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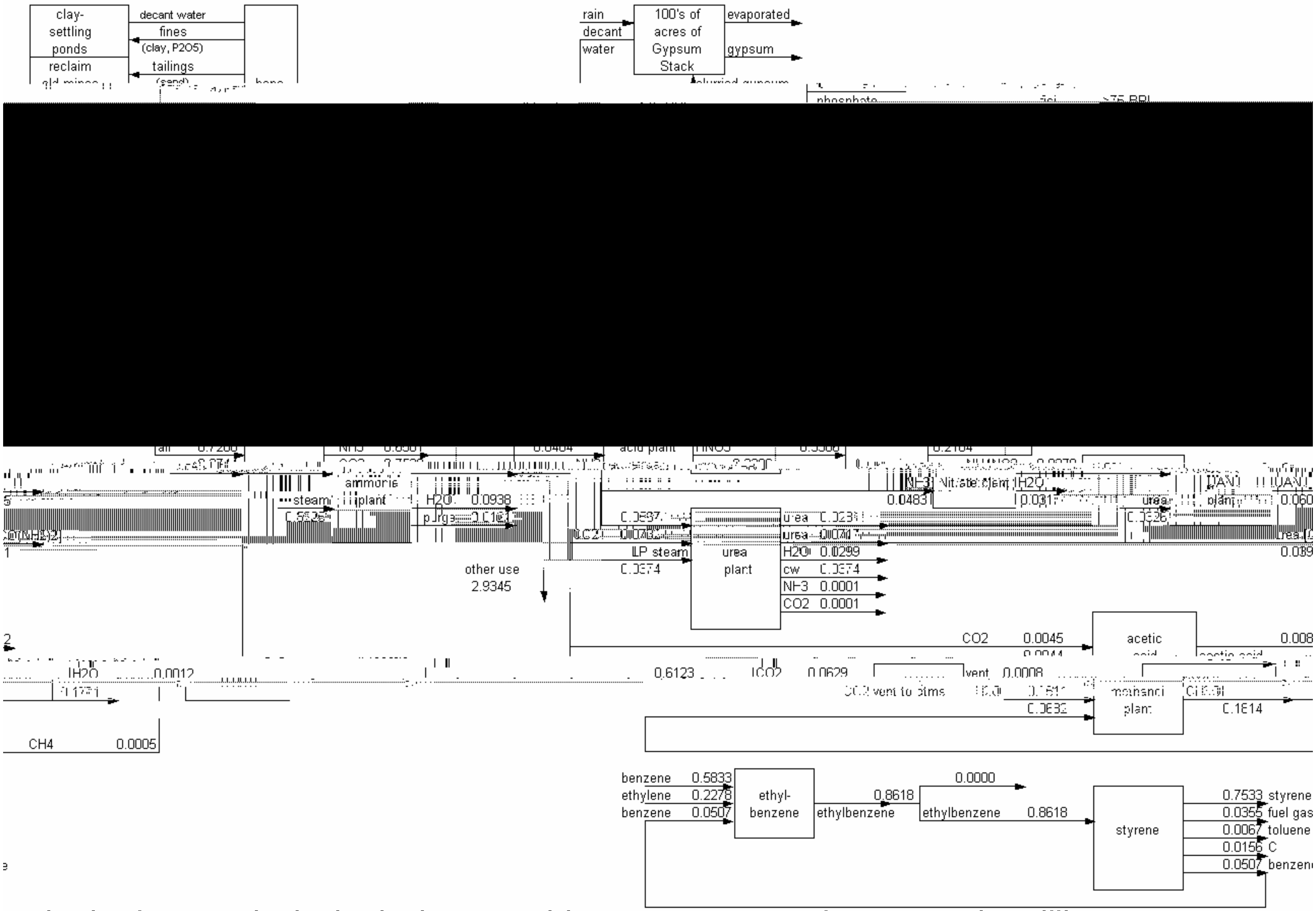
