


Thermal Conversion of Animal Manure to Biofuel


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Outline

- Manure availability and characteristics
- Motivation for returning to biorefineries
- Manure conversion technologies
- Combustion, gasification and pyrolysis
- Gasification issues
- Conclusion




Biorefinery approaches

- A **biorefinery** is a processing and conversion facility that converts biomass to individual components, then processes these components to marketplace products such as **biofuel**, **biopower** and conventional and new **bioproducts**.
- The biorefinery concept is similar to petroleum refinery, which produces multiple fuels and products from petroleum.



Biorefinery approaches


- **Sugar platform:** employs enzymatic hydrolysis to convert cellulose to simple sugars suitable for fermentation to ethanol and other products.
- **Biochemical platform:** employs transesterification to produce biodiesel from vegetable oil or animal fat.
- **Thermochemical platform:** employs gasification or fast pyrolysis as the route to convert biomass to fuels and chemicals.



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Motivation for returning to biorefinery


- Excess manure production
- Global climate change
- Rural development
- Reduced reliance on foreign Countries




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Availability of animal waste

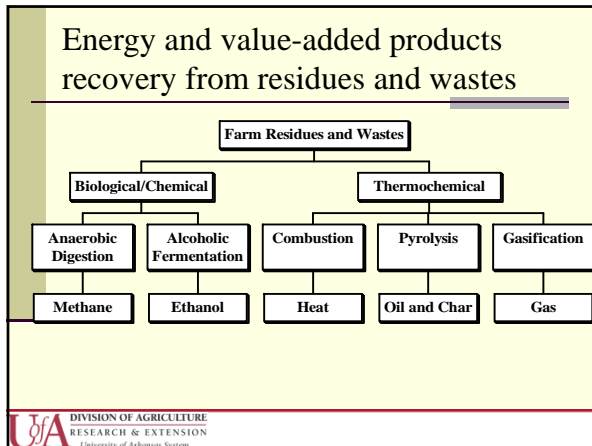
- In the United States, animal operations produce about 60 million ton dry weight of manure annually.
- According to the U.S. Department of Agriculture, the number of animal farms decreased by 5% from 1997 to 2007, while the average farm size, in acres, increased by 3%.

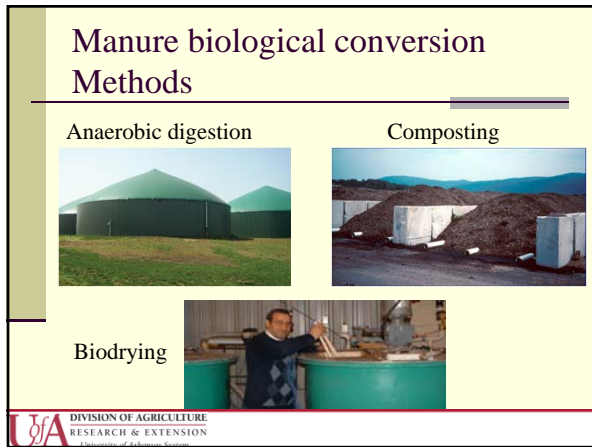


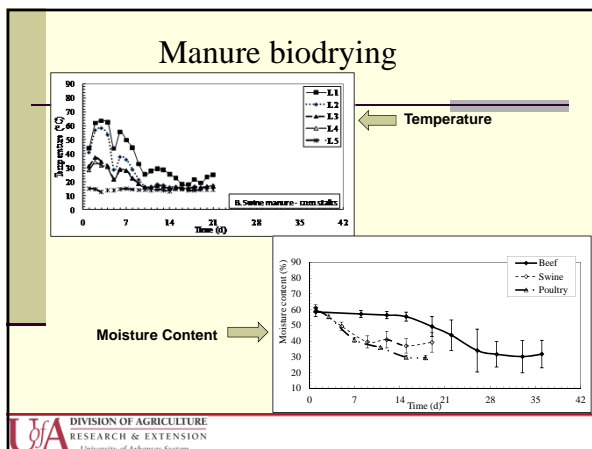
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Manure thermochemical conversion methods

