As the field of alternative energy is, in the public perception, a new one, characterized by incredible claims and spectacular failures, investors accordingly treat the industry with suspicion.

However, as this document will demonstrate, there are technologies within this field that are unfairly painted by the brush of scepticism. Specifically, we will show that modern pyrolysis which has been around for over 50 years, is a well studied and proven technology, is being applied in commercial settings and is economically viable.

Pyrolysis Defined

Simply stated, pyrolysis is the process whereby carbon based matter is brought to a high temperature in an oxygen deprived environment, resulting in a breakdown of the matter into its constituent chemical elements. When the gases produced by pyrolysis are cooled to room temperature, the heavier gases condense to liquids, which are called bio-oil. The lighter gases, like hydrogen and methane, which remain gases at room temperature, are called “syngas” (synthesis gas). By changing the temperature and duration of pyrolysis it is possible to optimize for one or more of the three by-products of pyrolysis: syngas, bio-oil and biochar. For example, slow pyrolysis under lower temperatures will produce more biochar whereas fast pyrolysis at higher temperatures will produce more bio-oil. With fast pyrolysis, the syngas that is produced can be burned within the system to maintain the temperature, resulting in bio-oil and biochar as the sole products of pyrolysis.

Pyrolysis in History

The practice of pyrolysis was used thousands of years ago in the Amazon rainforest to create bio char, a charcoal like product that was used to enrich and stabilize the nutrient poor rainforest soils. The indigenous peoples started fires and when the fuel was hot enough covered it with earth to deprive the fire of oxygen. The high temperature would continue to break down the fuel but in the absence of oxygen bio char was produced rather than ash.
More recently pyrolysis was used with wood waste feedstock during the two World Wars to produce transportation fuel when fossil fuels were unavailable. By 1945 trucks, buses and agricultural machines were powered by gasification. It is estimated that there were close to 9,000,000 vehicles running on bio-derived gas in many places around the world.

The Modern Era

Our modern development of pyrolysis emerged on a number of fronts in the late 1950s. In 1958 Bell Laboratories in the US, along with a number of universities and organizations around the world, started R&D programs to examine the usefulness of pyrolysis. These systems often focussed on the production of gas from waste materials.

The first Pyrolytic Gasification systems were firebrick ovens that used indirect heat in a low oxygen environment. These early systems were batch processes: ovens were filled, sealed and then heat was applied. After each batch the oven would be cleaned and readied for the next batch. The first commercial versions of pyrolysis batch systems for gasification were introduced in the hospital sector in the early 1970s, but due to low volume capacity and issues with the mortar used in the kiln construction they had limited commercial success. In the late 70s and early 80s the batch systems gave way to continuous feed systems with a cone design that made the evacuation of the gasses more efficient. The continuous feed cone design first showed up in England then the US, Germany, Japan, Canada and the Netherlands.

The Challenges of Incineration

Concurrent to these developments the 80s saw increasing environmental awareness and incineration technologies came under scrutiny. Environmental standards were put in place that necessitated the addition of very expensive equipment to clean the emissions, but even so the by-products remained problematic. Regulatory limits set for low volatile metals were exceeded within incineration systems by a factor of eight to ten times. As the oxygen molecule is a binding molecule the high oxygen environment of an incinerator causes the low volatile metals to be bound with the by-products. Also, dioxins are created in this high oxygen incineration environment as oxygen molecules are bound together along with other molecules within the gas stream. These drawbacks to incineration fuelled more research into pyrolysis.

Research & Commercialization of Pyrolysis

It was during the mid to late 1980s that pilot and commercial systems using direct pyrolysis gasification systems were introduced into the market place in the form of Fixed Bed, Fluidized Bed and hybrid designs. The fixed bed design passes the 'gasification agent' through a fixed bed of biomass while with the Fluidized bed the feedstock is fluidized in oxygen and steam or air while being subjected to pyrolysis. Problems with these systems lay in the impurity of their by-products: primarily hazardous tar and ash contaminants.

For the past 30 years these designs and their shortcomings have been subjected to a great deal of research, resulting in published university and governmental studies and the commercialization of new pyrolysis systems. Research has demonstrated that pyrolysis will provide as much or more energy per unit of biomass than fermentation of the same biomass into ethanol. The studies are too numerous to mention so a select few are noted at the end of this article. Detailed information on each of these studies can easily be found on the Internet.

Pyrolysis is Proven Technology

The research materials, demonstration facilities, existing commercial facilities and plants under construction provide ample proof that pyrolysis is neither new nor untested. The actual crux of the matter is not whether the technology works, but rather, is the APS Technology capable of providing a pure by-product in a safe and efficient manner?

To answer that question Magnum is able to provide lab tests from a commercial plant utilizing their first generation technology, which has been operational since mid 2008. The Company is also able to detail design changes made to that first generation technology which improve by-product quality, operational efficiency and plant safety.

MAGNUM GROUP INTERNATIONAL INC.

A Sampling of Recent Studies

Pyrolysis of Wood and Bark in an Auger Reactor: Physical Properties and Chemical Analysis of the Produced Bio-oils

Leonard Ingram,*,† Dinesh Mohan,‡ Mark Bricka,• Philip Steele,† David Strobel,† David Crocker,| Brian Mitchell,† Javeed Mohammad,• Kelly Cantrell,† and Charles U. Pittman, Jr.#
Forest Products Department, Mississippi State University, Mississippi State, Mississippi 39762, Department of Chemistry, Mississippi State University, Mississippi State, Mississippi 39762, Department of Chemical Engineering, Mississippi State University, Mississippi State, Mississippi 39762, and National Renewable Energy Laboratory, Chemistry Department, Mississippi State University Golden, CO 80401
Received June 15, 2007. Revised Manuscript Received September 20, 2007

Quality of poultry litter-derived granular activated carbon

Guannan Qiu, Mingxin Guo *
Department of Agriculture and Natural Resources, Delaware State University, Dover, DE 19901, United States
Article history: Received 19 February 2008; Received in revised form 14 July 2009; Accepted 18 July 2009; Available online 22 August 2009

BioEnergy Research Group at Aston University

BERG - the **B**io**E**nergy **R**esearch **G**roup at Aston University is one of the largest university based research groups in thermal biomass conversion in the world. It was formed in 1986 as a focus for a range of inter-related activities in biomass conversion and environmental studies related to global warming and has grown into a substantial multi-disciplinary research effort.
Our Mission - "To apply chemical engineering science and technology to help provide the world with sufficient energy, fuels and chemicals from renewable and sustainable biomass resources to meet tomorrow's needs."

University of Calgary advances pyrolysis project

Thomas Saidak | July 1, 2011

In Canada, Dr. Nader Mahinpey, with the University of Calgary is working with pyrolysis to turn the non-edible parts of plants into biofuel. The resulting oil needs to be upgraded before it can be used as transportation fuel, so Dr. Mahinpey and his team are working on developing the upgrading processes and to turn the waste by-products of biofuel conversion into chemicals such as fertilizer.