Volume 4 • Issue 1 • 2022

Short Communication

Archives of Chemistry and Chemical Engineering

Research Aspects of Novel Advanced Multi-Platforms (MPs) Integrated -Bio-Refineries (IBRs) for Sustainable Development (SD)

Said Salah Eldin Hamed Elnashaie*

Chemical Engineering Department University of Waterloo, Ontario, Canada

***Corresponding Author:** Said Salah Eldin Hamed Elnashaie, Chemical Engineering Department University of Waterloo, Ontario, Canada.

Received: December 26, 2022; **Published:** December 29, 2022

IBRs are becoming a very important subject for SD including Bio-Fuels (BFs) and Bio-Products (BPs). The subject has become widespread, not only in biochemical Journals but there are also new IBRs Journals. The state of the art at the present time is one RRM feed stock (e.g.: lignocellulose biomass, such as Rice Straw) and two platforms one biochemical and one (or two) thermal as shown below. The research work can include more types of Renewable Raw Materials (RRMs) and more than these 2-3 platforms. It is possible to include earlier work in an integrated manner (membrane and non-membrane fermenters, multi feed stocks RRMs, MPs IBRs for control of CO_2 emissions and other wastes to produce biodiesel and bioethanol.

In short, what is suggested includes producing BFs and BPs using multiple RRMs feed stocks, including wastes. These feed stocks will include:

1. Biomass formed of lignocellulose from agricultural waste and similar wastes and corresponds to two platforms, one is a biochemical formed of delignification to remove lignin from the lignocellulose. The lignin is used for producing chemicals or as a fuel to maximize the thermal efficiency of this part of the IBR and the remaining is cellulose-hemicellulose and their enzymatic hydrolysis produces mainly: Glucose, Xylose and Arabinose that can be fermented to bioethanol and similar products using Mutated S.Cervisea using classical Continuous Stirred Tank Fermenters(CSTFs) and/or membrane fermenters, and / or immobilize packed bed fermenters and/or periodic , aperiodic and chaotic fermenters.

The other platform is thermal, where the biomass is processed through possible two paths:

- Fast pyrolysis to syngas, then treating the syngas to remove CO_2 and make it almost completely CO, H_2 mixture suitable for Fischer-Tropsch catalytic reactions to produce different BFs and BPs
- Another thermal process for the processing of biomass is controlled thermal process that produces bio-oil which is similar to fossil crude oil but a bit lighter and is to be processed in a Fluid Catalytic Cracking (FCC) unit to produce fractions similar to that produced from fossil oil (e.g.: Diesel, Gasoline, Kerosene, etc.)

Therefore, the thermal platform(s) can be one of the above or both (2)

2. Another possible bio feedstock is one of the energy crops, switch grass, which is mainly formed of lignocellulose and is treated in 2-3 platforms as described above
3. Possible bio feedstock is another one of the energy crops, Jutropha, which is mainly formed of lignocellulose and Lipid. The lignocellulose is treated in 2-3 platforms as described above. The Lipid is treated as shown later regarding algae to produce biodiesel and bioethanol and the waste of this biodiesel platform is treated in thermal platforms (1-2)
4. Another possible and most promising for the future RRM is growing algae in a photo-bio-reactor using CO_2 as a feedstock and contributing to CO_2 emission control. Good choice of the

strain of the microalgae will give growth rate about 200 times (20000%) higher than the rate of growth of Soybean. The algae produced can produce from its Lipid, through trans-esterification, high quality biodiesel and from the first step waste it can produce bio-ethanol. The final waste can be used in thermal platform(s) (1-2) as described above. The same process applied to this Lipid from the algae can be applied to the Lipid from Jatrupha.

The no. of RRMs is:

1. Biomass, e.g.: Agricultural Waste, Municipal Waste, + =2+ (More than 2 types of Biomass)
2. Energy crops, e.g.: Switch Grass, Jatrupha, + =2+ (More than 2 types of Energy Crops)
3. Algae, e.g.: Artificially grown in Photo-bio-reactors, natural Algae in sea/ocean shores and lakes, += 2+ (More than 2 types of Algae)

Total = 6+++ (more than 6 types of RRMs)

For each RRM we need 2-3 platforms, and then this novel IBRs can be formed of 12-27 platforms depending upon RRMs and platforms chosen. This is a much larger no. of platforms than the present IBRs formed of 2-3 platforms and based on 1 RRM

The change of the raw materials to RRMs will require change of the processes and will need novel bioreactors of novel configurations (e.g.: CSTF with and without selective membranes & packed bed immobilized fermenter with and without selective membranes, etc.) and/or different modes of operations (e.g., Steady State, or periodic or aperiodic or chaotic, etc.)

The first stage of research can be exploratory with a limited budget and therefore the proposal at this stage can be only a first phase of such a large and ambitious project. The present proposal with 6+++ RRMs and 27 ++ platforms and all what is in between. This preliminary investigation will concentrate on Material and Energy (ME) balances and Modeling, Simulation and Optimization based on available experimental, pilot plant and industrial data. The Objective function for Optimization will be based on Maximum Production Minimum Pollution (MPMP), Economics and Sustainable Development (SD). The jump from MPMP to SD will depend upon the use of RRMs that makes the processes Sustainable. For MPMP is a necessary condition for Sustainability, what makes it sufficient is RRMs

The second phase will be more expensive and will be based on building laboratory scale and pilot plant scale IBRs and developing reliable steady state and dynamic models (design and control equations) to develop reliably industrial scale units.

All of the above phases will require multidisciplinary team of researchers, e.g.: Chemist/Bio-chemists; Chemical/Biological Engineers; Digital control Experts, etc.