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Identification of biomass fractions responsible for wear on biomass processing equipment

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Abstract:

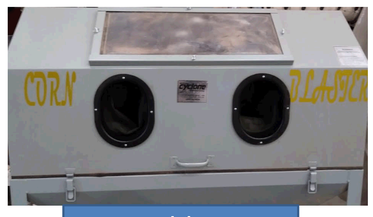
There is a current problem in the DOE supported Integrated Bio refineries where metal parts, including grinder blades and pneumatic ducting, are wearing out too early in the lifetime of the equipment. Repairing and replacing the equipment leads to unexpected equipment costs and the complete shutdown of the affected production lines.. It is believed that the ash content of the biomass is the likely cause of the wear on the metals. To address this ongoing problem, INL staff are analyzing the wear of metals caused by interactions with biomass . A sandblaster was modified to shoot ground biomass at metal coupons to simulate the wear that is occurring in the bio refineries. This system was able to test several variables including which biomass causes erosive and abrasive wear, impingement angle, particle densities of the biomass, and how the quantity of mass impacts the wear of the metals. Coupon mass loss after blasting was used to evaluate the wear caused by different biomass fractions. It was determined that the bark fraction of biomass caused the most wear and the whitewood fraction caused the least wear. Coupon mass loss in logging residues was found to be positively correlated with ash content, indicating that the ash content in the biomass is responsible for wear. It was also found that hand separated forest residues, sodium, aluminum and iron were positively correlated with wear, while silicon showed no correlation with wear.

Machines used in lab


Air classifier


Splitter


grinder



corn blaster


Forest residue


Logging residue


inside of corn blaster

Introduction

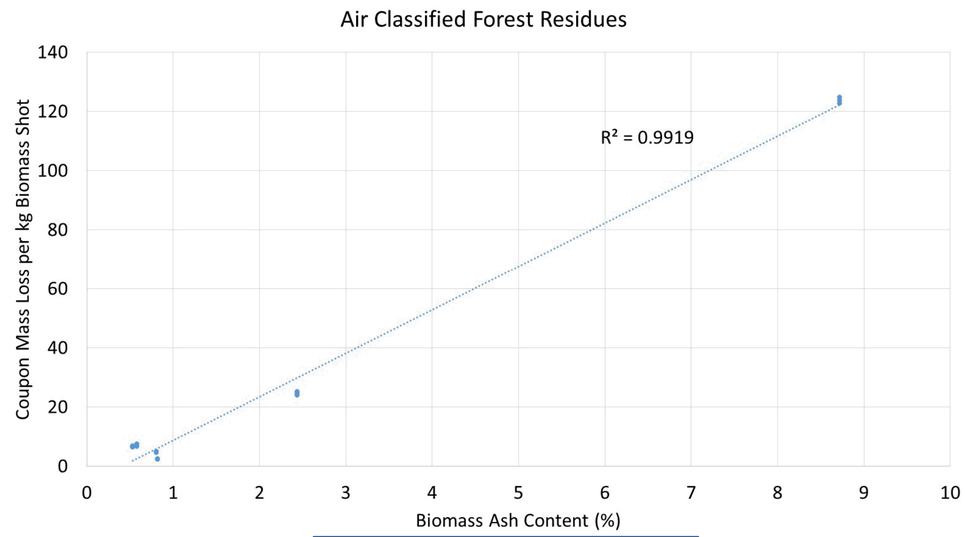
Recent observations at DOE supported Integrated Bio refineries have shown that metal parts, including grinder blades, ducting, and screw presses are wearing down too early in the lifetime of a metal, leading to additional costs and process line shut-downs.
These metal parts are impacted by wearing down through the process of abrasion or erosion, and this wear causes the metals to lose mass overtime as more biomass interacts with the metals.
Different biomasses such as corn stover, logging residue, and forest residue have different contents of ash in the material. The ash contains inorganic compounds such as phosphorus and iron, and the ash is what causes the wear of metals. The Biomass Wear project tests these different biomasses on the metals, and the data collected will help bio refineries reduce metal wear.
This work will help bio refineries determine which biomass types of fractions of biomass are causing abrasive and erosive wear and the extent to which the biomasses cause the wear. This information can then be used to modify the metals parts or the biomass to minimize wear on the metal equipment.