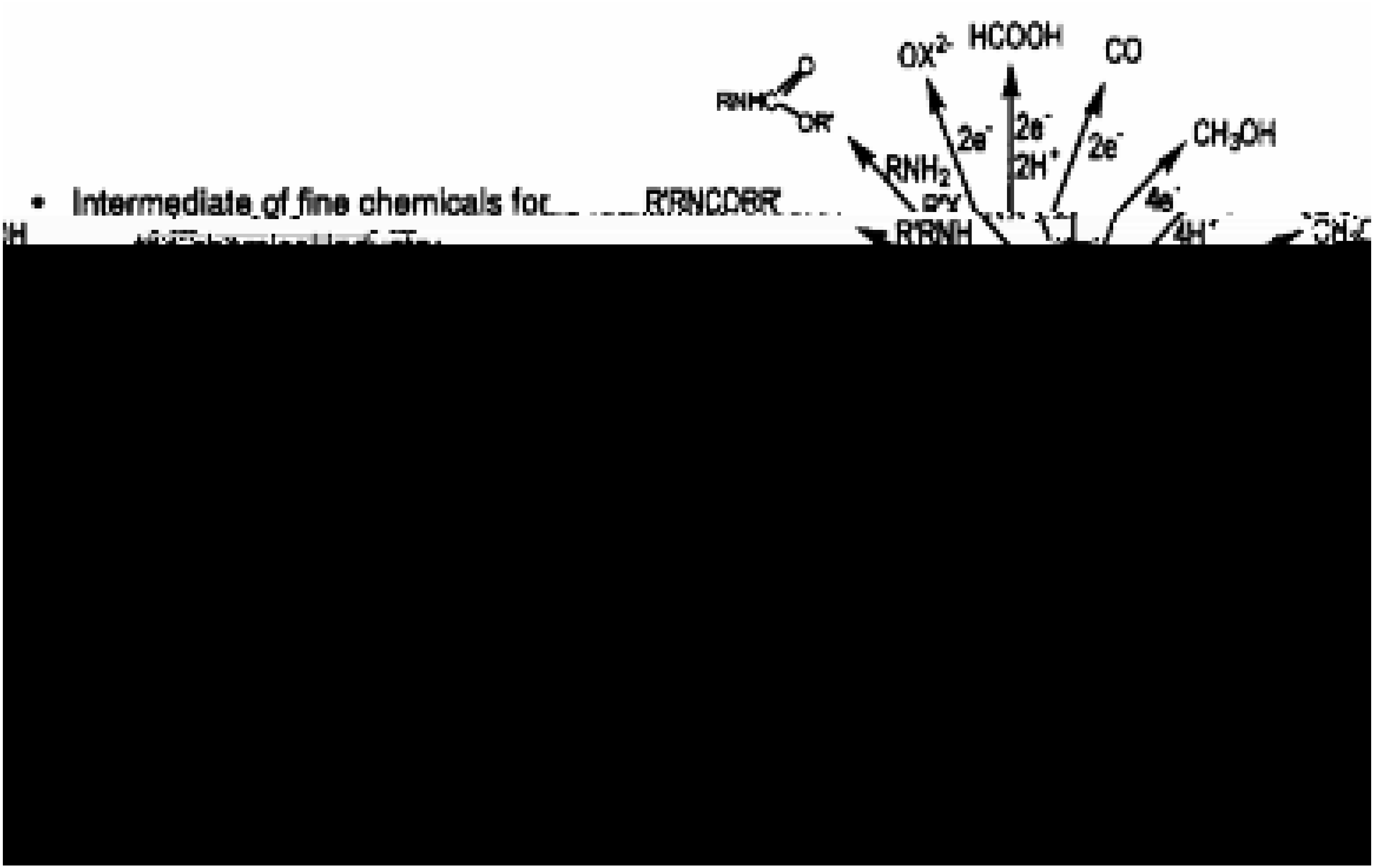
Base Case of Existing Plants



