/eng/ - ENGINEERING

Bio Resource

Document List

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A list of relevant documents to Bio char/crude/oil/gas/fuel with a small overview/preview of the document's content.

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Pyrolysis and Bio Oil

http://www.uaex.edu/publications/PDF/FSA-1052.pdf

Pyrolysis and Bio-Oil

Samy Sadaka
Assistant Professor - Extension Engineer

A. A. Boateng
Research Chemical Engineer, USDA Agricultural Research Service

Abstract

The proposed U.S. renewable fuels standards require increasing the domestic supply of alternative fuels to 36 billion gallons by 2022. Out of this, 21 billion gallons must come from advanced bio-fuels; i.e., ethanol and/or hydrocarbon fuels from lignocellulosic biomass (conversion of non-grain resources such as agricultural residues, energy crops, etc.). One conversion technology with the right footprint that fits the farm setting and that can have an immediate impact on the farmers' bottom line is "pyrolysis." It is the heating of biomass in the absence of oxygen to produce bio-oil and charcoal (biochar) that can be returned to the soil to build it up so food, fiber and bioenergy can be sustainably and simultaneously produced. Herein, we provide some basic facts about pyrolysis and bio-oil production technologies to the non-engineer.

What Is Pyrolysis?

The process of combustion, the burning of fuel in air to generate heat, is well known. There are three pieces of the puzzle in making fire by combustion, the so-called fire triangle – fuel, heat and an oxygen source (normally air). In combustion, the fuel first heats up to generate the carbon and volatile matter which find the oxygen in the air to burn and generate heat. The first step, prior to the exposure of combustible gases to air, is actually the pyrolysis process.

Pyrolysis is the initial process that takes place when organic matter is first heated in the absence of oxygen to produce combustible gases. Pyrolysis by itself does not normally release excessive heat; rather, it requires heat to sustain it. Pyrolysis of organic materials such as biomass at high temperatures (greater than 428° F) decomposes the fuel source into charcoal (carbon and ash) and volatile matter. The latter comprises condensable vapors called pyrolysis oil (also known as bio-oil, biocrude, etc.) at room temperatures and non-condensable (permanent) gases such as carbon monoxide, carbon dioxide, hydrogen and light molecular weight hydrocarbon gases such as methane, collectively called synthesis gas (syngas or producer gas).

What Is Bio-Oil?

Bio-oil (Figure 1) is the liquid condensate of the vapors of a pyrolysis reaction. It is a dark brownish viscous liquid that bears some resemblance to fossil crude oil. It is at times marketed as "liquid smoke." However, bio-oil is

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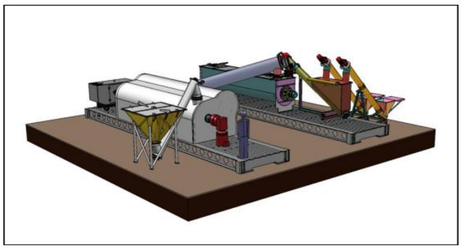
University of Arkansas, United States Department of Agriculture, and County Governments Cooperating

IBI Pyrolysis Plant Guidelines

http://www.biochar-international.org/sites/default/files/IBI_Pyrolysis_Plant_Guidelines.pdf

Guidelines for the Development and Testing of Pyrolysis Plants to Produce Biochar



Jane Lynch
Technology Extension Director
International Biochar Initiative

Stephen Joseph
Technical Director
International Biochar Initiative

International Biochar Initiative

www.biochar-international.org

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1. INTRODUCTION

This document was produced to assist in the development and testing of small pyrolysis plants and provides advice on equipment design and testing as well as the specification and testing of the biochar product.

The International Biochar Initiative encourages innovation and development of biochar production technologies at all scales. Because there are personal and environmental health and safety risks inherent in producing biochar, IBI has developed these Guidelines to assist in the safe and effective development and testing of biochar production technologies. The top concerns are to:

- Ensure the safety of equipment operators and the general public
- Minimise emissions of atmospheric contaminants
- Produce biochar that is suitable for soil application (refer to documentation of International Biochar Initiative's Characterisation Workgroup for parameters).

