Green Indicator

The challenges of handling different kinds of biomass and ways to overcome these difficulties are discussed in the main article of the 24th issue of Green Indicator. And in today's CatScan the difference between petrochemical feedstock and renewable feedstock are discussed; with the focus on the renewable feedstock's issues of lower energy density and higher oxygen content.

/Andreas Leveau

Biomass is all the same – or is it?

In the development of a chemical industry producing fuels and chemicals from renewable sources, biomass is the natural choice of feedstock. It is the main source of carbon that is available when turning from fossil resources such as oil, gas and coal. The interest in the biomass for the process engineers starts approximately when it is readily available as vegetable oil, wood chips or in other forms that can be traded in bulk. From there on, there is a tendency to treat biomass fractions as more or less equal in many aspects, neglecting natural variations in the biomass composition depending on for example species, growth region, storage, soil quality and focusing on downstream treatment options. Perhaps it is time to think more upstream.

Biomass fractions which initially seem to be identical can have significant variations, as will be shown in a few brief examples. For instance, black liquor – a biomass fraction available from Kraft pulp mills – has been considered a possible source for renewable carbon in the form of lignin for as well gasification as other processes. However, the black liquor has significantly different characteristics depending on whether hardwood or softwood is used in the pulp mill. Straw is a waste product from modern agriculture available in

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CatScan

Physical phenomena in catalysis for renewables

There is one major difference between traditional petrochemical feedstocks and renewable feedstocks: the oxygen content. Aside from the inherently lower energy density and the higher hydrogen requirement (in general) for processing these compounds, there are some more subtle differences. One such effect is that the oxygen content in the feedstock increases the boiling point of the feedstock. This is in normal practice not a problem when considering methanol, ethanol or other relatively low-boiling point alcohols, but when considering poly-alcohols such as glycerol the increase is considerable. To exemplify, propane boil at 231 K, propanol at 370 K, propylene glycol at 461 K and glycerol at 553 K.

This rapid increase in boiling point will affect several aspects of catalytic conversion, in particular in gas-phase conversion, e.g. higher quality heat will be required for condensation, but more importantly pore condensation becomes a relevant factor already at moderate pressures. In a with straw combustion experienced large problems due to the high content of ash with low melting points. It has however been shown that these problems can be significantly reduced by wetting the straw before storage. In gasification based processes drying is an energy intensive task. However, the moisture content of the biomass varies significantly over the year as many types of plants are almost completely dried during winter. Thus, the time of harvest can have a large impact on process energy demand.

Around the world researchers are working to improve plant species in many ways, and other researchers are working on ways to convert the biomass into useful products via bio- and thermochemical processes. However, there seems to be a discrepancy in the understanding of these two types of research. The transition from a fossil based to a renewable chemical industry could most probably benefit greatly by joint projects between chemical process research and agricultural research. Biomass is simply not all the same.

DOI 10.1007/s11244-013-0039-9) this phenomenon is discussed for glycerol dehydration to acrolein. It is shown that even under conditions applied for research (non-pressurised, up to 700 K) pore condensation is an issue that has to be accounted for. Indeed it was shown that in some cases the theoretical pore condensation filled pores three times larger than the average pore size of the catalyst. This indicates that this phenomenon has to be taken into account both when investigating these types of feedstocks and for purposely-designed catalysts for the conversion of renewable feedstocks.

Authors:
Christian Hulteberg,
christian@hulteberg.com
+46 733 969420 and
Fredric Bauer,
fredric@hulteberg.com

Editor:
Andreas Leveau,
andreas@hulteberg.com
+46 733 969423