Chicken Litter Leads to Energy (Chicken LittLE)

Valorizing Eastern Shore Poultry Biowaste

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Background

Goal

Convert biowaste from poultry farms in the Eastern Shore of Maryland into valuable chemical products, including ammonium sulfate and methanol

Current Status

- As of 2022, the Eastern Shore of Maryland created about 548 million pounds of poultry litter biowaste, including manure, feathers, and bedding
- Waste runoff pollutes water with nitrogen and phosphorus which can be deadly to marine life and food sources[1]

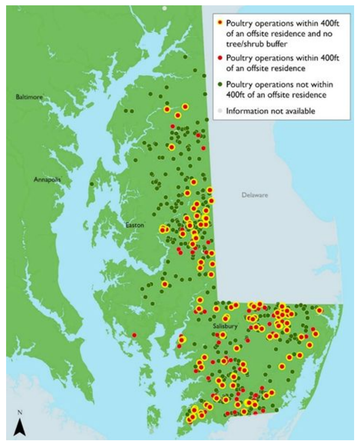

Figure 1: Locations of poultry operations in the Eastern Shore of Maryland[6]

Justification for Change

- Current biogas-producing technologies for handling excess poultry waste are anaerobic digestion facilities[2]
- Anaerobic digestion risks inhibition from high ammonia concentrations and polluting water sources due to nitrogen rich compound byproducts[3]
- Gasification is more efficient than anaerobic digestion and is more suitable for materials with high lignin content, like poultry bedding[4]

References

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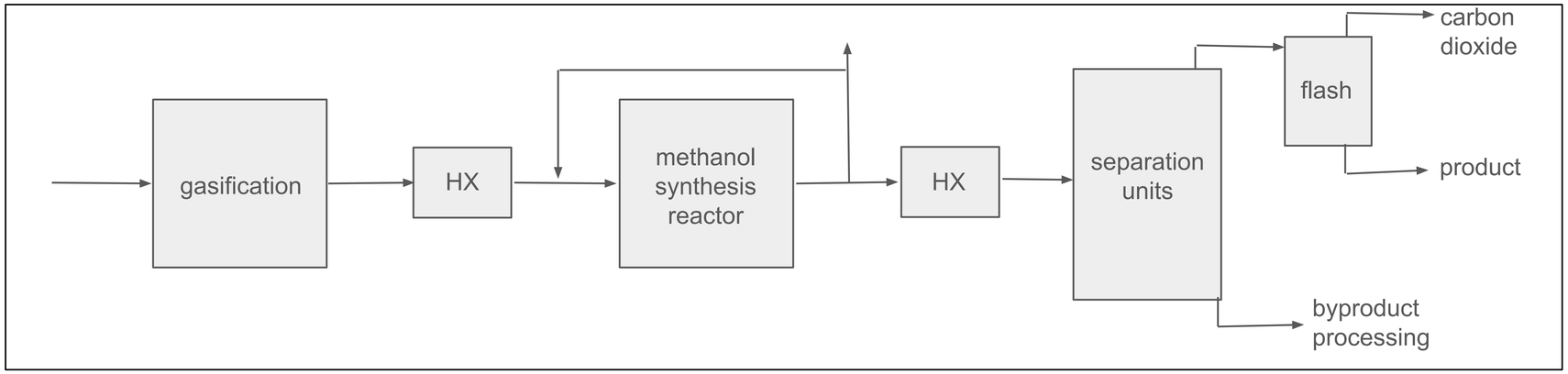
Design Concept

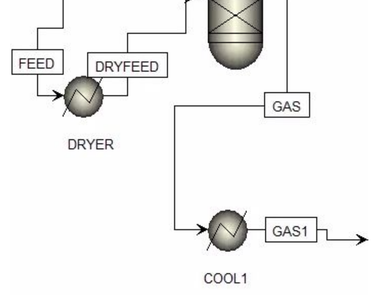
Functional Block Diagram



Operational Process

1. Gasification heats poultry waste to break it down into syngas and ammonia
2. Product stream enters a reactor where it is treated with sulfuric acid to separate ammonium sulfate
3. Ammonium sulfate stream enters a water evaporator where it is thickened and dried to form the crystal layer
4. Separately, syngas enters a methanol synthesis reactor where a copper catalyst facilitates the reaction to methanol
5. Finally, crude methanol product is purified through distillation

Gasification



Inlet Biowaste Composition:
- 42.7% Carbon
- 3.93% Nitrogen
- 32.6% Oxygen
- 0.640% Sulfur
- 5.50% Hydrogen
- 14.6% Other Components

Outlet Gas Composition:
- 38.9% CO
- 32.4% CO_2
- 19.2% H_2O
- 6.60% H_2
- 2.90% Other Components

Sustainability Assessment

This system is environmentally and economically sustainable. It provides a profitable pathway for the valorization of excess poultry waste into ammonium sulfate and eventually methanol, a clean burning alternative fuel. Around 200,000 metric tons of cooling water is made up in the system yearly as well as 3,000 metric tons of steam blow down, which is on the lower end for a system of this size. Assuming all steam production is through combustion, around 6,000 metric tons of CO_2 are produced yearly. A more realistic assumption is that waste steam is used.

Conclusions

Major Findings

- Ammonium sulfate product: **99.34% pure**
- Methanol product: **99.41% pure**
- Total product sales: **$5.3 million/yr**
- Total capital cost: $4.8 million
- Total operating + material cost: $4.2 million/yr
- P.O. Period: **8.9 years**

Recommendations

The implementation of heat integration would significantly reduce emissions and water usage.