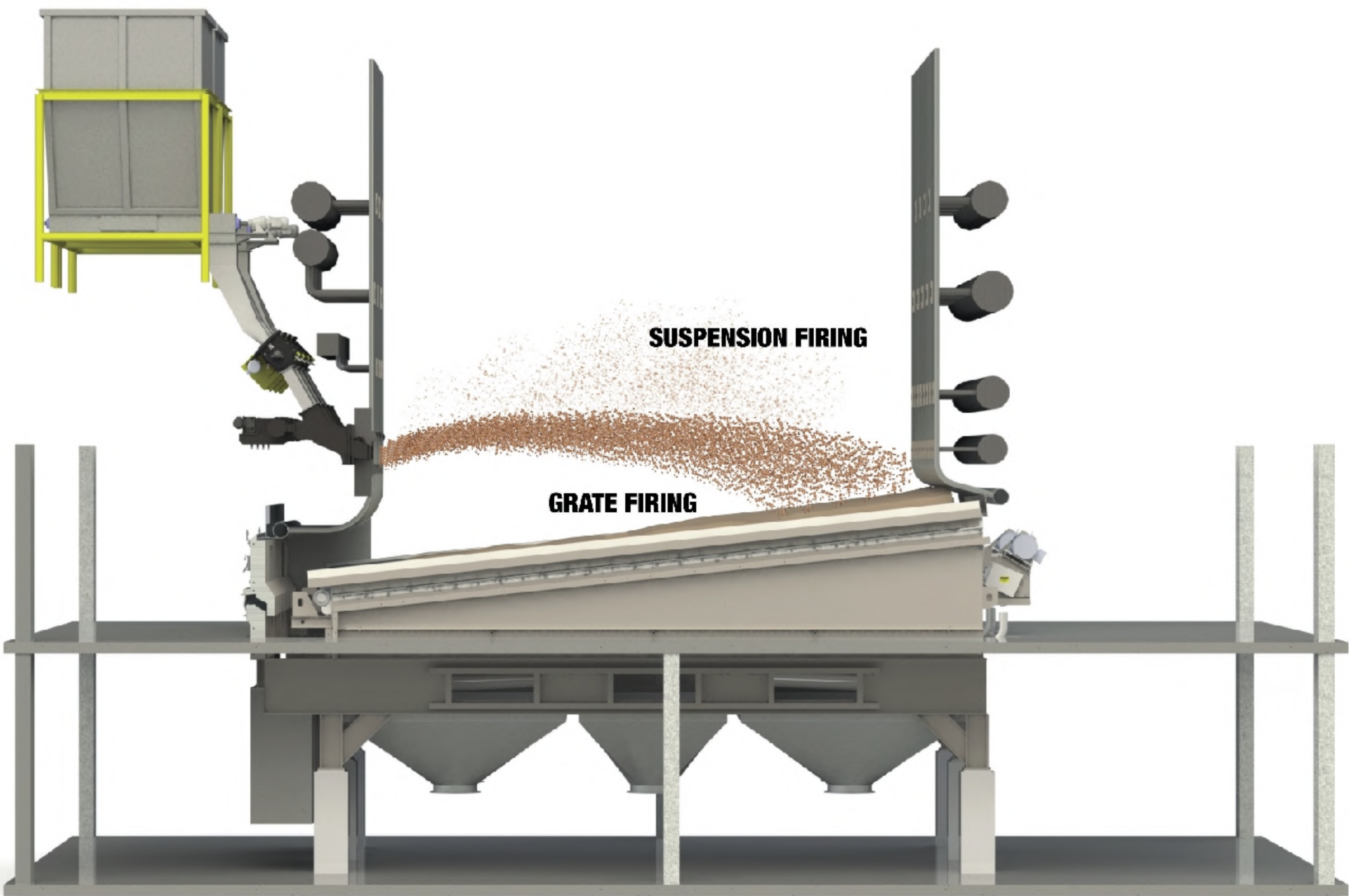


Figure 5:
Spreader
type grate
combustion
system.

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Figure 6:
Bagasse &
Coal.

