Particle Size Analysis and Roundness Distribution For more economical BSFI

By Zachary Laird

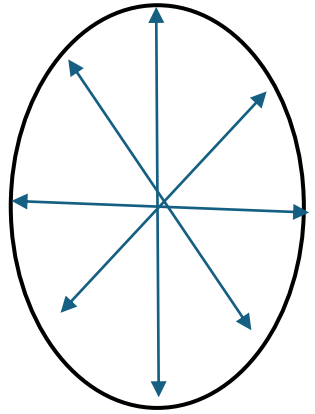
Introduction

- Reduction of Viscosity increases economic feasibility of biomass related projects
- As roundness increases viscosity decreases
- For BSFI this could make a serious difference in the amount of carbon captured
- LSA has proven to reduce viscosity we believe it is because it increases particle roundness.

Source: (*Basics of viscometry | Anton Paar Wiki*, n.d.)

Methods

- Pine Chips milled <=350 microns
- Combined with 150mL water and 0g, 2.5g, or 5g LSA
- Hydrothermal carbonization at 250°C for 1 Hour
- Particle Size Measurement
- Wadell's roundness coefficient



Measurement technique of the particles

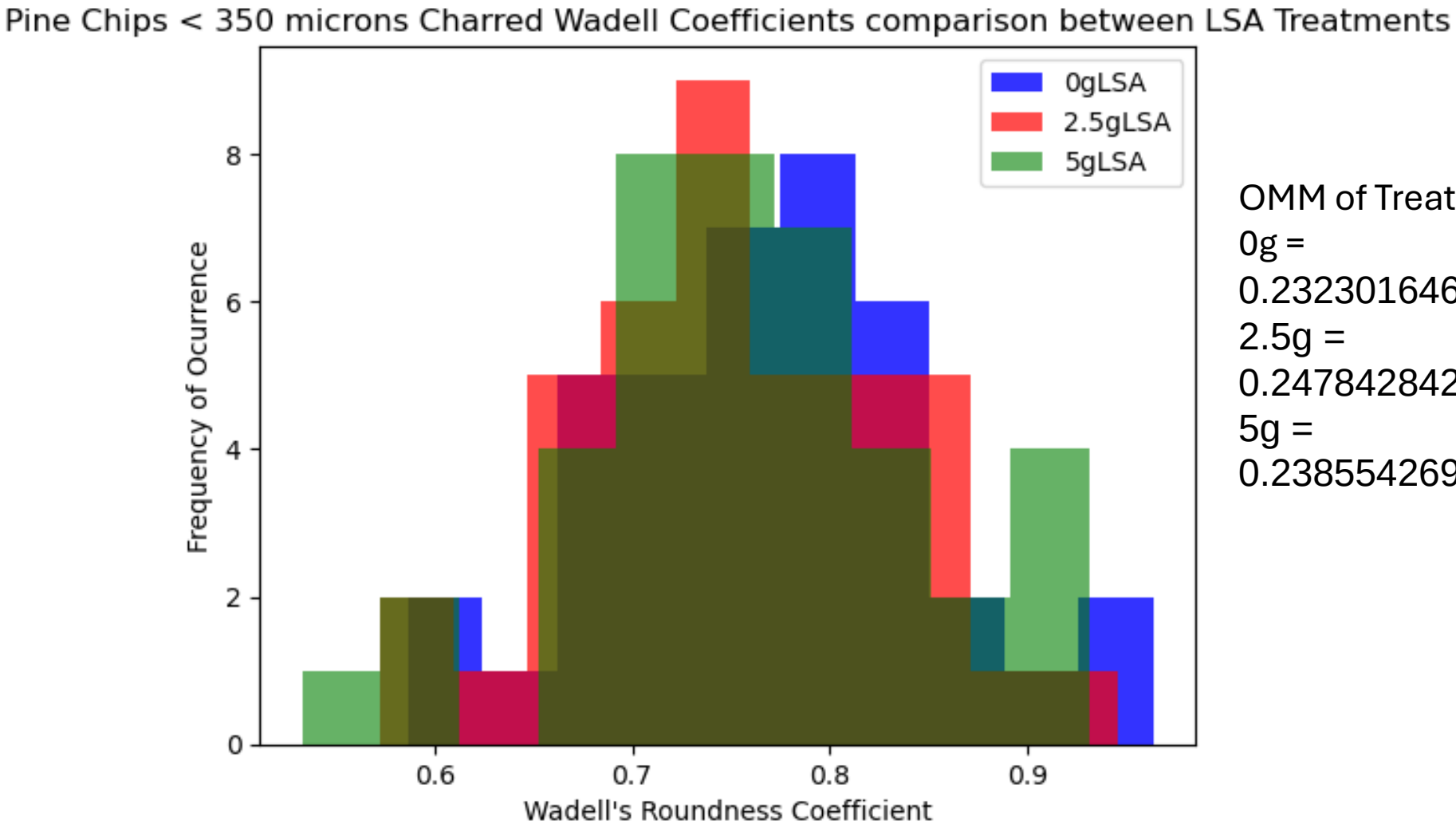
$$R = \left(\frac{1}{n}\sum_{i=1}^{n} r_i\right) \Big/ r_{max}$$

