Moisture Metrics Project

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Executive Summary

This research added to the understanding of moisture, as it relates to the processing of grass biomass in a commercial setting. It added to the understanding by reinforcing the idea that each grass species has its own unique characteristics as it relates to moisture and processing. And while sometimes these results were not able to be measured according to the parameters of this test project, it was an attribute distinctly noticeable by the end of this project, and discovered by the equipment operators themselves.

Key to this discovery was the fact that while a bale of grass may test at a specific moisture percentage with a handheld probe, the actual moisture content within the cell walls of the plant matter may vary significantly from that reading. This difference arises from the ability of some plant species to retain the moisture more within the cell walls, as opposed to other plant species simply holding the moisture on the outer surface of the stalks. This of course is coupled with the methodologies used by the individual landowner in the handling of the biomass, specifically, time of harvest and storage technique. However, it still comes down to different species retaining moisture in different ways according to their cell wall structure.

While this may not seem significant, it is of critical importance when you combine that varying trait, with the "action" of processing it.

The testing criteria initially established by this project, was in the end inadequate to document these traits thoroughly, and will require future, more detailed projects to adequately document it. The project approach, and the resulting data contained within this report, failed to give us the conclusive data we thought we would eventually arrive at when this project was completed.

However, the efforts put forth by this project , and the lack of hard data using our approach, <u>does</u> enable future projects to have a much better understanding of how to approach this subject from a technical standpoint. We have learned that the study must go deeper initially, back to the acreage where the grass was grown, and must include all attributes and inputs beginning there. This data must be logged and correlated along the entire lifecycle of the biomass, from beginning to end, to enable us to fully understand how moisture and specific species of grasses interact when combined with the action of commercial processing.

Accomplishments Compared to Goals & Objectives

The primary goal of this project was to determine the optimum moisture level of herbaceous biomass for processing into pellets.

While we hoped to discover an ideal moisture range where optimum processing economics and pellet quality would be achieved, we were unable in the end to discover this using the defined methodologies of this project.

As part of the educational objectives, interns from a local university were to be part of these testing procedures, thus allowing them to assist and gain educational exposure to the biomass industry.

As a result of these educational objectives, 2 different interns were hired, and allowed to assist in a variety of roles, each of them coming away from the experience with a thorough indoctrination in the field of biomass commercial processing.

Summary of Project Activities, & Conclusions

Approach:

The objective of this study was to record and correlate data from 4 basic data streams; moisture & humidity, electrical consumption, time to process, and pellet quality. It was decided to achieve this by conducting 498 tests, with each test consisting of monitoring 5 bales of biomass from the time they arrived on our scales, until they were processed into the finished product of biomass pellets.

All of the bales used in this study were “round” bales, and typically weighed an average of 1200 lbs. each. Upon arrival on the scales, 5 random bales would be selected from that particular delivery, and labeled according to date, moisture average of the bales, outdoor humidity, and type of grass. By doing this, it insured that the 5 bales selected for a particular test number came from the same field, and where all of the same species. A test number would then be assigned for these 5 bales.

Upon time of processing, the date, moisture average of the bales, & outdoor humidity would once again be recorded for the 5 bales matching a test number. If the ambient environment was sunny and warm, the bales would often dry out a percentage point while waiting to be processed.

Once the bales began the processing cycle, the time was logged and kept until the 5 bales had completely been processed into pellets. Energy consumption of key major equipment was carefully logged and noted as well.

Upon completion of the pelletizing process, the pellets were then bagged , and then tested for moisture and density. The ideal parameters were for the pellets produced to be below 11% moisture, and the weight/density to be above 32 lbs per cubic ft. This was part of Milestone #1, to see the quality of the pellets produced.

Problems Encountered:

Problem - Excessive moisture in pellet samples

The first noticeable problem was with excessive moisture in the pellet samples, even though the incoming biomass did not test high for moisture. After some investigation, it was determined to be from the hot pellets after they were processed being placed in bags and then sealed up too quickly. The normal pelletizing process enables the pellets to go to a cooler to slowly lower their temperature post production. By taking samples straight from the throat of the pellet mill, and placing in airtight bags, droplets of moisture would form inside the bag.

