FUEL (incl. Biogas, Biodiesel, Biomass energy, Ethanol, etc.)

NPARR 5(2), 2014-0128 Evaluation of methyl ester of microalgal oil as fuel in a diesel engine

Biodiesel can be obtained from various resources. However, the usage of vegetable oils as biodiesel source may impact global food market. Therefore, scientists focus on searching new biodiesel sources which are non-edible and easy to obtain. Microalgae have gained much attention recently due to their high growing rates and high oil contents. The objective of this study is to identify availability of microalgal biodiesel in diesel engines as alternative fuel. Microalgal biodiesel was blended with diesel fuel with the volumetric ratio of 5%, 10%, 20% and 50%. Fuel properties of blends and pure microalgal biodiesel were found out and the performance characteristics and exhaust emissions of the engine fueled with blends were analyzed. The results showed that, although microalgal biodiesel caused a slight reduction in torque and brake power values, the emission values of the engine using microalgal biodiesel were improved [Gökhan Tüccar* and Kadir Aydin (Çukurova University, Department of Mechanical Engineering, 01330 Adana, Turkey), Fuel, 2013, 112, 203–207].

NPARR 5(2), 2014-0129 Potential of bioenergy production from industrial hemp (Cannabis sativa): Pakistan perspective

Pakistan is facing severe economical crunch due to continuously growing gap between energy demand and supply. The shortage in power and gas supply has already halted many industrial sectors such as textile, small and medium enterprises and local transportation. The government has spent US $ 9 billion on energy import during 2008–2009 to fulfill current energy requirements. Indigenous energy resources, mainly fossil fuels, are already being exploited at their maximum. Besides these short term steps, energy demand is expected to double during next decade. Thus, renewable and sustainable energy resources, such as biomass, needs to be exploited so that a sustainable energy mix could be employed to ensure energy security. Industrial hemp (Cannabis sativa) has been successfully investigated for its potential to be used as a renewable feedstock for the production of biofuels. Hemp is an environmental friendly and low cost feedstock which grows wildly in most parts of Pakistan. Thus, hemp can be grown as a potential energy crop in Pakistan to meet its energy requirements by producing various kinds of biofuels. This sustainable feedstock will help the country to reduce its energy import bills, and ensure sustainable energy supply [Muhammad Saif Ur Rehmana, Naim Rashida, Ameena Saifd, Tariq Mahmoodd and Jong-In Hana*(Department of Civil and Environmental Engineering, Korea Advanced Institute of Science and Technology, Daejeon, Republic of Korea), Renewable and Sustainable Energy Reviews, 2013, 18, 154–164].

NPARR 5(2), 2014-0130 Selection and testing of Populus alba and Salix spp. as bioenergy feedstock: Preliminary results

Although large amounts of residue from agriculture and forestry are presently available for the production of bioenergy, to ensure a sustainable, long-term supply of biomass, it is necessary to establish and grow perennial energy crops on marginal agricultural land that is specifically intended to produce biomass for energy. Preliminary research has identified several perennial crops as potential biofuel crops including perennial grasses, poplars and willows. The high content of cellulose in these species indicates that the materials could be a potential feedstock for bioethanol production too. To select highly productive white poplar and willow clones suitable for these purposes, progenies of Villafranca (Populus alba) and willow clones from different species, mainly Salix matsudana,
Invasive plants as feedstock for biochar and bioenergy production