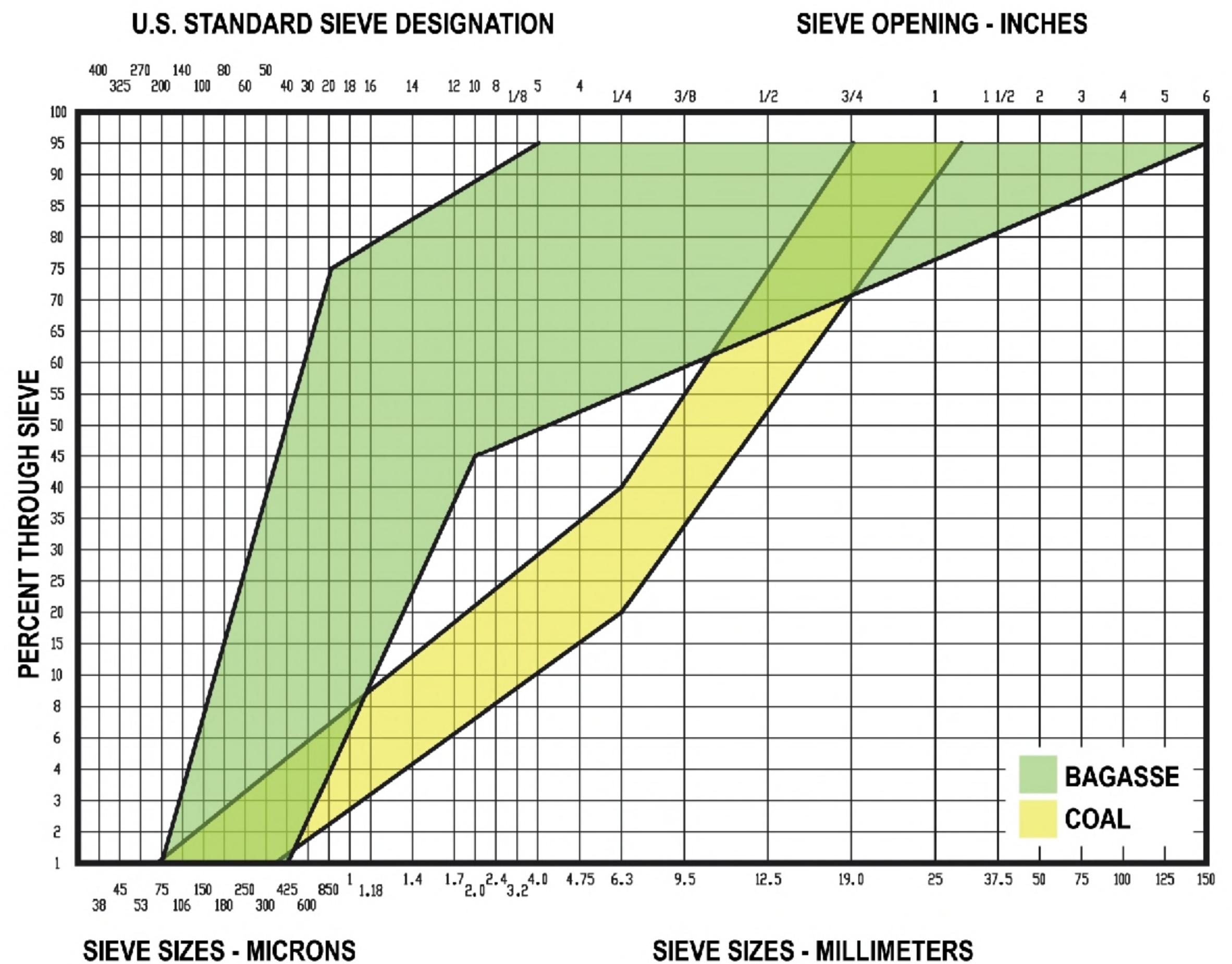
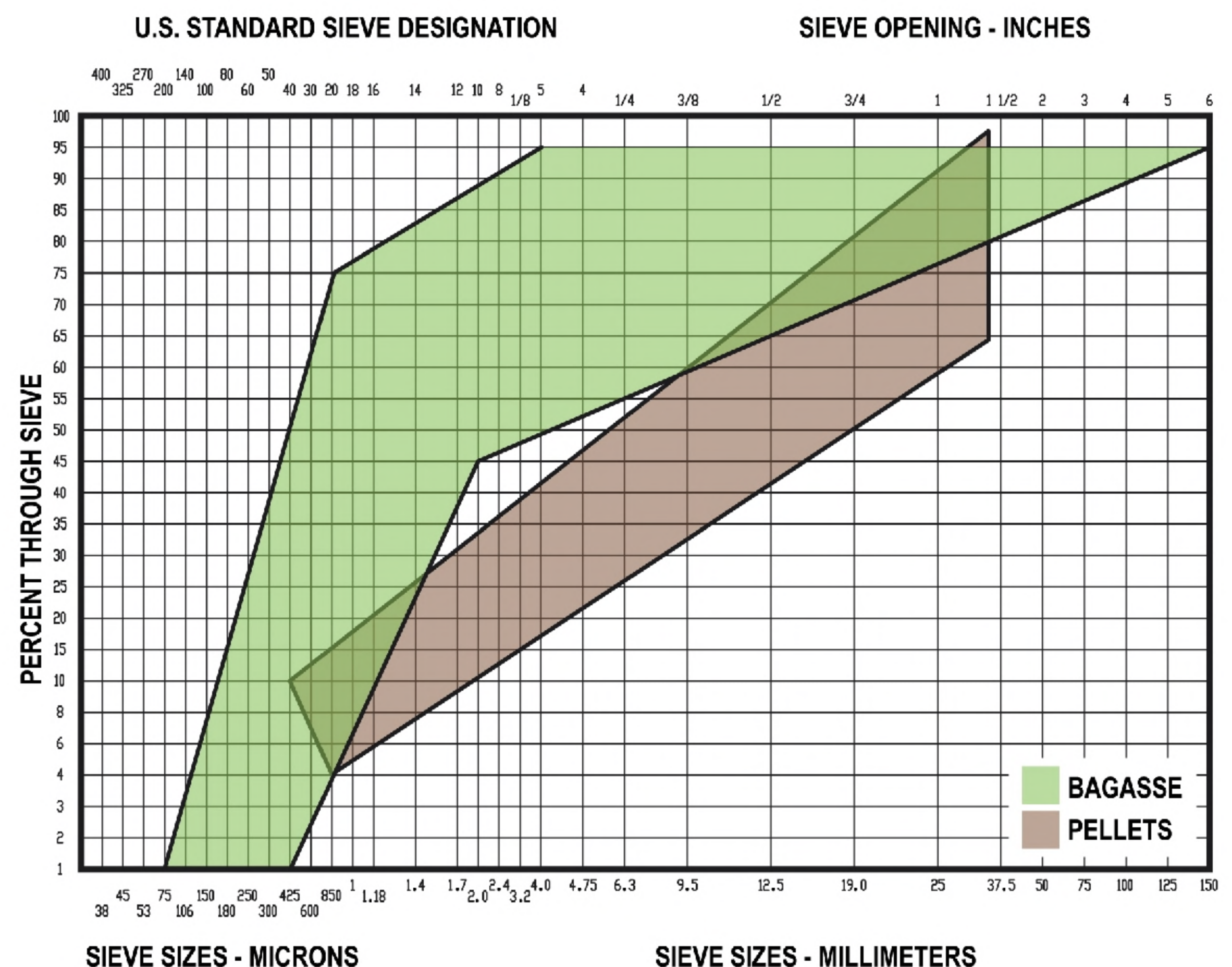