Solution:

The solution, was to simply let the pellets cool for 30 minutes in a bucket before placing them in a plastic bag, and then leaving the mouth of the bag open until ready to deliver to the next technician.

Problem- Graphing Data;

The second problem encountered was that the further we got into the tests, we did not see any significant variances in our graphing, that had continuity from test to test. Steven Thomas suggested separating equipment into different graphs for energy consumption, and to try making data points wider apart to enable us to see more variation. All of these were tried, with no significant continuity differences noted. It was hoped that by the end of the 498th test that after running more volumes of material and different types, that the data would show more deviation in the graphing, however it did not show any significant fluctuations that had continuity in the overall testing.

Suggested Solution:

The suggested solution by this writer, after analyzing all the collected data, would be to simply omit the pelletizing portion for a better methodology approach, and to collect the data only up through the initial grinding and hammer mill process.

The reasons for this are twofold; different species and different moisture levels react differently in the pellet machines. The term “residence time” will be used here. This refers to the time the biomass material actually spends within the dye portion of the pellet machine. Depending on the species and the moisture of that particular species, the biomass will at times, have longer, and shorter residence times within the pellet dye. When the material is wet for example, the machine takes longer to pelletize it, the longer residence time will “cook” the material inside the dye, using more energy, but yet also making a more “dense” pellet. The denser pellet occurs as higher heat is generated from the longer residence time, in excess of 200 degrees at times, the longer the residence time, the higher the heat created. This does two things; “drying” the material, and “caramelizing” the sugar/ lignin in the exterior of the pellet. Thus making the “friability” of the pellet much harder, and much denser. This effect can be noticed by physically observing the machine during this process and observing the amounts of steam & heat resulting when long residence time occurs.

For this reason alone, the data we were in search of, an optimum moisture range for the processing of herbaceous biomass into pellets could not be obtained adequately. This "residence time" effect of the pellet mill caused the data to be contradictory of itself continually due to energy, time, density, and produced pellet moisture not adding up on a consistent basis.

Therefore, since one of the greatest difficulties in making herbaceous biomass pellets is the initial grinding down of the material into the correct particle length prior to pelletizing, this writer suggests that the testing methodologies be confined to all the processes up to the point of pelletizing, and no further.

Conclusions:

As mentioned, the pelletizing portion should be omitted from determining the optimum moisture ranges for the processing of herbaceous biomass. As stated, the most difficult part is the initial processing down to a desired particle length.

In terms of monitoring the processes up to the point of pelletizing, it should be noted as stated in the opening comments of this report, that there are important characteristics of different species of grasses that are critical to their ability to be processed. It has been observed at this facility that the moisture characteristics differ according to the species being processed. Some species process easier with "less" moisture, and the opposite is also true that some species process easier with "more" moisture. But with each species, there are limits for the ideal moisture thresholds for processing. As an example; fescue grass's ability to be processed "increases" as the moisture level present in the bale of fescue "decreases", but only to a certain point. The opposite of this is true concerning certain species of native grasses, where their ability to be easily processed "increases" as the moisture level in the grass bale "increases", up to a certain point. Bone dry native grass is extremely difficult to process and will slug/bog down a grinding machine.

Therefore, it is the writer's conclusion, that any future "moisture metrics projects" should only assemble data on the grinding and hammer mill processes in reference to commercial processing of herbaceous biomass. By doing this, clear observable results should be able to be identified and correlated for the ideal moisture ranges for processing different species of herbaceous biomass, each species having its own "ideal moisture threshold".

Publications

There were no publications written as a result of this project.

Website

A website was maintained for the entire duration of this project. Raw data input results and resulting graphs can be viewed at the following website: smecenergy.com

Computer Modeling

Computer data work was accomplished by using Excel formats. Graphing was accomplished by using the average moisture readings of each test sample as the common denominator with all graphs, and the other corresponding data inputs serving as the other axis , ie; energy, time, pellet density. These then were graphed separately for each type of herbaceous biomass received.