A Collaborative Approach to Handling and Storage of Biocoal

Advanced Torrefaction Systems, LLC and HM3 Energy, Inc. combine technologies to address high COD levels in leachate and potential for self-heating in biocoal

By Thomas P. Causer and Hiroshi Morihara

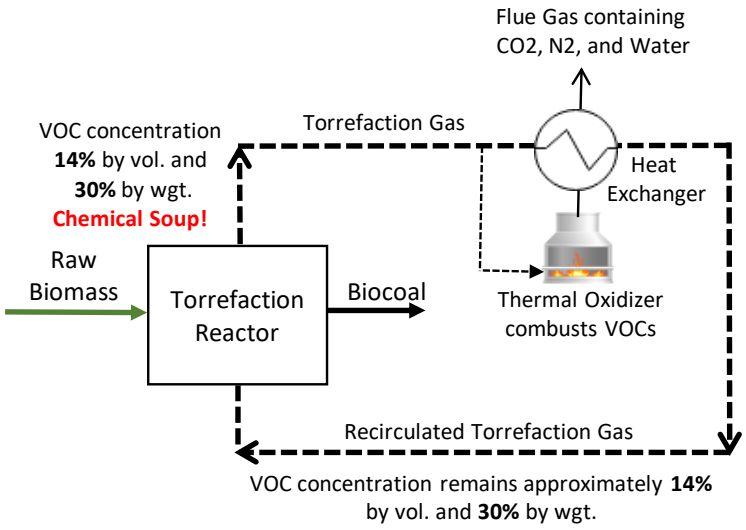
Under pressure to decarbonize, many coal plant operators have begun testing biocoal (or black pellets) produced from torrefied biomass as a renewable, carbon-neutral replacement for coal. The energy content and grindability of biocoal makes it a promising drop-in coal replacement fuel. And, like coal, properly manufactured biocoal is hydrophobic, so it can be stored outdoors, providing capital cost savings for end-users. Although the benefits of biocoal are excellent, some practical issues remain to be addressed.

Leachate and Self-heating Issues in Biocoal

Some testing with bulk deliveries of sample biocoal by end users has indicated two issues of concern. First, high Chemical Oxygen Demand (COD) levels in leachate can occur when biocoal is stored outdoors in the elements without cover, exposed to rain and snow. As a result, runoff can create environmental challenges. Secondly, there have been instances where biocoal, when stockpiled, has self-heated and ignited.

Raw biomass undergoing torrefaction produces volatile organic compounds (VOCs.). VOCs can condense and cause serious problems both in the process and in the final product. Conventional torrefaction technologies employ recirculation of a major portion of the torrefaction gases, with a small portion of the gas stream extracted and combusted in order to provide adequate temperature control of the larger portion that is then recirculated back to the reactor to provide the necessary process heat. The problem with this method is that the gas recirculated to the reactor is laden with VOCs and, when used in the reactor, results in a very high concentration of VOCs in the overall torrefaction system-- approximately 30% by weight (14% by volume) (See Figure 1 below). As a result, VOCs readily condense and adhere to the surface of the torrefied biomass as it exits the reactor, remaining in the final biocoal product after densification.