Figure 7:
Bagasse &
Pellets.



Based on the poor results of pellet metering and distribution by a mechanical distributor. Trials were performed with Detroit's air-swept distributor, traditionally used for biomass and refuse type fuels.

Pellet distribution trials utilizing an air-swept distributor produced much better results. There was little to no particle size degradation, but also the air-swept distributor had the ability to distribute pellets deeper into the furnace with the fine adjustment offered.

While performing distribution testing with the air swept distributor, it was found that a traditional, woody biomass metering screw feed system resulted in cascading of the pellets through the metering system. The uniform sizing, high bulk density, and required feed rate all determined that the flowability of wood pellets was problematic. Field observations from clients firing pellets also confirmed the difficulties in metering, particularly when considering the additional negative effects of operating the furnace with a negative draft.

Bagasse fired facilities normally use a three drum metering feeder to meter bagasse into the furnace. However, additional testing utilizing Detroit's bagasse triple drum feeder indicated similar issues noted above with a screw type bin were observed with the bagasse feeder.

Detroit has since performed hundreds of pellet metering tests with several different metering devices. The latest prototypes are based on the features of a rotary metering valve with modifications to seal the device from differential pressures, control fill capacities and mitigate the slug feeding seen with other devices. In addition, new prototypes of air-swept distributors have been developed to further improve the distribution of wood pellets. This is directly related to the pellet physical parameters and provide better control with lengthwise and widthwise distribution into a furnace.

