Proper Biomass Together With Microorganism Mediated Cellulosic Ethanol Production

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In cellulosic ethanol production, not only are the sugars in the plant fermented into ethanol (as with corn-based ethanol production), but the cellulose, which is most of the plant's mass, is broken back down into sugars and also fermented into ethanol. So, cellulosic ethanol production is able to utilize almost the entire plant to make ethanol, resulting in many fewer plants and much less acreage needing to be used to make a given amount of this fuel.

Two methods of breaking cellulose back down into sugars are the use of a different enzyme for each different form of cellulose, and the microorganism-mediated process, which uses a different microorganism for each step but can handle all forms of cellulose with the same set of microorganisms.

The microorganism-mediated process is unique in its ability to make ethanol because it can do so with the input of extremely small amounts of energy -- which in turn, results in little or no pollution, a large energy gain, and, an extremely low cost per gallon for ethanol produced by this process.

Furthermore, there are two existing biocrops requiring minimum cultivation that can provide, respectively, ten, and up to nineteen thousand gallons of cellulosic ethanol annually per acre. In the US, these crops must be grown in southern states like Louisiana, Florida, and South Texas. Another biocrop however, forage sorghum, can be grown throughout much of the US and yields sufficient cellulose per acre to enable cost-effective commercial production and use of cellulosic ethanol to become local.

The microorganism-mediated process of cellulosic ethanol has the following practical characteristics that make ethanol produced by this process the first desirable replacement for gasoline without any significant negative tradeoffs:

(1) The microorganism-mediated process, like other processes of cellulosic ethanol, can replace all oil imported into the US with selected biomass grown on no more than 10% of the acreage currently devoted to US agriculture. That is, unlike "corn ethanol" – which would require more agricultural acreage then exits in the US to replace all imported oil – no significant tradeoff of acreage is required for growing biomass for fuel versus food;

(2) The energy gain – the amount of energy produced in the form of ethanol compared to the energy needed to grow the biomass and turn it into ethanol is about 11:1. (Energy gain for corn ethanol is only 1.3:1);

(3) There is almost no pollution generated by the microorganism-mediated process when turning biomass into ethanol;

(4) Growing biomass for the process can be rendered truly sustainable if it's done right, even after oil and gas are gone or their use curtailed because of global warming;

(5) A simple, low cost, energy conserving step during manufacture removes all water to yield ethanol that is 200 proof.

(6) The microorganism mediated process of cellulosic ethanol production can use any mixture of cellulose –biocrops grown for the process, prairie grasses, straw or stubble left in the field after harvest of other crops, sawdust, scrap paper, etc. Other processes of cellulosic ethanol use dedicated enzymes to decouple cellulose molecules back into sugars. Enzymes are expensive, however, and each form of biomass requires a different enzyme.

(7) An additional step, applicable to some other biofuel production processes as well, can render this ethanol “carbon negative” during its manufacture – in the sense that the three processes, of growing the biomass, changing it into ethanol and burning the ethanol together remove more carbon dioxide from the atmosphere than they introduce. This is accomplished by: (a) growing biomass that requires few energy intensive inputs during its cultivation; and, (b) suitably capturing the copious amounts of carbon dioxide that are released during the ethanol manufacturing process. After suitable capture the carbon, which is no longer in gaseous form, can be sequestered in a manner that will keep it sequestered for a millennium or longer. Once a biofuel has been rendered carbon negative during its manufacture it can be burned at all sites throughout civilization without having to capture any *additional* carbon dioxide produced by burning the fuel – unless one wished to remove even more carbon dioxide from the atmosphere.

(8) The cost of producing microorganism-mediated cellulosic ethanol is significantly lower than any other process of ethanol production -- well under US $1 per gallon – providing substantial margin for rendering the biofuel carbon negative and then sequestering its carbon. (Current processes of cellulosic ethanol produce the fuel at around US $2 per gallon.)

Microorganism-mediated cellulosic ethanol, together with production of the proper biomass, is thus a practical replacement for most energy applications of oil and has a dual set of environ-mental benefits: The ethanol itself can be rendered carbon negative but also, to the extent it replaces oil, it eliminates one of the most carbon positive enterprises on earth – oil and its support industries and technologies.