Methods

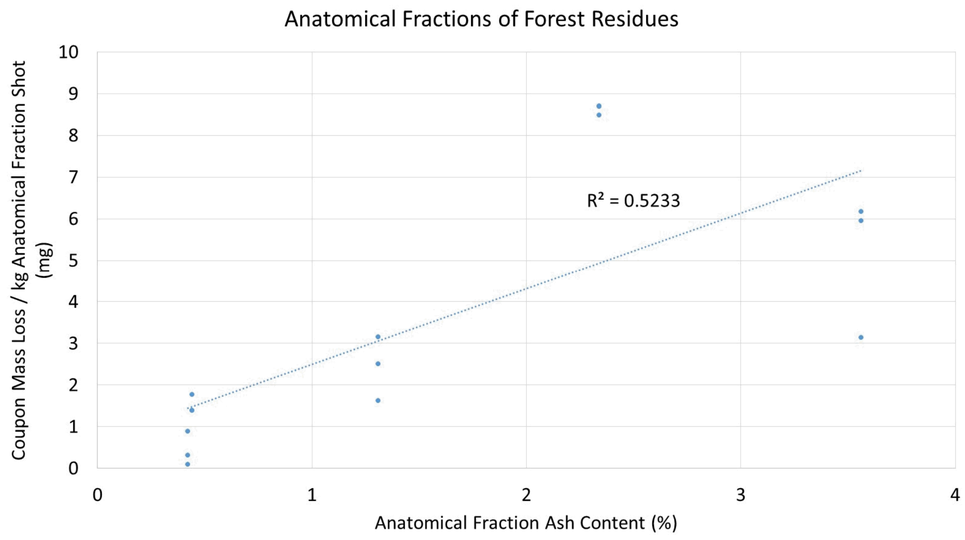
To determine how metals were impacted overtime, different procedures were used to create the optimal conditions for understanding how different materials caused wear and mass loss on the metals. Before the biomasses are on the metals, the biomasses had to be manipulated using machines before being tested on the metals.
A 2x Air Cleaner (Key Technologies, Walla Walla, WA) equipped with an Iso-flo dewatering infeed shaker (Key Technologies) was used in all air classification experiments. The air classifier separates biomass into different fractions based on densities and particle size differences of the material. The logging residue was air classified into five fractions using different fan speeds..
All biomass samples were ground to < 2mm .
50g of biomass was sent to an analytical lab for elemental analysis of the ash content.
In addition, the three trials of biomasses would each be further split to provide a sample to Huffman Hazen lab for elemental and ash analysis.
A sandblaster was modified to shoot ground biomass at metal coupons to simulate the wear caused on metal equipment by biomass. The sandblaster was operated at 65psi to blast the biomass to the piece of metal at a 45° impingement angle. Previous work has shown that this angle produced a mix of abrasion and erosion wear types. This angle is selected because then erosion which happens at an angled surface, and abrasion which happens on a perpendicular surface can both be analyzed.
2''X2'' metal coupons made from A36 steel were used for all experiments. Before use, the coupons were washed with detergent, labeled, and dried overnight at 100°C - 120°C. Coupons were weighed after drying. After the coupons were blasted with ground biomass, the coupons were rinsed with water, wrapped in aluminum foil, and dried overnight. The coupons were then weighed again to determine how much mass was lost due to the blasting.

Results

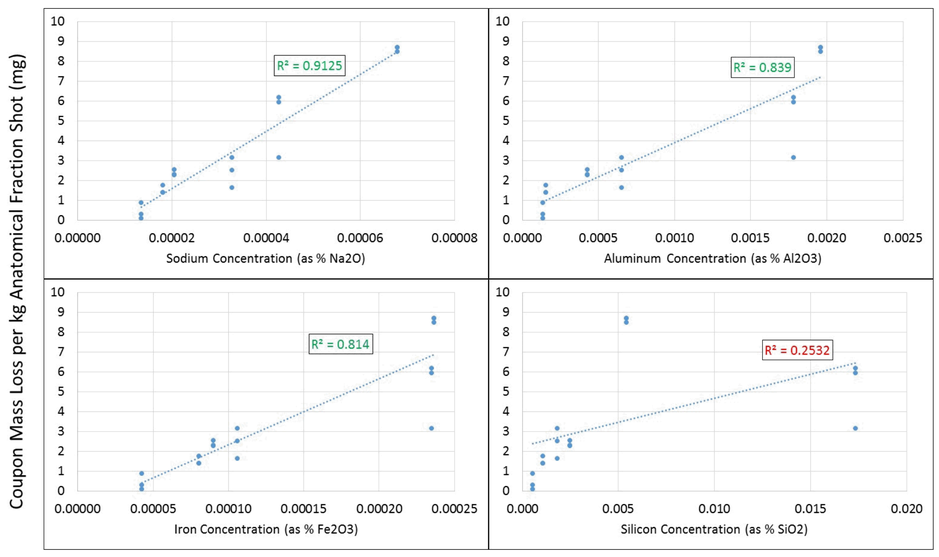
As the amount of ash content increased in the air-classified logging residue, so did the mass loss on the metal coupons
As the amount of ash content increased in the separated forest residue, there is no correlation between ash content and wear on the anatomical fractions
Although bark had a lower ash content than the needles, it caused more wear than the needles
Sodium, Aluminum and Iron concentrations in the separated forest residue were positively correlated with the wear whereas the silicon was not correlated with wear



Air Classified Forest Residue



Anatomical Fractions of Forest Residue



Elemental Analysis of Wear caused by Anatomical Fractions

Conclusion

Logging residue behaves as expected as when there is an increase in ash, there is an increase in wear of the metals
Forest residue does not have an increase in wear with an increase in ash because of the bark and potentially the needles
The bark will be analyzed for further analysis to determine mineral composition and then form a conclusion as to what minerals from the bark is causing the wear

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