In this work, the potential of invasive plant species as feedstock for value-added products (biochar and bioenergy) through pyrolysis was investigated. The product yield rates of two major invasive species in the US, Brazilian Pepper (BP) and Air Potato (AP) were compared to that of two traditional feedstock materials, water oak and energy cane. Three pyrolysis temperatures (300, 450, and 600 °C) and four feedstock masses (10, 15, 20, and 25g) were tested for a total of 12 experimental conditions. AP had high biochar and low oil yields, while BP had a high oil yield. At lower temperatures, the minimum feedstock residence time for biochar and bioenergy production increased at a faster rate as feedstock weight increased than it did at higher temperatures. A simple mathematical model was successfully developed to describe the relationship between feedstock weight and the minimum residence time [Rui Liaoa, Bin Gaob* and June Fangb (Department of Agricultural and Biological Engineering, University of Florida, Gainesville, FL 32611, USA), Bioresource Technology, 2013, 140, 439–442].
In this study, a bacterial strain, *Lysinibacillus sphaericus* which is relatively new in the vast list of biocatalysts known to produce electricity has been tested for its potential in power production. It is cited from the literature that the organism is deficient in some sugar or polysaccharide processing enzymes and thus is tested for its ability to utilize substrates mainly rich in protein components like beef extract and with successive production of electricity. The particular species has been found to generate a maximum power density of 85 mW/m² and current density of ≈270 mA/m² using graphite felt as electrode. The maximum Open Circuit Voltage and current has been noted as 0.7 V and 0.8 mA during these operational cycles. Cyclic voltammetry studies indicate the presence of some electroactive compounds which can facilitate electron transfer from bacteria to electrode. The number of electrogens able to generate electricity in mediator free conditions are few, and the study introduces more divergence to that population. Substrate specificity and electricity generation efficacy of the strain in treating wastewater, specially rich in protein content has been reported in the study. As the species has been found to be efficient in utilizing proteinaceous material, the technique can be useful to treat specific type of wastewaters like wastewater from slaughterhouses or from meat packaging industry. Treating them in a more economical way which generates electricity as a outcome must be preferred over the conventional aerobic treatments. Emphasizing on substrate specificity, the study introduces this novel *Lysinibacillus* strain as a potent biocatalyst and its sustainable role in MFC application for bioenergy generation [Arpita Nandy, Vikash Kumar and Patit P. Kundu* (Department of Polymer Science and Technology, University of Calcutta, 92, A.P.C Road, Kolkata 700009, India), *Enzyme and Microbial Technology*, 2013, 53(5), 339–344].

**NPARR 5(2), 2014-0133 Utilization of proteinaceous materials for power generation in a mediatorless microbial fuel cell by a new electrogenic bacteria *Lysinibacillus sphaericus* VA5**

Meeting EU targets for renewable transport fuels by 2020 will necessitate a large increase in bioenergy feedstocks. Although deployment of first generation biofuels has been the major response to meeting these targets they are subject to wide debate on their sustainability leading to the development of second generation technologies which use lignocellulosic feedstocks. Second generation biofuel can be subdivided into those from dedicated bioenergy crops (DESGB), e.g. miscanthus, or those from co-products (CPSGB) such as cereal straw. Potential supply of cereal straw as a feedstock for CPSGB’s is uncertain in England due to the difficulty in obtaining data and the uncertainty in current estimates. An on-farm survey of 249 farms (Cereal, General Cropping and Mixed) in England was performed and linked with Farm Business Survey data to estimate current straw use and potential straw availability. No significant correlations between harvested grain and straw yields were found for wheat and oilseed rape and only a weak correlation was observed for barley. In England there is a potential cereal straw supply of 5.27 Mt from arable farm types; 3.82 Mt are currently used and 1.45Mt currently chopped and incorporated. If currently chopped and incorporated cereal straw from arable farm types was converted into bioethanol, this could represent 1.5% of the UK petrol consumption by energy equivalence. The variations in regional straw yields (t ha⁻¹) have a great effect on the England supply of straw and the potential amount of bioethanol that can be produced [Neryssa J. Glithero*, Paul Wilson and Stephen J. Ramsden (Division of Agricultural and Environmental Sciences, School of...
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Biosciences, University of Nottingham, Sutton Bonington Campus, Loughborough LE12 5RD, UK), Biomass and Bioenergy, 2013, 55, 311–321].

NPARR 5(2), 2014-0135 Hemp: A more sustainable annual energy crop for climate and energy policy

