

## Pyrolysis: Process and Products

### Pyrolysis

CenUSA is a USDA funded collaboration which is finding alternative sources for fuel, utilizing perennial grasses grown on land unsuitable for producing food crops in the Midwest. An objective of the CenUSA grant was to refine the technologies needed to extract an oil substance from the grasses to produce fuels. Pyrolysis is a promising method to meet this need.

During pyrolysis agricultural residues such as corn stover or dedicated energy crops like 'Liberty' switchgrass are burned at high temperatures in the absence of oxygen. This process results in a number of products, which are then utilized for various purposes such as drop-in fuels, chemicals for industrial uses, and biochar for soil amendments or water filtration.

To help you learn more about the various aspects of pyrolysis, the following diagram was created. In it you will see numbers, which label depicts some of the different components of the pyrolysis technologies. Visit the corresponding number in the list under the graphic to find additional materials about the associated step or component from the diagram. These additional materials includes links to videos and text based articles.

### Pyrolysis Diagram

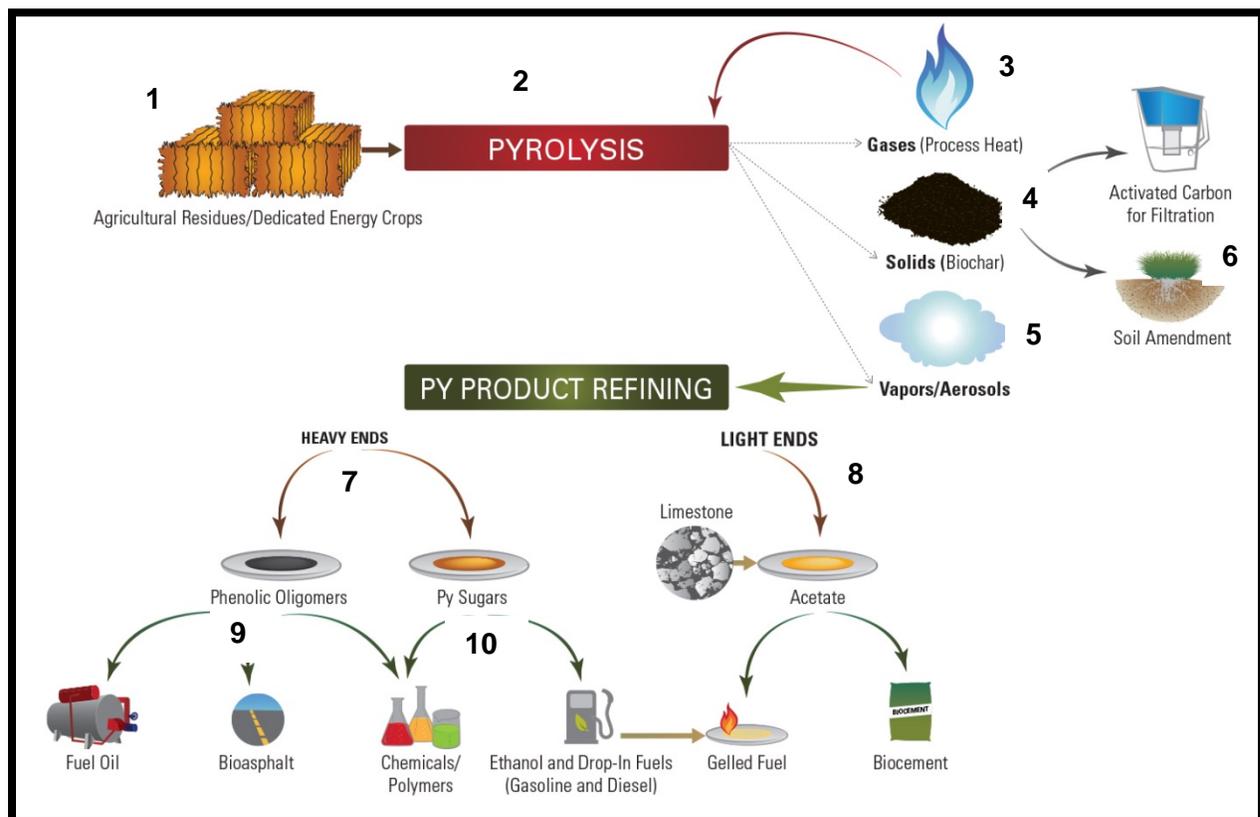


Image courtesy of Iowa State Bioeconomy Institute

## Pyrolysis Videos and Articles

### 1. Agricultural Residues/Dedicated Energy Crops

The native prairie grass, Switchgrass, is one of the energy crops CenUSA is working on as a source of materials for pyrolysis technologies in generating biofuel. Switchgrass has excellent potential as a bioenergy feedstock for cellulosic ethanol production, direct combustion for heat and electrical generation, gasification, and pyrolysis. The U.S. Department of Energy (DOE) Bioenergy Feedstock Development Program selected switchgrass as the herbaceous model species for biomass energy. Go to this eXtension article to learn more about the grass and how to grow it.

[Switchgrass \(Panicum Virgatum\) for Biofuel Production](#)

### 2. Pyrolysis

The process of pyrolysis requires machinery to burn materials in the absence of oxygen, and equipment to capture the products from burning. Visit the link below to take a video tour of the pyrolysis unit at Iowa State Bioeconomy Institute (ISU BEI).

[Fast Pyrolysis Development Unit \(video\)\\*](#)

**3. Gases** generated while burning residues can be captured, and then burned to heat the reactor.

### 4. Biochar solids

Biochar solids are referred to as a co-product of pyrolysis. While biochar is not the primary desired output of pyrolysis, this charcoal like substance is still valuable. Visit the video link below to learn more about biochar and its uses.

[Biochar: an Introduction to an Industry \(video\)](#)

**5. Vapors and aerosols** (smoke) are captured and condensed into a liquid form. This liquid is a mixture of water and organic compounds known as bio-oil.

### 6. Biochar as a soil amendment

Biochar has shown promise as a potential soil amendment to improve certain characteristics of soil for growing row crops or horticulture crops. Visit the links below to read how biochar could be used to improve sustainability of stover removal, or take a video tour of the University of Minnesota biochar research garden project.

[Research Summary: Biochar Can Improve the Sustainability of Stover Removal for Bioenergy](#)

[University of Minnesota Extension Master Gardener Biochar Research Summary \(video\)](#)

## 7. Heavy Ends /Sugar Recovery

Heavy ends consist of two parts, water soluble and water insoluble fractions. Visit the link below to learn how each of the heavy ends are processed and utilized for end products.

[BEI Sugar recovery \(video\)\\*](#)

## 8. Light Ends

Light ends resulting from pyrolysis can be separated and processed to result in useful products. Visit the video link below to view the process being developed at ISU BEI to turn light ends into useful products.

[BEI Separation of light ends\\*](#)

## 9. Processing Phenolic Oil

Phenolic oil generated during pyrolysis is unstable, making it challenging to use as an end product. Click on the link below to learn about work being done at ISU BEI to improve the stability of phenolic oil.

[BEI Low Temperature Low Pressure hydrogenation\\*](#)

## 10. Purifying sugar from heavy ends of bio-oil

The sugar fraction of heavy ends contains contaminants which must be removed to improve sugar quality. Visit the video link below to learn more about sugar purification and analysis conducted at ISU BEI.

[BEI Sugar purification and analysis\\*](#)

\*Material courtesy of Iowa State University Bioeconomy Institute

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