Figure 1



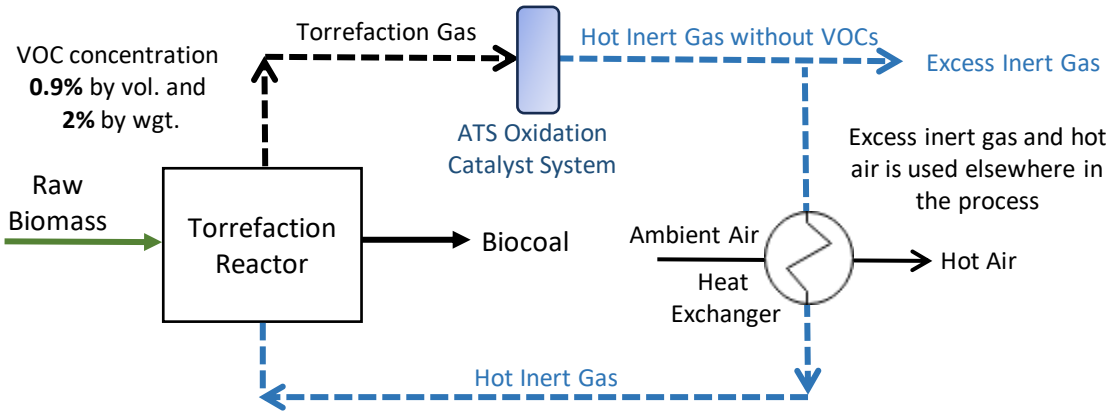
Reducing VOCs to an Acceptable Level

Based on extensive experience in torrefaction, HM3 Energy, Inc. (HM3), and Advanced Torrefaction Systems, LLC (ATS), have concluded that the presence of excessive VOCs in the biocoal is the cause of high COD levels in the leachate and self-heating/auto-ignition. To resolve this problem, two steps are required. First, the VOCs must not be recirculated to the torrefaction reactor. Secondly, inert gas must be used as a purge gas to 'strip' away any evolving VOCs from the torrefied biomass as it exits the reactor. The combined technologies of HM3 and ATS accomplish these steps.

ATS's Catalytic Oxidation System

ATS has designed and patented an oxidation catalyst system that drastically reduces the concentration of VOCs in the overall torrefaction system (See Figure 2 below). ATS's system creates an essentially inert catalyst flue gas that provides the necessary heat to the reactor (without adding VOCs as with conventional torrefaction technologies) and a purge gas that strips VOCs from the biocoal.

Figure 2



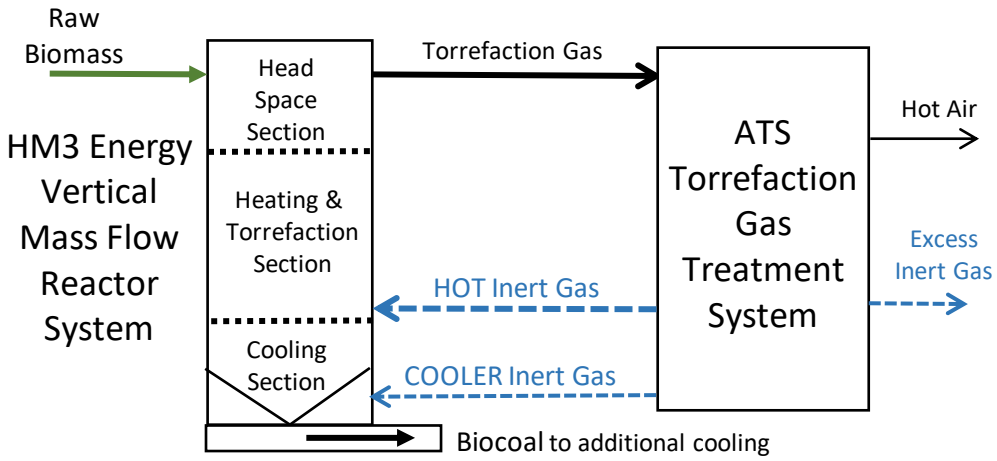
HM3 Energy's Vertical Mass Flow Reactor Design

HM3 has designed and patented a three-section vertical mass flow torrefaction reactor capable of torrefying a broad range of biomass feedstocks. The top section or head space area allows proper disengagement of the counter-current flow gas stream from the biomass. The middle section dries the biomass as it heats the biomass to torrefaction temperature and torrefies it. The lower section cools the torrefied biomass to a lower temperature terminating the torrefaction reaction and providing a final purge of any remaining VOCs from the torrefied biomass.

HM3's torrefaction system provides: (1) uniform torrefaction with excellent temperature control in the torrefaction section (no hot spots), (2) controlled termination of the torrefaction reaction in the cooling section, and (3) torrefied biomass that has been scrubbed of any remaining VOCs. This reactor design has a

high thermal efficiency, is relatively inexpensive, and has few moving parts. A simplified block diagram of HM3's reactor using ATS's catalytic oxidation system is shown in Figure 3 below:

Figure 3



The combined HM3/ATS approach results in a drastic reduction in the concentration of VOCs in the system and a final biocoal product that has been purged of VOCs from its surface. ATS and HM3 believe this reduction of VOCs in conjunction with HM3's densification into sturdy hydrophobic HM3Biocoal™ briquettes will dramatically reduce the COD levels in leachate to an acceptable level and reduce or eliminate the occurrence of self-heating/auto-ignition in storage.

Authors: Thomas P. Causer, VP and COO, Advanced Torrefaction Systems, LLC
www.atscat.com

Hiroshi Morihara, President and CEO, HM3 Energy, Inc.
www.hm3e.com