

EUROBIO 2008

Green chemistry of renewable Carbon

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10 to 20% of petroleum are transformed by chemical industries for the production of large families of chemicals at a world scale. In the frame of green chemistry as defined by Anastas et al (1998) renewable carbon is becoming a central supply with specific features : availability of suited raw materials, design of products and materials with controlled lifespan (biodegradability), design of white and green biotechnologies enabling atoms and energy savings.

Renewable carbon represents actually an important part of the different markets of chemicals. Six main components are the starting blocks for these industries : starch, cellulose, fibers, sugars, oils and proteins, coming from cereals, oilseeds and sugar beet. They already give high volume markets (> million tons) for the major products which are ethanol, lactic acid, glycerol, 1,3 propanediol, succinic acid, furfural, fatty chains, sorbitol, and starch and cellulose derivatives.

The new tendency of this domain is the interest of fossil carbon-based chemists in supplies based upon renewable carbon. Last recent forecasts estimate that 25-30% of the chemicals will be replaced by renewable carbon in 2030. Main sources of supplies could be located South America, South Africa and eastern countries, with biorefineries still located in countries where a strong excellence in chemistry already exists.

The most significant event is the shift towards strictly biotechnological process due to process selectivity as well as energy and atoms savings. Lactic acid (see Cargill) and 1,3 propanediol (see Dupont Tate & Lyle Bio Products Company) are mainly coming from renewable carbon now.

Three applications, fuels, intermediate blocks, biomaterials (biopolymers, composites, fibers), will contribute to the reduction of energetic dependence on imported oils and emission of green house gaz . Other domains will contribute with less weight : biolubricants, biosolvants, biocleaning agents, pigments, inks, besides papers and corrugated boards.

The objective of the European Union (5.75% in 2010 and 8% in 2015) is a strong trigger to develop biofuels. Lignocellulose with dedicated plants, Miscanthus and peuplar, is the best way to transform solar energy into primary energy (ethanol and biomass-to-liquid).

It must be reminded that this role of renewable carbon has to cope with six challenges identified for all countries for sustainability:

- reduction of greenhouse gaz emissions, in agreement with factor 4,
- shift in uses of chemicals (>1T/year) due to Reach regulation in UE,
- reduction of dependence on politically unstable regions,
- savings as fossil carbon is becoming too expensive over the long term,
- feedstocks able to support foods, energy and the chemical industry,
- improvement of biodiversity.

The general assumption underneath remains that growth and demands for fossil and renewable carbons will continue at a world scale.

Green chemistry from biomass

This book edited by P. COLONNA encompasses the various applications of green chemistry from biomass in the different fields concerned. 18 chapters, gathering 54 specialists have presenting contributions in 5 topics :

The first one is devoted to the diversity of the molecules issues from renewable carbon, with strong emphasis on lignocellulose, green and white biotechnologies

The second one displays an overview of the different technological solutions already available in material uses,

The thrid one is committed to functional molecules and basic molecules necessary to create fine chemicals, mainly in lipids and sucrose chemistries

The fourth concerns biofuels, their production and their uses in engines

The last part is dedicated to the environmental approach, the reduction of green house effect, the biodegradability, the economical aspects for biofuels.

This text book should concern students and engineers for all industries processing biomass from agriculture or forests ressources towards non food uses (energy, lubricants, tensioactive agents, solvants, surface modifications, packaging materials ...).

La chimie verte - Éditions Tec & Doc – Lavoisier - 560 pages, 2005, ISBN : 2-7430-0834-2, 120.

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