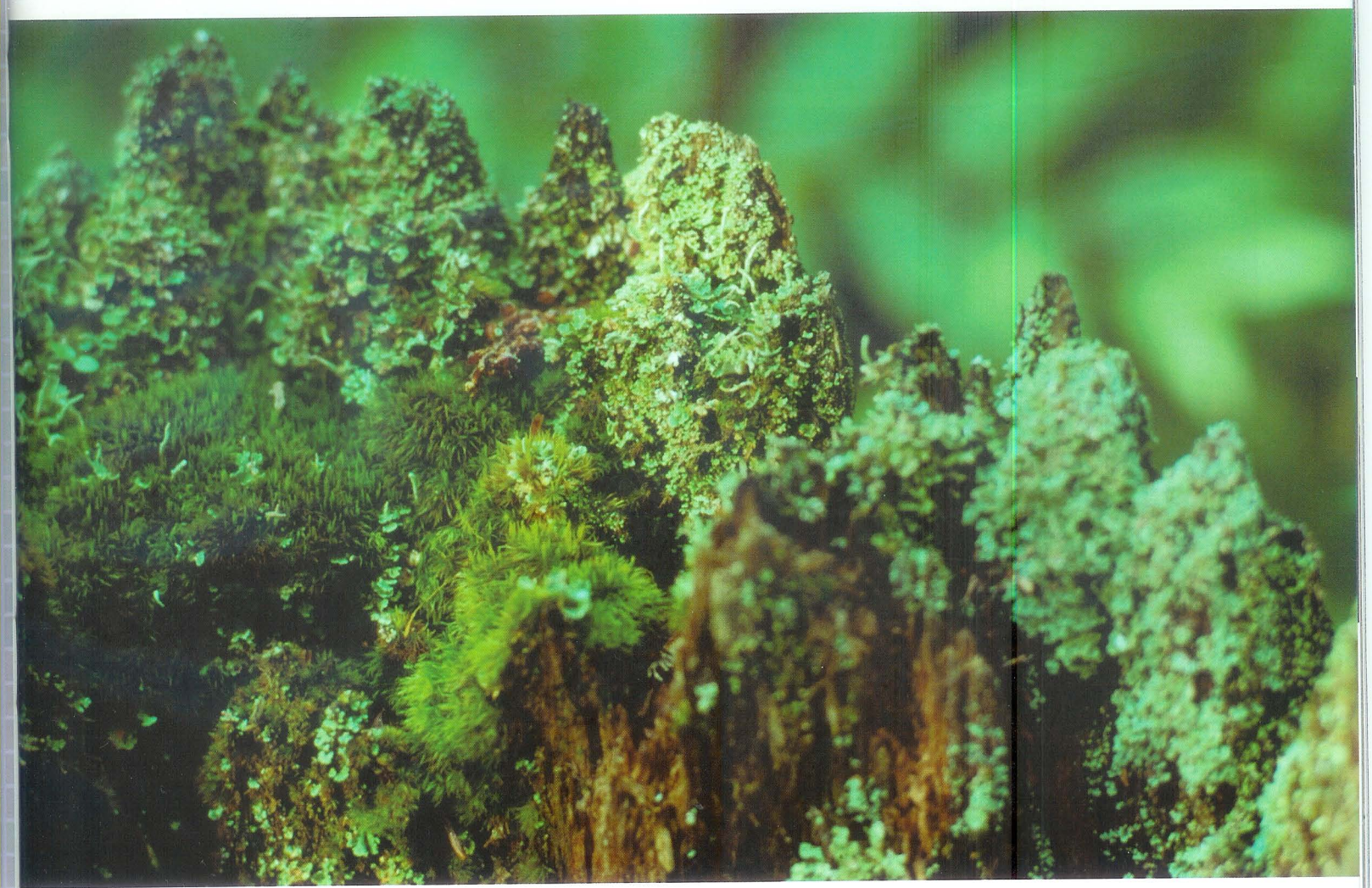
Pre-combustion Preparation of Coal and Biomass Fuel

By Peter Rugg, MacArthur Energy

At the recent ACC Fuel Flexibility Conference in Chicago, there was considerable discussion relating to variations in fuel. Historically, boilers were designed for a specific fuel, usually the closest or most economically available. Periodic regulation, emissions standards, transportation logistics and changing coal prices have forced utilities to purchase coal from farther afield to remain in compliance. These variations in fuel characteristics create new problems with burner operations, including grindability, ash and slagging inefficiencies.