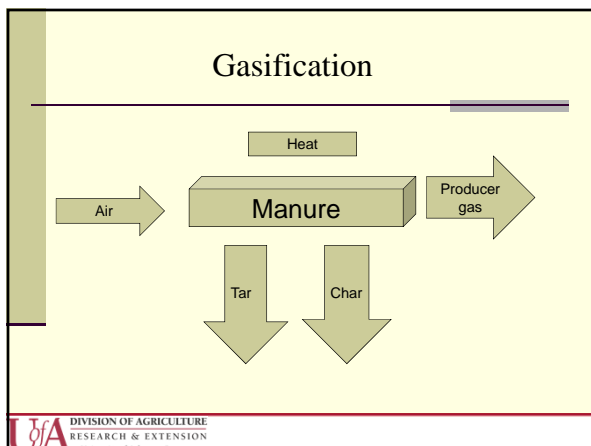
- > **Combustion:**
manure + excess air → to produce heat
- > **Pyrolysis:**
manure + heat → bio oil
- > **Gasification:**
> manure + limited air + initial heat → gas + char + tar

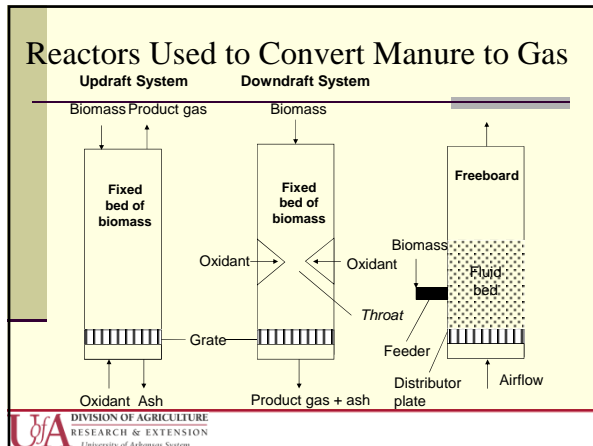
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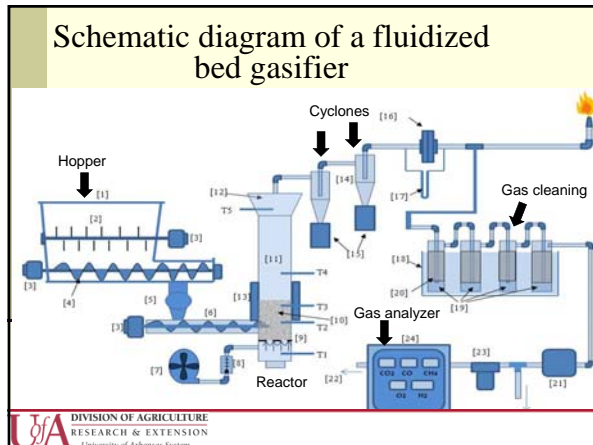
Gasification

- > Gasification is a thermochemical process (650-1000 °C) where a ratio of the combustion oxygen (less than 1) is supplied to convert carbonaceous materials in the fuel into gaseous products using different gasifying media

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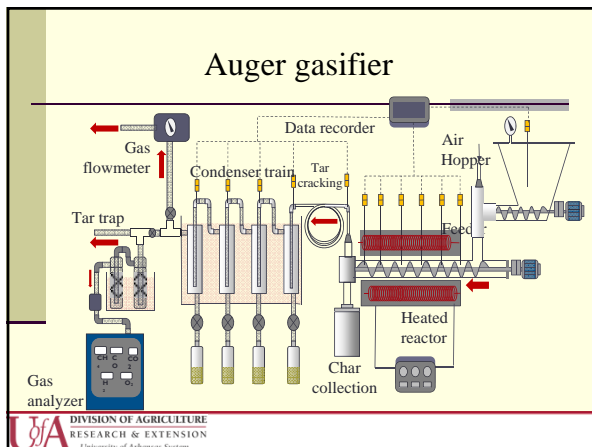




