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Process for removal and recovery of phenolic compounds from switchgrass

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•Removal and Recovery of Phenolic Compounds from Switchgrass

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Integrated process

- **Objective**: Our preliminary data have shown that phenolic compounds extracted from switchgrass can be used as an “organic pesticide” against bacterial plant pathogens and have value as an anti-inflammatory agent for humans. The objective of this project is to develop a new and potentially valuable stream for increasing sustainability of a lignocellulose-based biorefinery .

- **Outcomes of this project**: In the work presented here our experimental data are used as a basis to create a conceptual biorefinery processing 588,000 ton switchgrass per year. The cost of the individual process steps indicates that concentration and drying of the product dominate capital investment costs.

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Conceptual Biorefinery

- The conceptual lignocellulose-based biorefinery is composed of the following process steps:
  - Removal and recovery of phenolic compounds,
  - Organosolv separation of cellulose, hemicellulose and lignin, and
  - Conversion of hemicellulose and cellulose to ethanol,
  - Products are ethanol, lignin and phenolic compounds

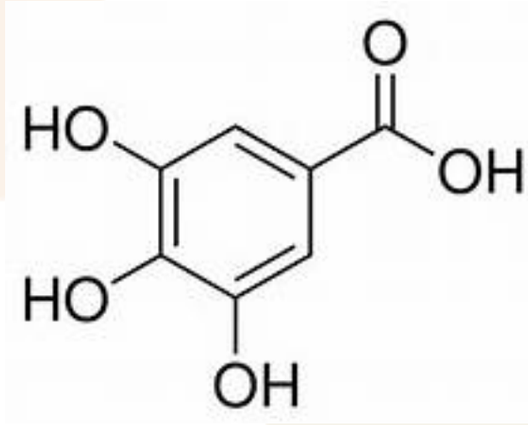
Experimental Data

time (min)	mg GAE*/g dry grass
5	1.25
10	2.15
15	3.1

* Phenolic compounds are characterized as gallic acid equivalent (GAE)

Gallic Acid Equivalent

- Phenolic acid compounds are characterized as gallic acid equivalent (GAE)



- GAE is determined using the Folin-Ciocalteau colorimetry method*

*Waterhouse, A.L. Current Protocols in Food Analytical Chemistry, John Wiley & Sons, New York, I1. 1.1-I1.1.8 (2001).