Wadell's Roundness Coefficient (Cruz-Matías et al., 2019)

Python Methods

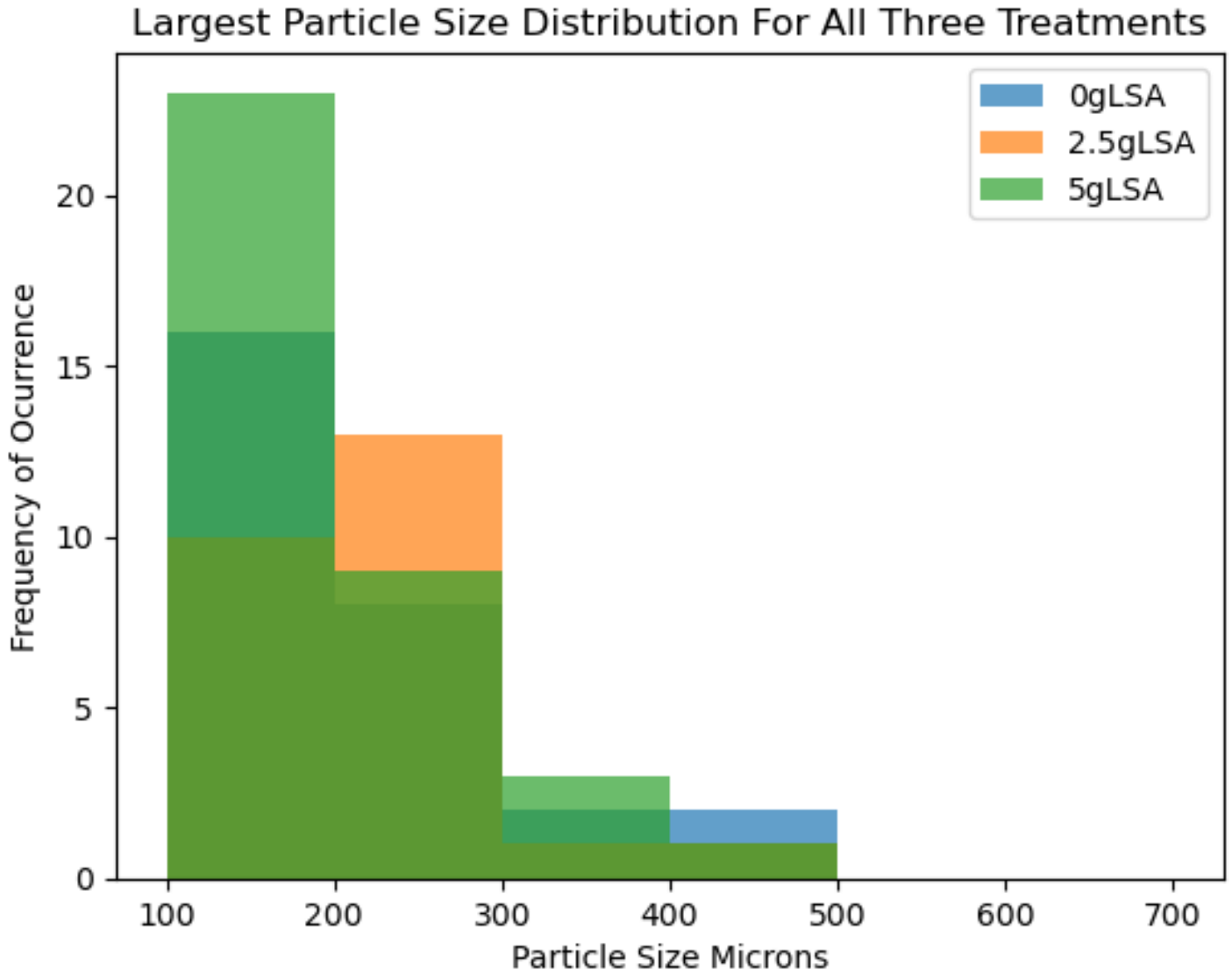
- Generate histograms and scatterplots using matplotlib.pyplot
- Use Pandas Functions to manipulate and modify dataframes
- Testing for distribution shapes for particle size distribution and roundness coefficient distribution
- Numpy to determine means and use in OMM equation for proximity to perfect roundness