IBI seeks to promote biochar for environmental management and biochar production methods which are safe and beneficial for people and the environment. You can find more information about the IBI and about biochar at the IBI website:

www.biochar-international.org

1.1 Components of Pyrolysis Plants

Pyrolysis is the thermal degradation of biomass under the absence of oxygen. Pyrolysis results in three products: biochar, non-condensable gases and condensate (tars and water). The proportion of each is a strong function of the feedstock and the operating conditions of the pyrolyser. Some systems (slow pyrolysers) focus on biochar production with syngas as the major co-product, while other systems (fast pyrolysers) focus on bio-oil (condensate) production with biochar as the major co-product. These guidelines focus on slow pyrolysers.

Depending on the size and complexity of the pyrolysis plant, the main components of a pyrolysis plants include: pre-processing equipment (e.g. grinding, drying, chipping, sieves or screens), materials handling (belt conveyors, storage bins) and feeding equipment (feed screws, lock hoppers, feed belts), dryer (as required), biochar kiln, burners including syngas burners, gas cleaning, cooling and/or quenching equipment, instrumentation, and electrical equipment including generators.

The outline of a Functional Specification for Pyrolysis Plant in 2.1.1.1 provides an example of the scope of components which may be part of a plant. The Process Flow Diagram in 2.2 and the Process and Instrumentation Diagram in 2.4 provide illustrations of different pyrolysis plants.

BQM V1.0 – Biochar Quality Mandate

http://www.britishbiocharfoundation.org/wp-content/uploads/BQM-V1.0.pdf

What is the Biochar Quality Mandate?

Preparation of the Biochar Quality Mandate was supported by the Esmeé Fairbairn Foundation, with a contribution from the UK Engineering and Physical Sciences Research Council (EPSRC). Expert advice and inputs have been provided by the Environment Agency (England), Waste & Resources Action Programme (WRAP), Scottish Environmental Protection Agency (SEPA), Rothamsted Research, the James Hutton Institute, Newcastle University, the UK Biochar Research Centre at the University of Edinburgh and the British Biochar Foundation. The Biochar Quality Mandate (BQM) was initially based on the format of a Quality Protocol document, with the hope that it might be converted into a quality protocol. A quality protocol has two purposes: to assist in identifying the point at which a waste has been fully recovered, ceases to be a waste and becomes a product; and to give assurance that once recovered the product conforms to adequate standards and may therefore be used with confidence.[1] As of 2013, the Environment Agency is not intending to produce further Quality Protocols as a result of policy changes.

The Biochar Quality Mandate (BQM) aims to fulfil the two goals of a quality protocol as stated above. However, the BQM differs from a Quality Protocol in a number of ways: firstly, it applies to non-waste as well as waste biomass feedstocks; secondly, it does not carry the same authority to set out criteria by which regulators agree to assess products; and thirdly, it is not based upon a large body of case-law or regulatory experience with the product class in question. Even so, it is hoped that this document will be used by producers, end users and environmental regulators of biochar.

Foreword

Biochar is defined as 'a solid material obtained from the thermochemical conversion of sustainably sourced biomass in an oxygen-limited environment using clean processes and which is used for any purpose that does not involve its rapid mineralisation to CO2'.

Examples of the existing and potential uses of biochar include application as a: soil amendment, constituent of fertilisers, soil remediation technology, water filter and animal feed supplement. Version 1.0 of the Biochar Quality Mandate (BQM) focuses only on the use of biochar as an addition to soil.

Biochar has the potential to be used widely across the UK - by itself or as a constituent of other products. Whatever the proximate use, the end-use of biochar is as a carbon storage technology on timescales (100's of years) that are relevant to carbon abatement. The goal of the BQM is to remove impediments to the widespread use of biochar by categsorising and providing, where possible, methodologies for quantifying the risks associated with the production and use of biochar. The BQM provides the criteria by which a safe to use, good quality biochar product can be evaluated with reference to the UK context.

Biochar can be made from waste materials as well as from virgin biomass. Uncertainty as to whether producing biochar from a waste material can be classified as a waste recovery operation, and how to go about achieving end-of-waste status, are barriers to further biochar usage. Although ultimately this is a matter for the regulators, the BQM aims to provide guidance on such issues. Biochar (containing) products are at a very early stage of development and their regulatory and testing requirements are liable to change, even in the short term, hence it will be necessary for the BQM - and other regulatory guidance or standards which emerge to regulate biochar - to be updated as and when appropriate.

