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From Waste to Power: Pulsing Biosludge Atomization for Efficient Energy Conversion DANIEL WILSON, WAYNE STRASSER, Liberty University — Efficient conversion of human waste to usable energy is sought by introducing a highly concentrated non-Newtonian biosludge to a steam boiler via direct spray injection. Compared to other methods of energy conversion that require dilution and/or drying, using a more concentrated biosludge increases energy conversion efficiency, reduces water usage, and reduces fossil fuel emissions by decreasing the transportation load. The use of steam as the assisting gas for a twin-fluid atomizer reduces the viscosity of the biosludge, enabling more effective atomization; however, the steam reduces boiler efficiency. Therefore, two objectives must be balanced in an atomizer design: minimizing steam usage and effective atomization of the viscous biosludge. CFD simulations provide preliminary assessments of inverted twin-fluid atomizer designs when the steam flow is reduced to a desirable rate. Typical designs involve the steam flowing outside of the slurry stream, while the inverted design has the steam entering inside of the slurry stream. It is shown that the inverted design produces superior atomization and is robust in that droplet size does not change significantly for a range of acceptable steam flows. Additional difficulties arise because the viscosity of boisludge varies widely; if viscosity levels are too high, an undesirable pressure drop restricts the flow, and atomization quality suffers. To improve the robustness of this system, two PID controllers are added. The first automates the flow of biosludge based on pressure drop, and the second compensates for phase momentum ratio and controls the flow of steam based on droplet size distribution.

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