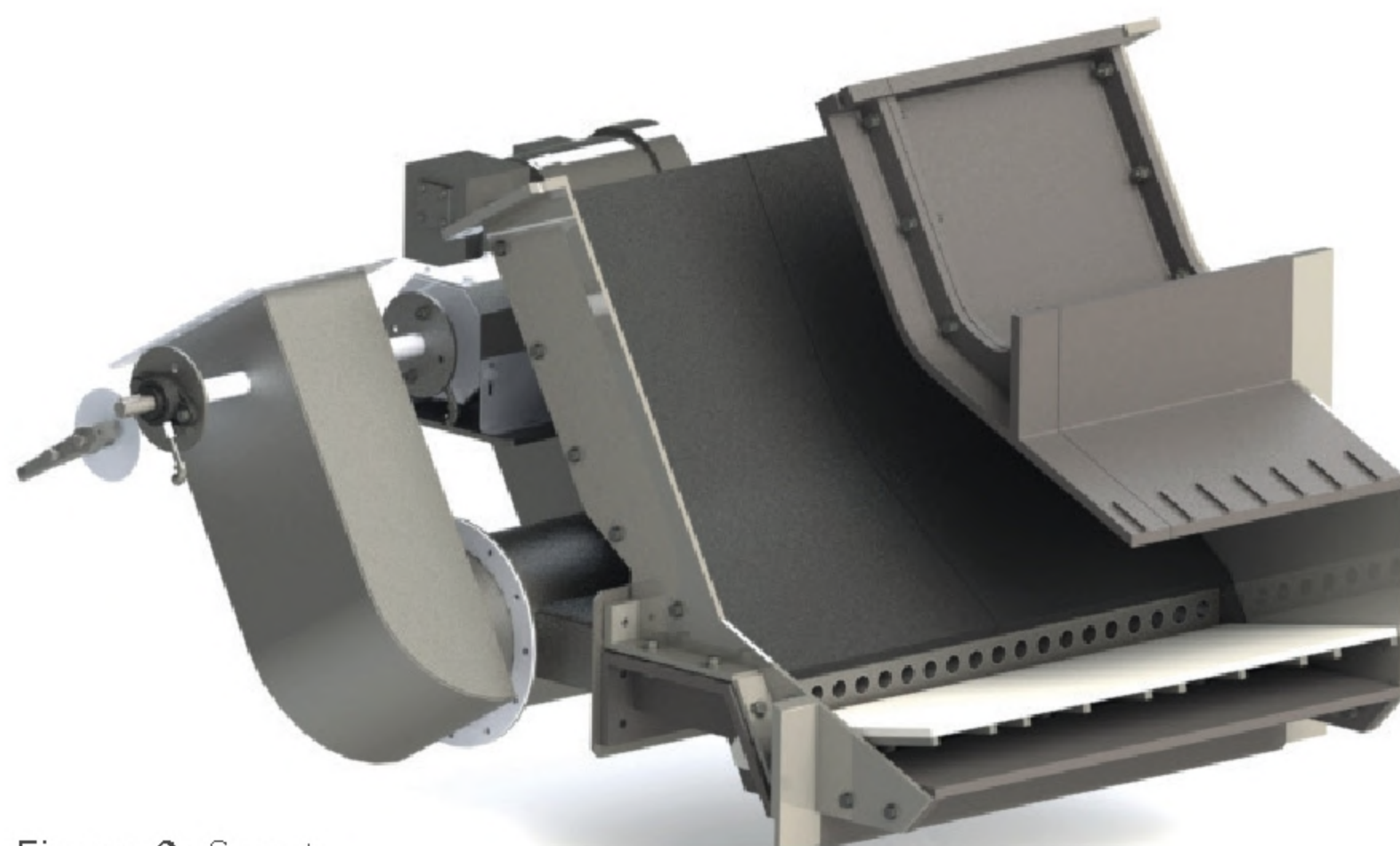


Figure 8: Spout.



Figure 9a: Twin screw.

