Transforming Saudi's Municipal Waste into Energy and Products with Waste Segregation using AI.

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TEAM 73

INTRODUCTION & BACKGROUND

In response to the increasing challenges posed by municipal solid waste (MSW) and its impact on the environment, there is a critical need for sustainable waste management solutions. Currently, large amounts of MSW are sent to landfills, leading to land degradation, greenhouse gas emissions, and resource wastage. Our project focuses on transforming this waste into electricity and valuable by-products, such as calcium carbonate and food-grade CO_2, using advanced Waste-to-Energy (WtE) technology. This innovative system integrates AI-driven waste segregation and Carbon Capture, Utilization, and Storage (CCUS) to maximize resource utilization and minimize environmental harm.

Supplying electricity: The system provides a reliable and sustainable source of electricity to support local energy demands.

CO_2 capture technology: Incorporating advanced CO_2 capture methods, the system significantly reduces greenhouse gas emissions and contributes to carbon neutrality goals.

Project Statement: Sustainable Waste-to-Energy system: transforming municipal solid waste into electricity and valuable by-products.

IDENTIFICATION OF CONSTRAINTS:

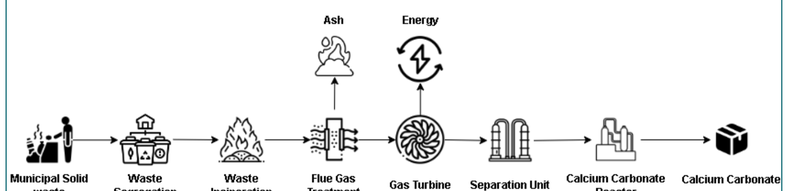
CO2 Capture Efficiency	CO2 emissions to the atmosphere should be reduced by 90% throughout the process.
Houses Supplied with Energy	The number of houses supplied with electricity should not be less than 400 on per 1000kg/hr MSW
Moisture Reduction	Waste segregation should be implemented to minimize moisture entering the process which could hinder the incineration.

TARGET SPECIFICATION:

- Calcium carbonate yield >70%.
- Carbon Dioxide reactor conversion >97%
- Classification Precision >95%

PROCESS OVERVIEW

Municipal solid waste (MSW) is segregated using AI, incinerated to produce electricity and CO_2, and treated for emissions. CO_2 is captured via CCUS technology and converted into calcium carbonate, with excess CO_2 purified for industrial use, ensuring efficient resource utilization and minimal environmental impact.



Results of Simulation

Parameter	Value
Overall CO_2 Conversion	91.15%
Reactor CO_2 Conversion	99.00%
Daily Energy Production	31,112 kWh/day
$CaCO_3$ Yield	81.76%
Amount of $CaCO_3$ Produced	4,493 kg/hr

Physical Prototype

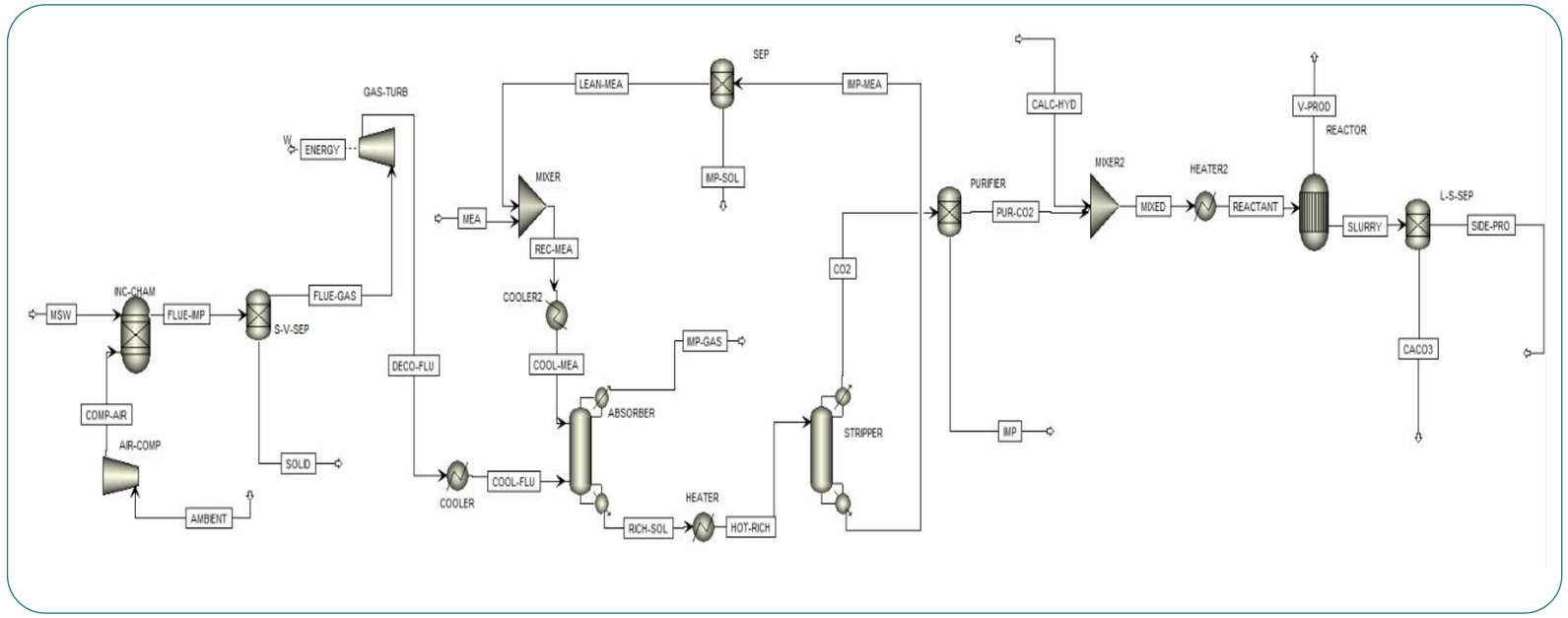
The conveyor belt moves waste towards the sorting area for classification and processing.

The purpose of the camera is to capture images of the waste, allowing the AI system to be analyzed and classified

The sorting arms redirects classified waste into the designated bins based on AI analysis.

ASPEN PLUS DESIGN

Aspen Plus simulation for electricity production from municipal solid waste involves key processes. AI-powered waste segregation ensures efficient sorting, and the sorted waste is combusted in an incineration chamber. The resulting flue gas powers a gas turbine to generate electricity, while CO_2 is captured and converted to calcium carbonate, ensuring minimal emissions and efficient resource recovery.



VALIDATION

Specifications	Results
Calcium carbonate yield >70%.	Met (81.76%)
CO2 reactor conversion >97%	Met (99.00%)
Classification efficiency >95%	Met (98%)
Houses Supplied with Energy >400	Met (512)

CONCLUSION