The objective of this study was to compare the fuel-chain greenhouse gas balance and farm economics of hemp grown for bioenergy with two perennial bioenergy crops, Miscanthus and willow, and two more traditional annual bioenergy crops, sugar beet and oil seed rape (OSR). The GHG burden of hemp cultivation is intermediate between perennial and traditional annual energy crops, but net fuel chain GHG abatement potential of 11 t/CO$_2$ eq./ha/year in the mid yield estimate is comparable to perennial crops, and 140 % and 540 % greater than for OSR and sugar beet fuel chains, respectively. Gross margins from hemp were considerably lower than for OSR and sugar beet, but exceeded those from Miscanthus when organic fertilizers were used and in the absence of establishment grants for the latter crop. Extrapolated up to the EU scale, replacing 25 % of OSR and sugar beet production with hemp production could increase net GHG abatement by up to 21 Mt CO$_2$ eq./year. Hemp is a considerably more efficient bioenergy feedstock than the dominant annual energy crops. Integrated into food crop rotations, hemp need not compete with food supplies, and could provide an appealing option to develop more sustainable non-transport bioenergy supply chains [John Finnan* and David Styles (Teagasc Crops Environment and Land Use Programme, Oak Park Crops Research Centre, Carlow, Ireland), Energy Policy, 2013, 58, 152–162].

NPARR 5(2), 2014-0136 The properties of pellets from mixing bamboo and rice straw

Rice straw pellets are the main type of biomass solid fuel and have great potential as a bioenergy resource of the future in China. But it also showed important problems because of its high content of ashes and its low gross calorific value, reducing the possibility to be used in domestic heating. It was certified that mixing different types of biomass materials was helpful to improve the properties of pellets. To improve properties of rice straw pellets and investigate the effect of mixing bamboo and rice straw on the pellet properties, some properties of pellets, manufactured using different mixing ratio of bamboo and rice straw particles, were determined in this research. It can be concluded from this research that physical properties of all pellets meet the requirements of Pellet Fuels Institute Standard Specification for Residential/Commercial Densified except for bulk density of pellets, manufactured using mixing ratio (≤3:2) of bamboo and rice straw. The inorganic ash and gross calorific value of rice straw pellets cannot meet the requirement of Pellet Fuels Institute Standard Specification for Residential/Commercial Densified (8.0%) and the minimum requirement for making commercial pellets of DIN 51731 (>17,500 J/g). Both properties are improved through mixing bamboo particles and rice straw particles. It is significant that inorganic ash content and gross calorific value of pellets, manufactured using mixing ratio (≥3:2) of bamboo and rice straw, were lower than 8.0% and higher than 17,500 J/g, respectively. This also shows that mixing different biomass materials is an effective way to optimize properties of biomass solid fuel. All pellets after improvement are proposed as biomass solid fuel and have the potential to be developed as commercial pellets on an industrial scale in China [Zhijia Liu, Xing’e Liua*, Benhua Feia, Zehui Jianga, Zhiyong Caib and Yan Yu (International Centre for Bamboo and Rattan, Beijing 100102, China), Renewable Energy, 2013, 55, 1-5].

NPARR 5(2), 2014-0137 Sustainable bioenergy production from tofu-processing wastewater by anaerobic hydrogen fermentation for onsite energy recovery

The conversion efficiency of tofu-processing wastewater (TPW) into hydrogen and
ethanol for energy source in a tofu-making factory was evaluated by testing various sludge types, initial cultivation pH values, temperatures and substrate concentrations. Experimental results indicated that a peak H\textsubscript{2} production yield (HY) of 107.5 mL-H\textsubscript{2}/g COD and ethanol concentration of 2181 mg-COD/L were at 35\textdegree C, TPW concentration 20 g-COD/L and pH 5.5–6.0 in batch tests. Peak H\textsubscript{2} production rate of 1.73 L H\textsubscript{2}/L-d was obtained at HRT 8h in a CSTR. Main soluble metabolic products were acetate and butyrate during TPW fermentation. The peak total energy (H\textsubscript{2} and ethanol) production efficiency of 485 J/g COD (160 J/g COD from H\textsubscript{2} and 325 J/g COD from ethanol) and rate of 43.3 kJ/L-d (19.6 kJ/L-d from H\textsubscript{2} and 23.7 kJ/L-d from ethanol) were obtained at HRT 12 and 8h, respectively. This could support up to 3.5% of the annual energy consumption in a tofu-making factory and also reduce the carbon dioxide emission up to 6.65 ton CO\textsubscript{2} equivalents/y [Chyi-How Laya, Biswarup Sena*, Shih-Ching Huangb, Chin-Chao Chend and Chiu-Yue Lina (Department of Environment Engineering and Science, Feng Chia University, Taichung 40724, Taiwan), Renewable Energy, 2013, 58, 60–67].