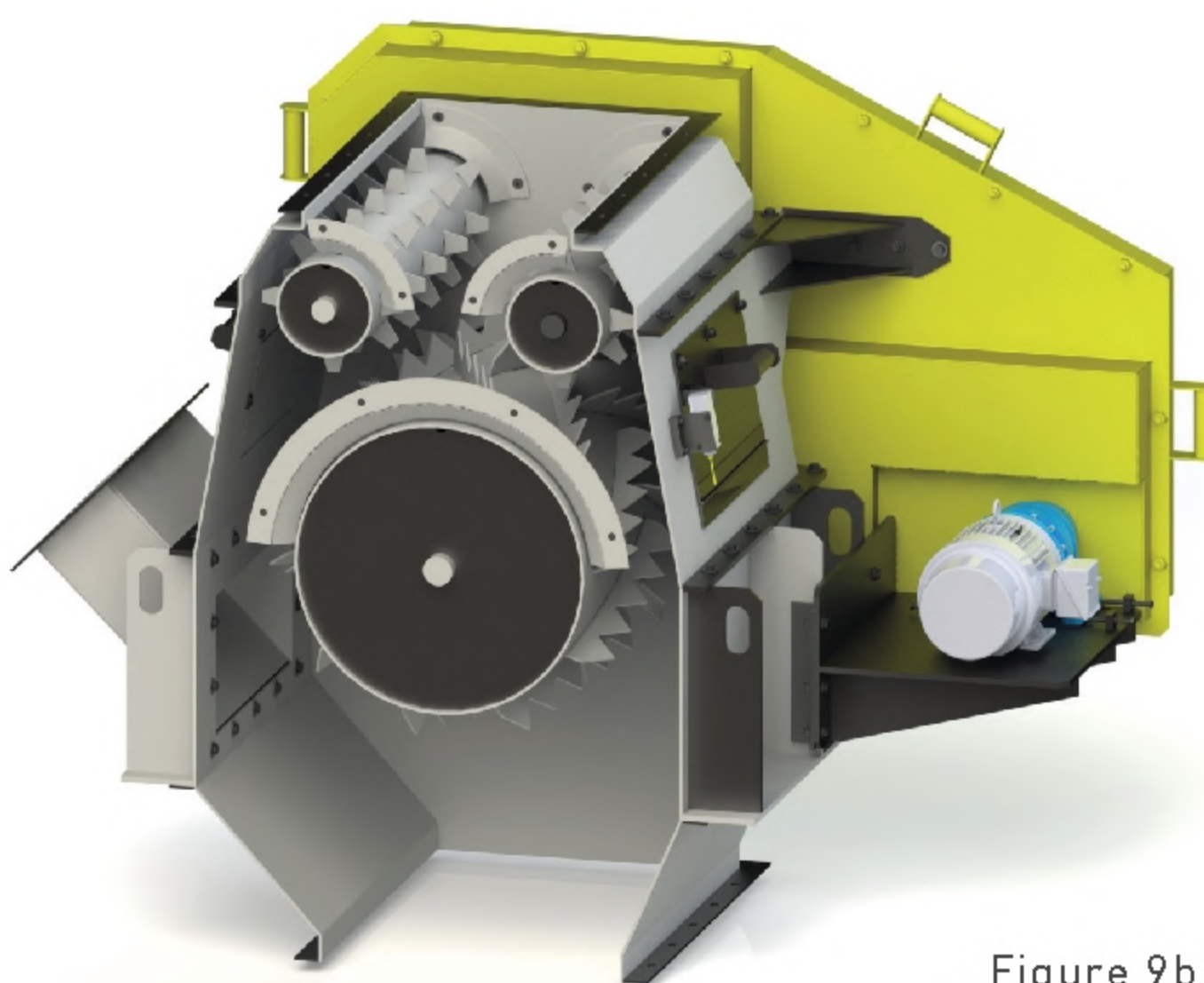


Figure 9b: Bagasse feeder.

Pellet distribution trials utilizing an air-swept distributor produced much better results. There was little to no particle size degradation, but also the air-swept distributor had the ability to distribute pellets deeper into the furnace with fine adjustment offered.



Figure 10a: Pellet feeder.

