SUSTAINABILITY OF GREEN BIO-REFINERIES BASED ON MULTICOMPONENT FEEDSTOCK

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In order to decrease the CO_2 emissions causing global warming, fossil fuels have to be replaced with clean, renewable energy. In response to this issue, environmental policies have favored the increase in research, development and the use of biofuels and biorefineries. First-generation biofuels (FGB) are derived from crops such as sugar cane, beet, corn, and soy using conventional technologies such as fermentation and transesterification. However, the sustainability of the production of these biofuels has been strongly challenged by the great demand of surface for crops required for their production; in addition, they compete with the food industry over the use of the same raw material and the need for arable land for crop development. Second-generation biofuels (SGB) are produced from a variety of raw materials that do not compete with food sources. These include lignocellulosic material resulting from agro-industrial activities such as the extraction of sugar. SGB promise to be more beneficial than FGB in terms of efficient use of land and proper environmental management. Most processes and technologies for the production of SGB are still in the pre-commercial stage (pilot plants, demonstration plants). Third-generation biofuels TGB also called advanced biofuels, due to the raw materials and technological processes used to produce them. These biofuels are derived specifically from micro-organisms as microbe and microalgae, and considered a viable energy resource without the disadvantages associated with those of the FGB and SGB; microalgae cultures contribute in a great way to the sequestration of atmospheric CO_2. A biorefinery is a facility that integrates biomass conversion processes and equipment to produce bio-based products (food, feed, chemicals, materials) and bioenergy (biofuels, power and/or heat). The main challenge is to achieve the sustainable processing of biomass which includes economic sustainability, zero emission and positive energy balance.

Traditional biorefineries based on specific biomass could not yet achieve the sustainable processing of biomass which includes the above mentioned factors. For example despite of positive energy balance, Sugarcane based Biorefineries produced different types of negative environmental impacts such as CO_2 due to fermentation processes for first and second generation bioethanol, CO_2 due to bagasse or lignin combustion processes and residual vinasse such ground water contaminant. The Algal Biorefineries presents the negative energy balance with relation consumption/production close to 2 which is far of sustainability from energy point of view. The author proposed the strategy to achieve sustainability of green integrated biorefinery based on computer aided design of multicomponent feedstock and biorefinery topology. From one hand with energy and material integration of Sugarcane and Multi Species Algae Biorefineries it is possible to approach to zero emission system due to CO_2 (produced in fermentation and combustion processes) sequestration in phototrophic algae cultivation systems and vinasse utilization in algal mixotrophic systems and to positive energy balance due to utilization of energy stored in sugarcane bagasse or lignin in the integrated topology. And from other hand the integrated biorefinery takes advantage of the numerous components in multicomponent feedstock producing several low-volume, but high-value, chemical biochemical or biological products increasing the general profitability and assuring the economic sustainability. The PSE, Process Integration, LCA, exergy and economic analysis tools were applied at all steps of integrated biorifiery design, integration and evaluation for selected case study.

CHEMICAL KINETICS OF COMPLEX REACTIONS: DECODING THE FUTURE

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The 20th century was a time of great achievements in chemical kinetics: this period is characterized by the triumph of catalysis and the discovery of new reaction types such as chain and oscillating reactions. That is why some scientists exclaimed: "Everything has been done in the past, chemical kinetics has been completed". As is well known, the idea that "physics is completed" was expressed explicitly at the end of the 19th century on the very eve of the atomistic revolution, which completely changed this scientific discipline.

At present, we could hear a similar "fin-de-siècle" point of view regarding chemical kinetics. In 2000, Michel Boudart stated that "…the 21st century will be, for kinetics, the century of the rate constants…" [1]. However, in the same year, Boudart also stated something different: "A catalyst is a resilient self-assembly in space and time. A dead catalytic material comes to life by contact with reactants… a catalyst as a dead object in line with a fixed structure is a wrong model of the catalytic cycle" [2]. We agree with Boudart's second statement, but not with the first one: the knowledge of the rate constants alone is not sufficient in our opinion.

The concept of the "end of developments in chemical kinetics" appears to be one of the illusions that crop up from time to time in the history of science. As most illusions it is fueled by reality.

Three major advancements that were crucial for chemical kinetics during the last 50 years are:

1. the development of new analytical techniques that enable monitoring the chemical composition of multi-component reaction mixtures;
2. the development of a battery of new physical methods for catalyst characterization, enabling the determination of the structure of the catalyst surface and the surface intermediates. Recently, it has become possible to apply most of these techniques operando, *i.e.* during the reaction;