Results (Roundness Coefficients)



OMM of Treatments:
0g = 0.2323016463589744 3
2.5g = 0.2478428420000006
5g = 0.2385542697250000 5

Results (Largest Particle Size Distribution)



Results (OMM of Treatments)

OMM of Treatments:
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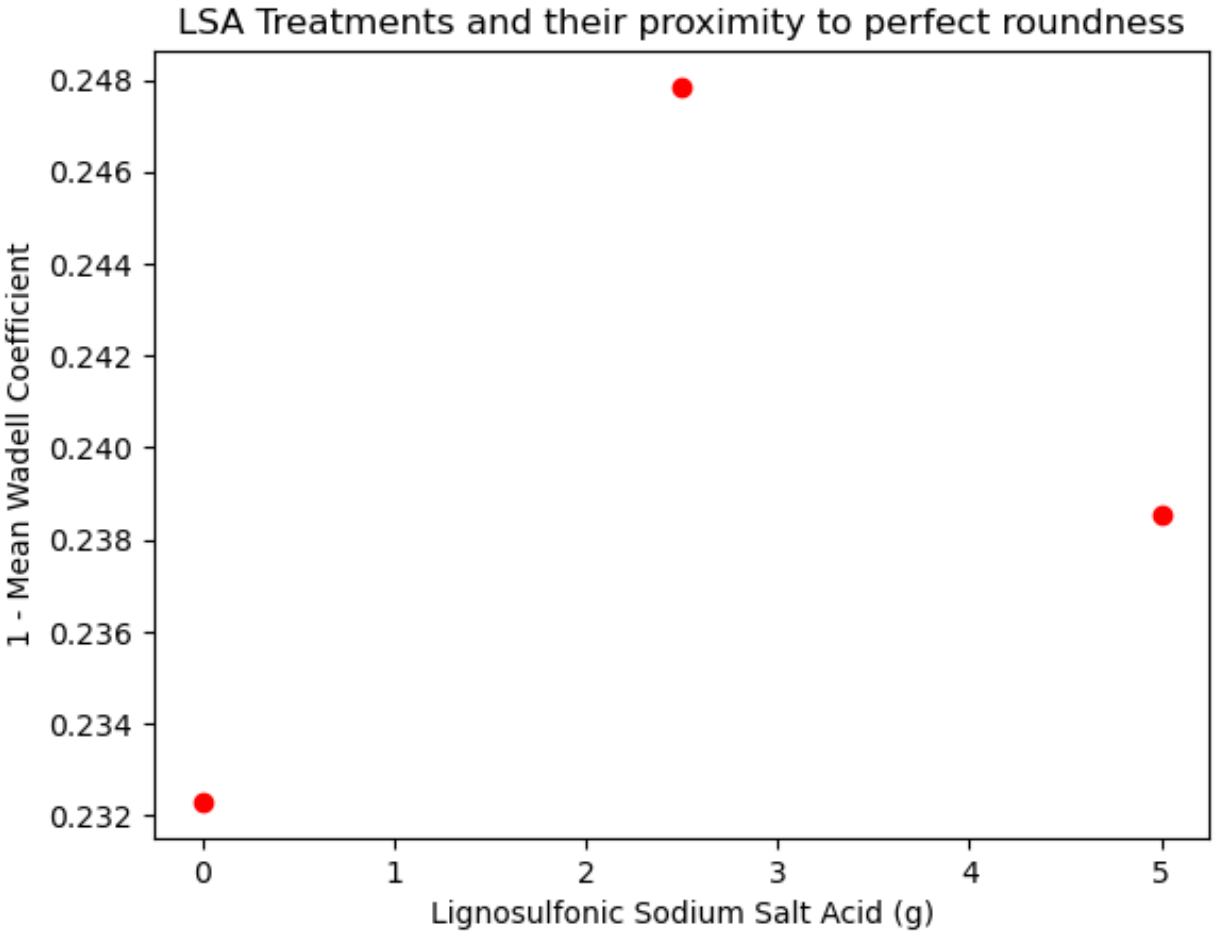
0.23230164635897443
2.5g =
0.24784284200000006
5g =
0.23855426972500005