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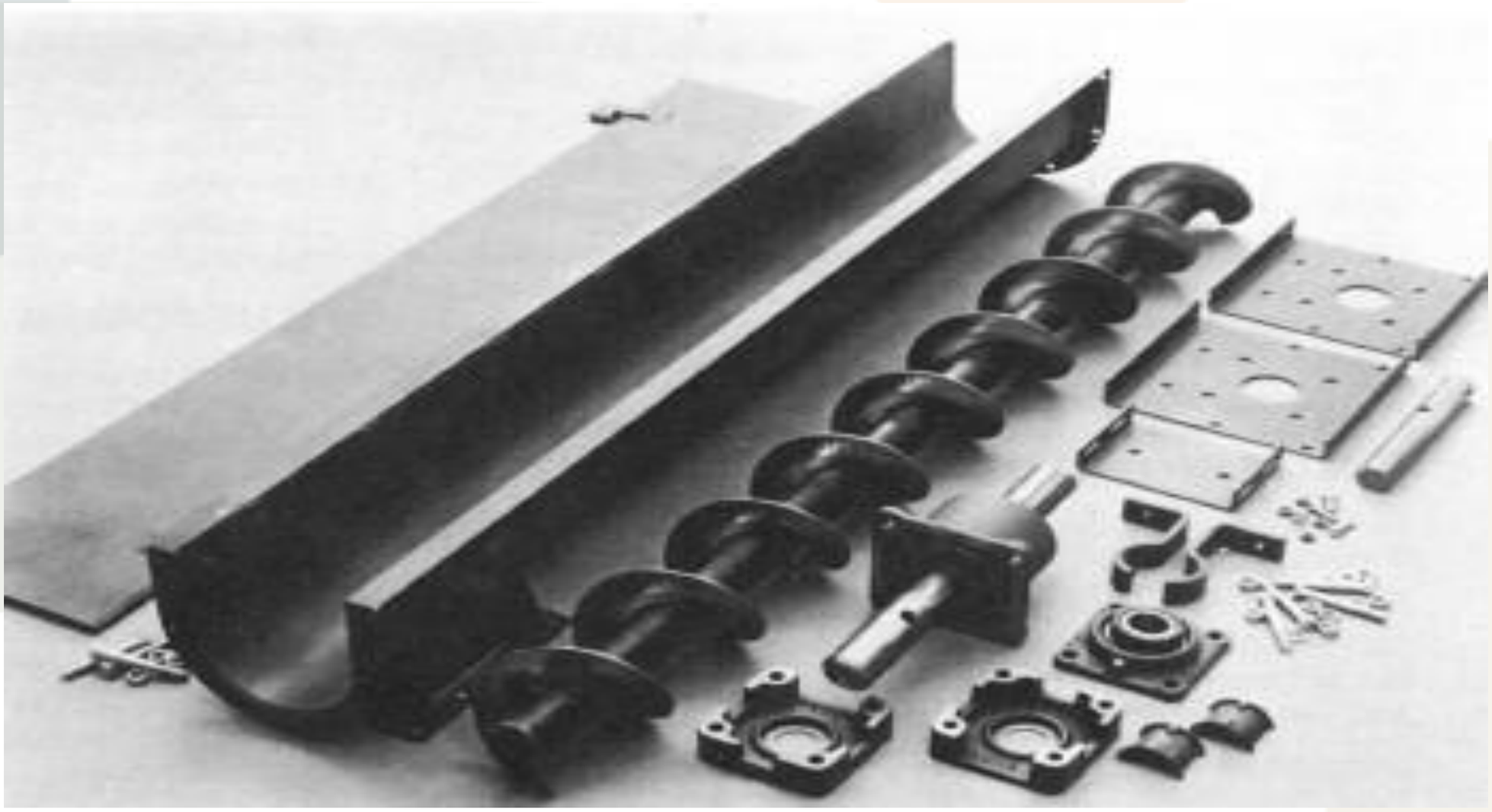
Auger Reactor

- Conceptual contact of water with switchgrass is by auger reactor (FMC Technologies)