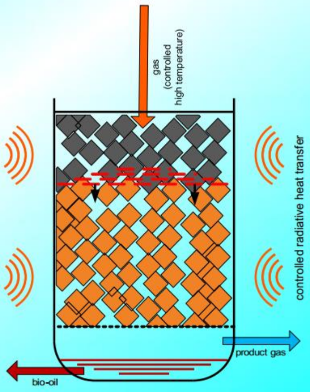
Industrial Charcoal with the Clean Fuels Condensing Retort

http://www.cleanfuels.nl/Sitepdfs/Condensingretort.sheets.pdf

CLEAN FUELS
for a sustainable energy economy

Principles of the Condensing Retort

- Batch process (2 x 5 m³ retorts processed simultaneously)
- Vapour combustion and energy storage sustain the process
- Combined direct and indirect heating to boost capacity, and to apply and control process temperature
- Fixed bed, controlled moving reaction front
- Bio-oil condensation inside retort:
  - secondary carbonisation increases yield
  - secondary carbonisation reduces ash content
  - surplus liquid bio-oil



Results:

- Increased production capacity
- Suitability for many feed materials (from nut shells to lump wood)
- Increased yield (process efficiency)
- Controlled and increased product quality
- By-product (bio-oil)
- No harmful emissions (proper combustion of product gas)

Patent pending

www.cleanfuels.nl 4

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Implementation: true scale test facility

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Our technology characterisation

Improved material use	Small wood pieces and larger (not only large pieces) Nut shell
Increased yield	35%-40% (vs 10%-30%) (mass % charcoal / dry wood)
Clean emissions	No noxious gases No GHG gases
High charcoal quality	Controlled All qualities demanded (up to 0 volatile matter)
By-products	Electricity (80 kW_e) (topping cycle) (to come 2014) Residual heat for steam or drying (1 MW_{th}, 500 °C) (bottoming cycle)
Capacity 1000-1500 t/yr	for Medium, Large & Very Large Industries Modular

Assessment of Bio-Oil as a Replacement for Heating Oil
http://www.nrbp.org/pdfs/pub34.pdf

Assessment of Bio-Oil as a Replacement for Heating Oil

By
James L. Easterly, P.E.

Easterly Consulting
9200 Santayana Dr.
Fairfax, VA 22031

For
Northeast Regional Biomass Program
Managed by the
CONEG Policy Research Center, Inc.

November 1, 2002

Executive Summary
Key issues regarding bio-oil commercialization are assessed in this white paper, with a particular focus on the use of this fuel in heating oil applications. The report is intended to be a first cut assessment of the potential for future development of regional bio-oil production and markets. Markets for lower valued wood from the forest are important for preserving the economic viability of the forest products industry in the Northeast. One potential use for lower value wood is the production of bio-oil. In general, liquid fuels are more convenient to store, transport, and combust than solid fuels. Thus a primary benefit offered by converting solid biomass fuels into bio-oil is the production of a more convenient and thus more readily marketable liquid product. Although bio-oil has a number of physical characteristics that differ from conventional petroleum-based fuel oil, including lower energy content per gallon and higher acidity, tests and demonstrations to date indicate that bio-oil should be a reasonable fuel for applications such as

heating or electricity generation. In circumstances where biomass can be obtained as a residue at near zero cost, bio-oil production is likely to be economically competitive. In the Northeast United States, where biomass such as wood chips often costs in the range of $18 per green ton, there will be a need for strong markets for the by-products of bio-oil production (such as specialty chemicals), or the existence of renewable energy mandates or incentives in order to make bio-oil applications economically attractive. There are a number of programs or market areas where the renewable nature of bio-oil may make it a viable option for nearer-term applications in heating commercial/institutional-scale buildings. These programs or market areas include federal buildings (where there are specific targets/requirements to increase the use of renewable energy sources), commercial-scale buildings/complexes that are targets of a new federal initiative to facilitate biomass fueled “super” energy saving performance contracts (ESPCs), state programs that are designed to encourage renewable energy use at state-owned facilities, and municipal governments (or institutions such as universities) that have formally adopted policies to reduce the net greenhouse gas emissions from their facilities.

Assessment of Bio-Oil Use as a Replacement for Heating Oil

By
James L. Easterly, P.E.
Easterly Consulting

Overview

Markets for lower valued wood from the forest are important for preserving the economic viability of the forest products industry in the Northeast. One potential use for lower value wood is the production of a liquid fuel often called bio-oil.