Additionally, with few tools previously available to clean up fuel prior to combustion, costly systems to clean up off gasses post-combustion (scrubbers) were added to meet emissions standards. As a result, **to date most technologies employed have focused on combustion tuning and optimization, and the removal of the pollutants out of exhaust gasses post-combustion.**

A second major theme at the Fuel Flexibility Conference was the morass of conflicting regulations facing anyone burning solid fuel today. For example, the U.S. EPA has a program covering the use of Land Fill Gas (LFG) for generation, but the proposed Minimum Achievable Control Technology (MACT) rules for industrial boilers restrict carbon monoxide, without exempting LFG with its high CO footprint. The installed fleet of coal-fueled plants produces 40 percent of global electricity, and coal combustion will grow at least through



2030 to meet increasing demand, according to EIA forecasts. Thus, since the world will be significantly dependent on solid fuels for the existing installed base for at least the next 50 years, it is imperative that we have regulations that foster burning solid fuels as cleanly as possible. The regulators should allow industry to choose the best alternative between reducing methane as a GHG and an offsetting increase in less polluting CO. **We must look for opportunities to utilize clean renewable solid fuels, including biomass, in our existing solid fuel-burning infrastructure.**

Conference participants heard presentations on a range of issues facing variations in fuel characteristics, as well as the use of solid biomass fuels. Attempts to co-fire moist low-BTU biomass as a fuel in coal-fueled plants have failed many times. Upon reflection, such attempts seem analogous to introducing leftover paint, solvents or cleaning fluids with combustion value into the gas tank of a car or the tank for a home oil burner. For safety and efficiency reasons, there must be a serious focus on pre-treating solid fuels to meet energy and emission goals.

Pre-combustion technology solutions currently exist to address variable fuel characteristics. The primary properties of any solid fuel that are most important to a boiler operator are BTU content (dry), pollutants (Cl, Hg, S, heavy metals), grindability, ash, slagging propensity and, more recently, qualification as a renewable fuel. Pre-combustion technologies exist to remove moisture, mercury, chlorine, heavy metals, sulfur, and ash to aid in emission compliance. Selectively and economically deploying these technologies and careful blending can tune the fuel to meet the optimal burning characteristics of each individual boiler and its present post-combustion cleanup in the existing fleet. Research has shown that many biomass species can be prepared to mill and combust effectively without modifications to fuel handling or to the boiler. Importantly, the high costs of fuel switching and/or implementation of further post-combustion technologies make **now** the time for commercializing pre-combustion technologies.

Many forms of biomass are generally available; however, only purpose-grown biomass can assure consistent supply. Algae have demonstrated the capability of growing the highest calorific value yield of all purpose-grown fuel crops. MacArthur's biomass processes employ CO_2 that is immediately available from the flue gas of the boiler client burning partially renewable fuel grown with Nitrogen, Phosphate, Potassium (NPK), and water. The flue gas provides ambient heat that supports algae growth. NPK are generally available in waste streams from farms, ranches, or municipal water plants nearby. The algae are grown in closed bioreactors that minimize contamination and evaporative water loss and support a proprietary harvest and concentration system.

The dewatering of biomass is accomplished as it mixes with coal in a low cost mechanical, non-thermal system. Nutrient-laden water is recycled to the algae growth bioreactors after alkali removal. Finally the CoalBio fuel is upgraded with the removal of the chlorine and mercury present in the raw coal. This fuel can either be the entire fuel mix for the boiler, or it can be blended with raw coal as it is conveyed to the boiler depending on specific boiler requirements.

The resultant fuel can have a range of desired properties. For example, a 50/50 mix of high lipids chlorella and Powder River Basin (PRB) coal produces a fuel that is:

- 50% renewable
- Absorbent of one ton of CO_2 for each ton produced
- About 12,000+ BTU/lb (dry)
- About 0.3 percent sulfur
- About 1.5 10-6 Mercury
- About 2.3 10-3 Chlorine
- HGI in the 50s
- Not friable
- Sized for either stoker or pulverizer
- Priced 15-20 percent above coal with similar BTU and Sulfur content

MacArthur systems are modular, and range from a demonstration plant utilizing 15-20 acres under cultivation and producing about 10 tons per day to multiple commercial size modules producing about 10 tons per hour with 400 acres under cultivation.

For more information email Info@MacArthurEnergy.com or telephone 347-414-9267. ◆

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