Biomass Powered Desalination Year III: Combustion Tuning by Closed Loop Control System

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Energy poverty and water scarcity impact a large percentage of the global population. To address these growing issues, this project began with a rudimentary idea of a biomass-powered desalination device and the goal to create a functioning prototype that would use steam from desalinated salt water to generate electricity and output freshwater. In Year I of the project, testing was conducted to determine energy densities of biomass fuel. In Year II, the first combustion chamber iteration to power the desalination process was constructed and combustion tuning was performed by sending fixed rates of airflow into the chamber. In Year III, the second iteration of the chamber was constructed; a closed loop control system with a programmable power supply-controlled fan for airflow was implemented for more accurate tuning to increase the system's energy efficiency. The controller sends live data from a combustion analyzer to a computer and the computer adjusts the airflow entering the combustion chamber based on received readings of excess air. To mimic a desalination system, a saltwater boiler was placed in the chamber. The first controller version linearly decreased airflow and the second was a Proportional-Integral-Derivative (PID) controller for more accurate combustion tuning. The maximum system energy efficiency was 62.4%. While comparable to some solar- and biomass-powered desalination systems, this efficiency indicates the PID controller gain terms require further tuning. This would require a fuel feeder in future iterations to stabilize the combustion rate for clear combustion tuning analysis.

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