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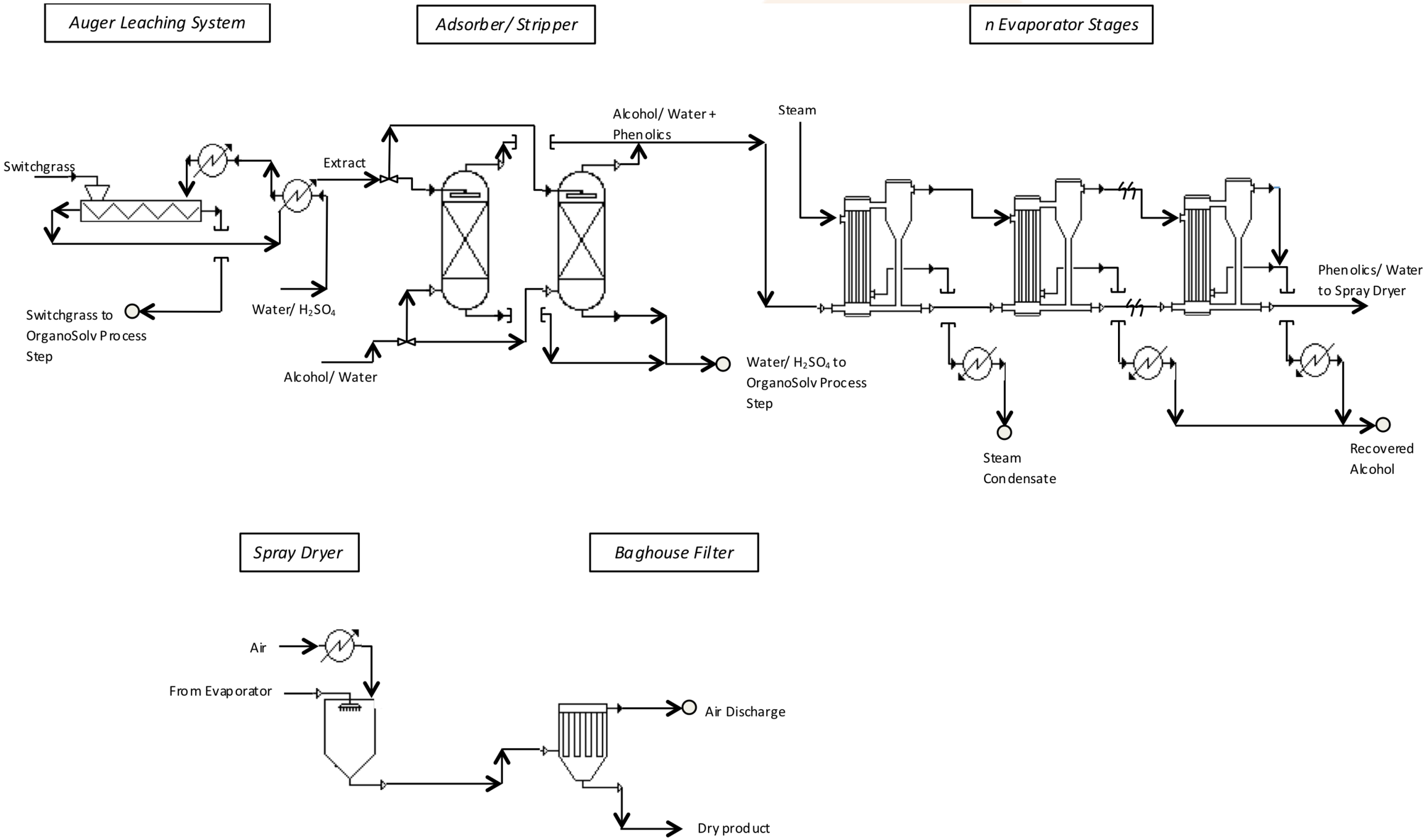
Removal & Recovery of Phenolic Compounds

- Leaching of GAE from switchgrass
- Cost of heated aqueous phase for leaching not assigned to current process
- Preferential sorption of GAE onto activated C
- Desorption of GAE into alcohol/water solution
- Concentration of GAE and recovery of ethanol
- Spray dryer to produce dried GAE product
- Product recovery by fabric filter (bag house)

Flowsheet


Auger Leaching System
Adsorber/ Stripper
n Evaporator Stages
Switchgrass
Switchgrass to OrganoSolv Process Step
Water/ H_2SO_4
Extract
Alcohol/ Water
Alcohol/ Water + Phenolics
Steam
Water/ H_2SO_4 to OrganoSolv Process Step
Steam Condensate
Phenolics/ Water to Spray Dryer
Recovered Alcohol
Spray Dryer
Baghouse Filter
Air
From Evaporator
Air Discharge
Dry product

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Economics

Equipment	Investment	Annual cost	$/kg GAE
Extractor	$1,088,000		$ 0.23
Heat Exchan	$288,890		$ 0.06
Steam Adsorber	$1,117,517		$ 0.99
Carbon Replacement		$39,885	$ 0.04
Evaporator	$794,400		$ 0.63
Steam		$957,194	$ 0.85
Spray Dryer	$3,719,000		$ 0.79
Natural Gas		$384,276	$ 0.34
Filtration	$1,732,222		$ 0.37
Total	$8,740,029		$ 4.30

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Conclusions

- A conceptual process for creating a dry phenolic compound product from switchgrass
- Economics analysis indicates a production cost of approximately $4.30/kg GAE
- Concentration and drying cost dominate capital investment costs

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THANK YOU!