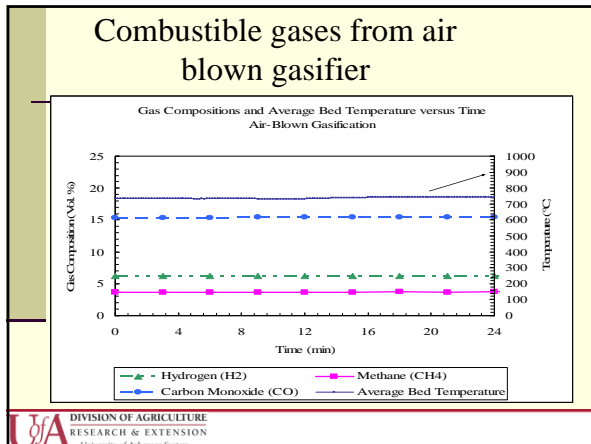
Auger gasifier

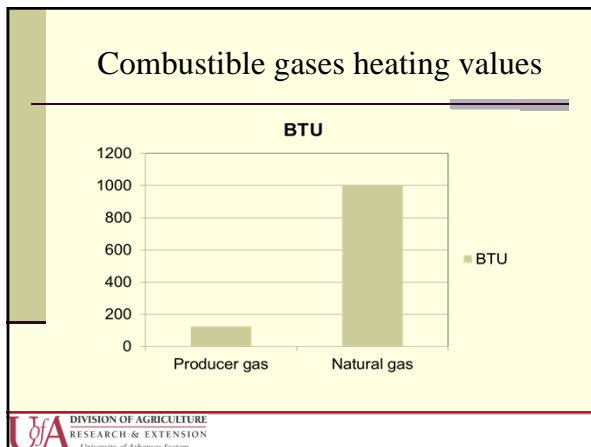
- How does this work?
- Advantages of the auger gasifier
- Disadvantages of the auger gasifier

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- ### Challenges facing thermochemical conversion of manure
- High moisture content
 - Feeding challenges
 - High ash content
 - Low BTU producer gas
 - Agglomeration
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Challenges facing thermochemical conversion of manure (continued)

- Ash
- Tar
- Ammonia
- Sulfur
- Particulate matter (PM)
- Low BTU gas
- Fixed and variable costs
- Permit: We like manure gasification but not in our backyard.



Reported gasification processes

- Manure into energy and ash - New Gasification Technology (North Carolina)
- Poultry manure gasification (West Virginia)
- Turkey farm uses a gasification system to produce Heat (Minnesota)








Reported gasification processes

- Assembly and testing of an on-farm Manure to energy conversion for animal waste pollution Control (Texas A&M)
- Rice husk/straw gasification to generate 12.0 MW of electricity and up to 100,000 Pound Per Hour of process steam (Riceland, Arkansas).




Biochar

Reactor Temperature of 300oC (1 h, 2 h, 3 h) →	
Reactor Temperature of 350oC (1 h, 2 h, 3 h) →	
Reactor Temperature of 400oC (1 h, 2 h, 3 h) →	
Continuous system (400oC, 500oC, 600oC) →	

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Carbon sequestration

- Aside from the production of gaseous fuel, gasification process produces biochar. Biochar soil application could potentially provide an ecological service by sequestering carbon in the soil thus creating a carbon sink.
- Carbon sequestration from auger gasification could reach about 30% of the raw feedstock carbon which could be returned back to the soil in the form of biochar carbon.

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Why should we consider gasification as a plan?

- Any instability in the supply of fossil fuels would profoundly effect the quality, availability and prices of food commodities, especially if it happen during the grains drying season
- The recent propone supply shortage, during the grain-drying season, in the Mid-West is a clear example of this dependency.
- Therefore, we need to have a plan B.

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Conclusion


- Although the gasification process have been extensively developed, it still have several limitations.
- Some of these limitations are related to gasifiers design while others are related to the feedstock characteristics.
- Gasification of manure and/or agricultural wastes can be the backup plan in cases of fossil fuel supply shortages.



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Thank You for your attention

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