Discussion

- No relationship between LSA and roundness
- Errors (measurement and bias)
- Possibility that relationship of LSA and Viscosity is only detectable at a molecular scale
- Further experiments need to be conducted to reduce particle-particle interactions
- To solve the energy transition and slow the climate crisis there must be findings for economical reduction in biomass slurry viscosity.

References

- *Basics of viscometry | Anton Paar Wiki*. (n.d.). Anton Paar. Retrieved December 10, 2024, from https://wiki.anton-paar.com/ch-de/grundlagen-der-viskositaetsmessung/
- Cruz-Matías, I., Ayala, D., Hiller, D., Gutsch, S., Zacharias, M., Estradé, S., & Peiró, F. (2019). Sphericity and roundness computation for particles using the extreme vertices model. *Journal of Computational Science*, *30*, 28–40. https://doi.org/10.1016/j.jocs.2018.11.005
- Browning, W. C. (1955). Lignosulfonate Stabilized Emulsions in Oil Well Drilling Fluids. *Journal of Petroleum Technology*, *7*(06), 9–15. https://doi.org/10.2118/393-G
- Dasari, R. K., & Berson, R. E. (2007). The Effect of Particle Size on Hydrolysis Reaction Rates and Rheological Properties in Cellulosic Slurries. In J. R. Mielenz, K. T. Klasson, W. S. Adney, & J. D. McMillan (Eds.), *Applied Biochemistry and Biotecnology: The Twenty-Eighth Symposium Proceedings of the Twenty-Eight Symposium on Biotechnology for Fuels and Chemicals Held April 30–May 3, 2006, in Nashville, Tennessee* (pp. 289–299). Humana Press. https://doi.org/10.1007/978-1-60327-181-3_26

- *Basics of viscometry | Anton Paar Wiki*. (n.d.). Anton Paar. Retrieved December 10, 2024, from https://wiki.anton-paar.com/ch-de/grundlagen-der-viskositaetsmessung/
- Browning, W. C. (1955). Lignosulfonate Stabilized Emulsions in Oil Well Drilling Fluids. *Journal of Petroleum Technology*, *7*(06), 9–15. https://doi.org/10.2118/393-G
- Cruz-Matías, I., Ayala, D., Hiller, D., Gutsch, S., Zacharias, M., Estradé, S., & Peiró, F. (2019). Sphericity and roundness computation for particles using the extreme vertices model. *Journal of Computational Science*, *30*, 28–40. https://doi.org/10.1016/j.jocs.2018.11.005
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- Konduri, M. K. R., & Fatehi, P. (2019). Alteration in interfacial properties and stability of coal water slurry by lignosulfonate. *Powder Technology*, *356*, 920–929. https://doi.org/10.1016/j.powtec.2019.09.019
- Kuznetsov, G. V., Romanov, D. S., Vershinina, K. Yu., & Strizhak, P. A. (2021). Rheological characteristics and stability of fuel slurries based on coal processing waste, biomass and used oil. *Fuel*, *302*, 121203. https://doi.org/10.1016/j.fuel.2021.121203