Bio-oil is produced by a process known as pyrolysis, where biomass (such as wood) is essentially cooked rapidly in a high temperature oxygen-free environment, yielding a mix of liquid fuel (bio-oil), combustible gases, and solid char. On a weight basis, 60 to 80% of the incoming biomass is converted to bio-oil, depending on the conversion process and the type of biomass feedstock being converted. The char and gases can be used as fuel to provide heat to dry the incoming biomass feedstock and to run the pyrolysis conversion process. If the incoming biomass has less than about 50% moisture content, there may be residual heat available for other industrial heat applications. Alternatively, the char can potentially be sold for higher-value uses (e.g., for the production of activated carbon, various chemicals, or charcoal).

In general, liquid fuels are more convenient to store, transport, and combust than solid fuels. Thus a primary benefit offered by pyrolysis is the production of a more convenient and thus more readily marketable liquid product.

Bio-oil producers claim a number of potential uses for bio-oil, including a fuel to power electric generators and to replace heating oil. The development of a successful bio-oil production facility is dependent on a number of factors. The following report is intended to be a first cut assessment of the potential for future development of regional bio-oil production and markets.

Bio-oil Characteristics

Bio-oil characteristics vary somewhat, depending on the production technology and the type of biomass feedstock from which the bio-oil is produced. This means that bio-oil fuel specifications are likely to be fairly important. Bio-oil's energy content is in the range of 72,000 to 80,000 Btu/gallon. (At the higher end of this range, there will typically be greater amounts of suspended char in the bio-oil.) Conventional heating oil has an energy content of about 138,500 Btu/gallon, thus bio-oil has about 52% to 58% as much energy as heating oil per gallon. However, it is interesting to note that bio-oil weighs about 40% more per gallon than heating oil.

Bio-oil is typically a dark brown liquid with a smoky acrid smell. It tends to have a relatively high water content – typically in the range of 20 to 25% water. The water comes from the pyrolysis conversion process, as well as from the initial water in the biomass feedstock. When the water content of the bio-oil is in the 20 to 25% range, it is entirely miscible in bio-oil (i.e., it

Biomass Extraction Methods

http://www.intechopen.com/books/biomass-now-sustainable-growth-and-use/biomass-extraction-methods

http://cdn.intechopen.com/pdfs-wm/44370.pdf

Chapter 15

Biomass Extraction Methods

Adina-Elena Segneanu, Florentina Cziple, Paulina Vlazan, Paula Sfirloaga, Ioan Grozescu and Vasile Daniel Gherman

Additional information is available at the end of the chapter

http://dx.doi.org/10.5772/55338

1. Introduction

Biomass represents an extremely valuable potential to obtain new clean energy sources and natural structurally complex bioactive compounds. Renewable energy can be produced from any biological feedstock, that contains appreciable amounts of sugar or materials that can be converted into sugar (e.g. starch or cellulose). Lignocellulose's biomass–dendromass and phytomass is natural based material consisting of complex of heterogenic macromolecules with cell structure (celluloses, hemicelluloses and lignin) as well as numerous organic and inorganic structures with low molecule weight (Sun, 2002).

Long-term economic and environmental concerns have resulted in a great amount of research in the past couple of decades on renewable sources of liquid fuels to replace fossil fuels. Producing of cellulose and alcohol from biomass is important technological process. Conversion of abundant lignocellulosic biomass to biofuels as transportation fuels presents a viable option for improving energy security and reducing greenhouse emissions. Lignocellulosic materials such as agricultural residues (e.g., wheat straw, sugarcane bagasse, corn stover), forest products (hardwood and softwood), and dedicated crops (switchgrass, salix) are renewable sources of energy. These raw materials are sufficiently abundant and generate very low net greenhouse emissions. The use of biomass with low economic value, the waste from agriculture, forestry and wild flora as sources of clean energy, is a viable way to avoid potential conflicts with the biomass production for food, which represent the main concern of UE regarding the biofuels production from biomass.

The presence of lignin in lignocelluloses leads to a protective barrier that prevents plant cell destruction by fungi and bacteria for conversion to fuel. For the conversion of biomass to fuel, the cellulose and hemicellulose must be broken. The digestibility of cellulose present in lignocellulosic biomass is hindered by many physicochemical, structural, and compositional factors. The lignocellulosic biomasses need to be treated prior to fuel production to expose