CHAPTER 5

ANALYSIS OF ALTERNATIVES

5.1 ALTERNATIVES OF TECHNOLOGIES

Chempolis’ formicobio™ is a technology to produce cellulosic sugars and further ethanol. The technology has been specially developed for non-food raw materials (e.g. bamboo, bagasse, straws, oil palm biomass, and other agricultural residues), and it is based on selective fractionation of biomass with fully recoverable biosolvent containing formic acid.

The formicobio™ technology avoids the main problems associated with other technologies developed for non-food raw materials and represents a true third-generation (3G) technology to produce cellulosic sugars and further ethanol. The technology enables co-production of platform chemicals, such as acetic acid and furfural, which are used as raw materials in the production of paints, adhesives, and plastics, and as solvent and raw material for resins. Furfural can also be converted into synthetic diesel or gasoline ingredient by hydrogenation. In addition, combustion of co-produced solid biofuel (biocoal) can generate all the energy needed in biorefinery, with some surplus to be used in other production.

The formicobio™ technology offers two principal options to produce cellulosic ethanol:

a) Production of ethanol from cellulose and chemicals from hemicelluloses

b) Production of ethanol from cellulose and hemicelluloses with co-production of chemicals from hemicelluloses

The principle of the technology (Option a) has been described as a simple block diagram in the picture below. The main steps in the process are the following:

1. Selective fractionation of biomass with a fully recoverable biosolvent (i.e. formicodeli™). Fractionation takes place in a much lower temperature and pressure than pretreatment in typical 2G technologies. During fractionation, hemicelluloses and lignin dissolve while cellulose remains insoluble
2. After fractionation, dissolved solids and biosolvent are separated from cellulose by washing. Washing also purifies cellulose for hydrolysis
3. Enzymatic hydrolysis of cellulose into glucose
4. Conventional fermentation by Saccharomyces Cerevisiae yeasts followed by conventional separation of ethanol
5. Spent liquor from biomass fractionation contains hemicellulose sugars and lignin. The liquor is evaporated and evaporation concentrate is dried. Vaporized biosolvent is directly recycled for reuse.
6. Washing liquors and a part of biosolvent from evaporation are distilled into water and concentrated biosolvent in the formicopure™ distillation system.
7. Acetic acid and furfural, which are generated during fractionation and evaporation, are separated in the formicopure™ system and recovered as valuable co-products.
8. The dried evaporation concentrate (biocoal) is combusted at an on-site power plant that generates steam and electricity for the biorefinery. Combustion of biocoal generates more energy than is needed in biorefining, i.e. biorefining is more than self-sufficient in energy.1
The principle of the technology (Option b) has been described as a simple block diagram in the picture below. In Option b), less furfural is generated from hemicelluloses, and unreacted hemicellulose sugars are separated for ethanol fermentation. Option b) includes the same steps as Option a) with the following additional steps:

1. Separation of lignin and hemicellulose sugars from evaporation concentrate (hemicellulose sugars dissolve in water/dilute biosolvent while lignin remains insoluble)
2. Fermentation of hemicellulose sugars into ethanol (either separately or together with glucose)

The present project proposal focuses on implementation of the technology according to the option a), i.e. the ‘Basic concept’. Implementation of the technology according to the option b) will be an add-on to the ‘Basic concept’ and the project for the expansion may begin once the biorefinery based on ‘Basic concept’ has started operation.
5.2 ALTERNATIVES OF SITE

Proposed project of bio-refinery consumes annually 300,000 tonnes (estimated) of cellulosic feedstock (dry basis). Northeast region of India is very rich in bamboo diversity. Approximately 60% of the total bamboo species reported from India is represented from this region. NER alone shares 66% of India’s bamboo resources. Arunachal Pradesh has the maximum area under bamboo in NER with 16,083 sq. km, followed by Manipur (9,303 sq.km.), Mizoram (9,245 sq. km.), Assam (7,238 sq. km.), Nagaland (4,902 sq. km.), Meghalaya (4,793), Tripura (3,246 sq. km.) and Sikkim (1,181 sq. km.). Hence, Arunachal Pradesh, Assam, Meghalaya, Manipur, and Nagaland states were considered for the setup of project. To identify suitable state criteria like Feedstock availability and price, Infrastructure, Political stability, government support, products Market proximity, land availability, labor availability studied based on weighted score.

TABLE-5.1 WEIGHTED SCORES CALCULATION FOR SELECTION OF STATE

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Source: Detailed Feasibility Report for feasibility study of bio refinery project.

Based on the weighted scores developed using the above criteria, Assam received the highest points and comes out to be the best location for setting up of bio-refinery. Arunachal Pradesh is the second highest ranked state with 64 points. The remaining states are closely ranked with points of 59, 55 and 53 for the Meghalaya, Nagaland and Manipur respectively.

After establishing that the proposed bioethanol plant would be somewhere in Assam, the most preferred location for the implementation of the plant has to be determined. Therefore, on the basis of primary and secondary study following 3 locations within Assam have identified for the project. These locations have selected considering that project proponent have to buy majority of the feedstock from Arunachal Pradesh, Manipur and Nagaland and less from Assam and Meghalaya and these locations are also near to feedstock rich states.

1. Numaligarh,
2. Jogighopa and

To identify most suitable site among above criteria like Delivered, Transportation, Power, water, land availability, labor, product dispatch and external factors were studied.
Based on the weighted scores developed using the above criteria, Numaligarh received the highest points and comes out to most suitable location for setting up of bio-refinery.