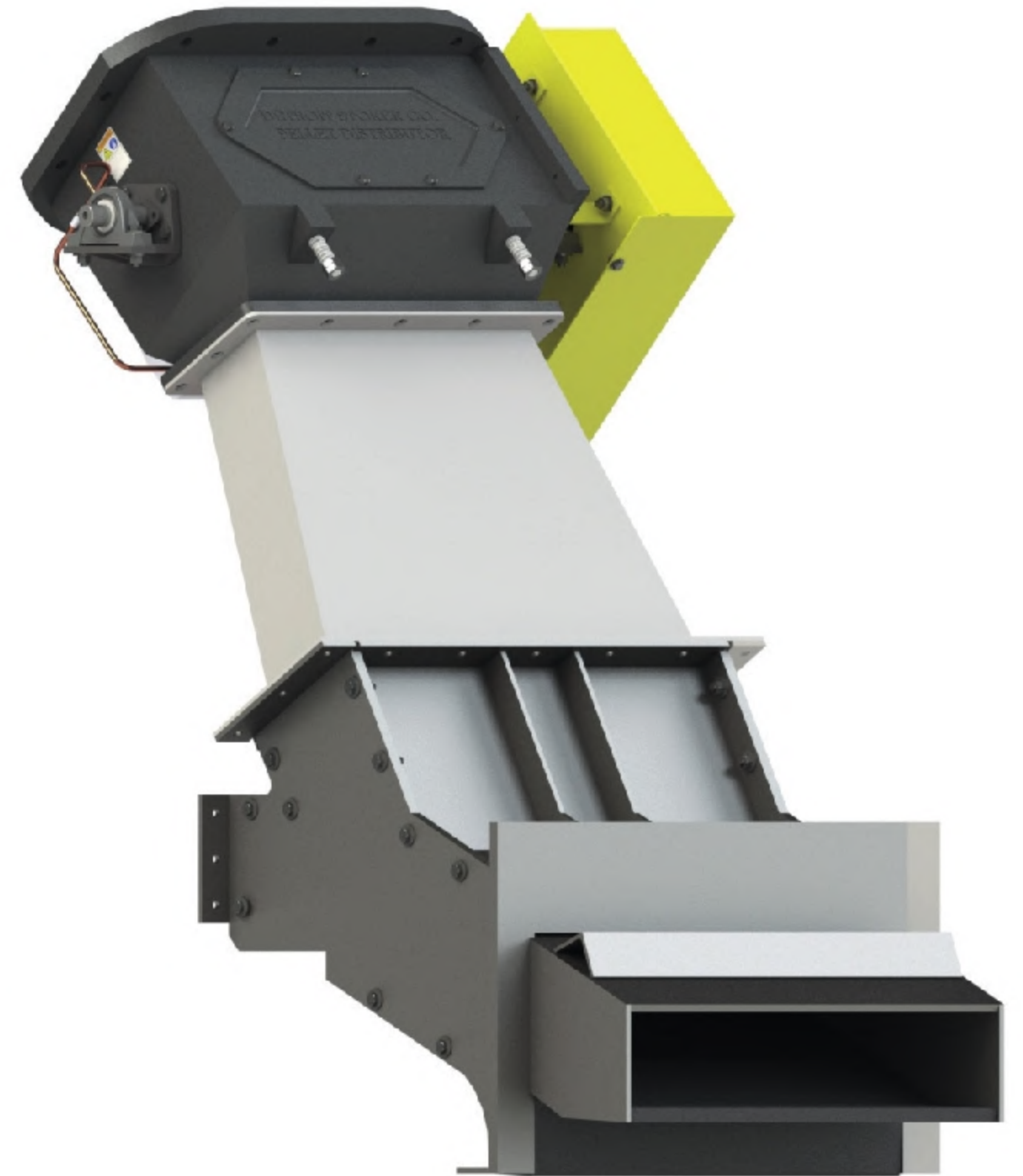


Figure 10b: Pellet metering system.



Figure 11: Pellet metering testing in R&D test facility.

Real world application has proven the importance of consistent fuel metering and distribution to be more prudent than ever in establishing successful commercial operation on wood pellets.

While Detroit has over 120 years of solid fuel combustion, we have found that wood pellets are more difficult to successfully meter and distribute than previously thought. As with all combustion systems, delivery of the fuel is imperative for industrial boilers to provide a consistent supply of process steam or electrical generation capacity while operating reliably and while minimizing environmental impacts. Additional work and testing are continuing to determine final system designs, for a variety of multi-fuel arrangements. Real world application has proven the importance of consistent fuel metering and distribution to be more prudent than ever in establishing successful commercial operation on wood pellets. Final systems will be available by 2nd quarter of 2021.