Plants in the lower Mississippi River Corridor, Base Case. Flow Rates in Million Tons Per Year

Carbon Dioxide as a Raw Material



Methodology of Developing New Carbon Dioxide Processes

- Identify potentially new processes
- Simulate with HYSYS
- Estimate utilities required
- Evaluate value added economic analysis
- Select best processes based on value added economics
- Integrate new processes with existing ones to form a superstructure for optimization

New Processes Included in the Complex

Application of the Chemical Complex Analysis System to Chemical Complex in the Lower Mississippi Riv Ri0.000i1irreipu0

Processes in the Superstructure

Triple Bottom Line

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Some of the Raw Material Costs, Product Prices and Sustainability Cost and Credits

Triple Bottom Line Results
for the Base Case and Optimal Structure

Life Cycle Assessment using TRACI

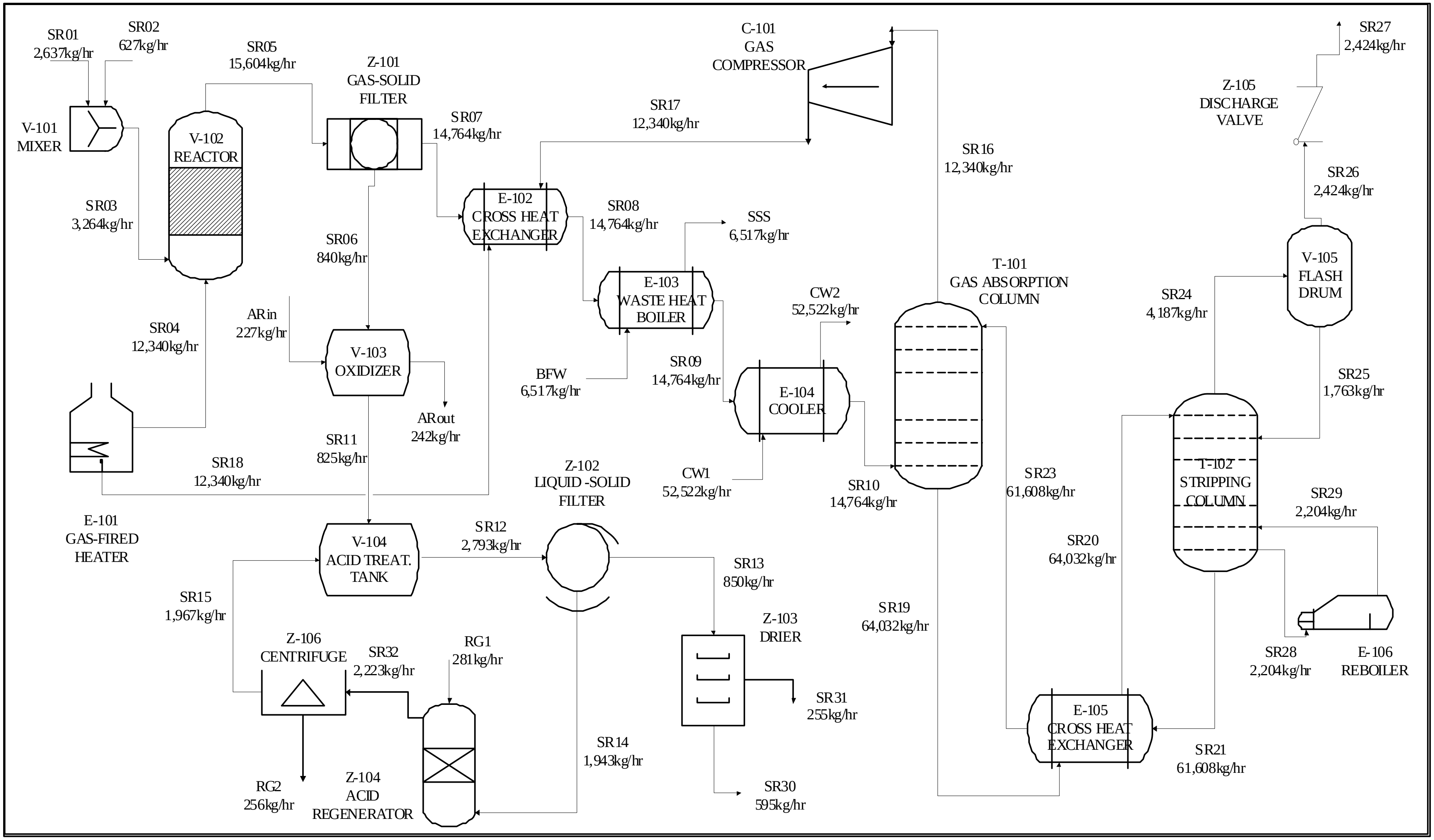
Carbon Nanotubes

- Seamless cylindrical tubes, consisting of carbon atoms arranged in a regular hexagonal structure
- Consist of carbon filaments with nanoscale (10-9 m) diameter and micron scale (10-6 m) length.
- Considered as the ultimate engineering material because of their unique and distinct electronic, mechanical and material characteristics.
- Challenge - production of purified carbon nanotubes in commercial quantities at affordable prices.

Market price is $100-$400/gm for purified nanotubes

Summary of Conceptual Designs of CNT Processes

Flow Diagram of CNT-FBR Process



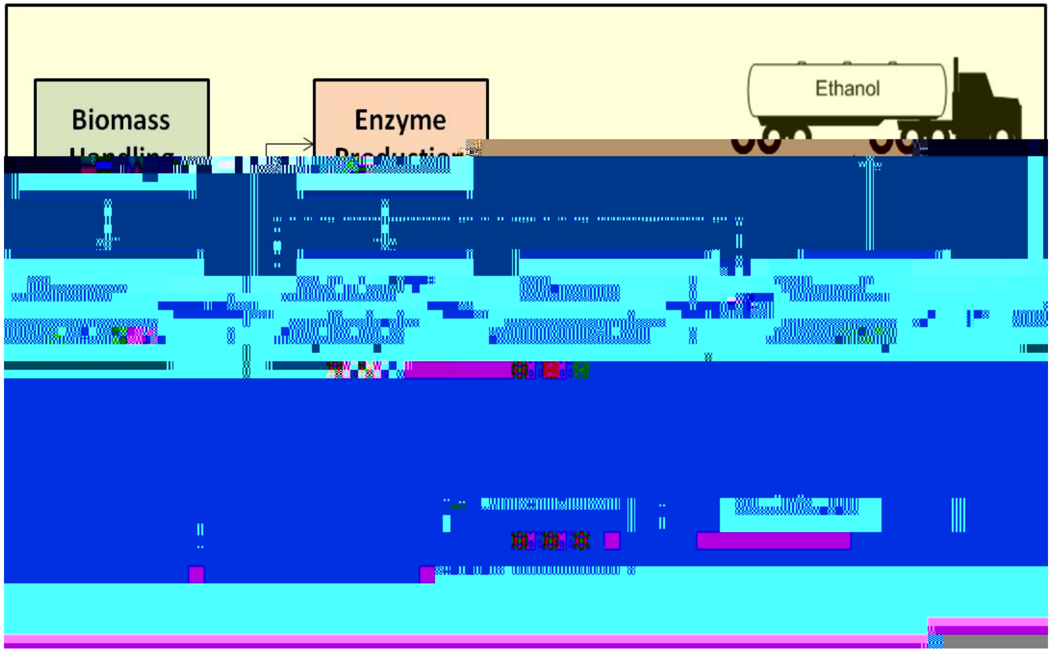
Summary of the Profitability Analysis for the Conceptual Designs of CNT Processes

Sustainable Chemical Plants using Biomass Feedstocks

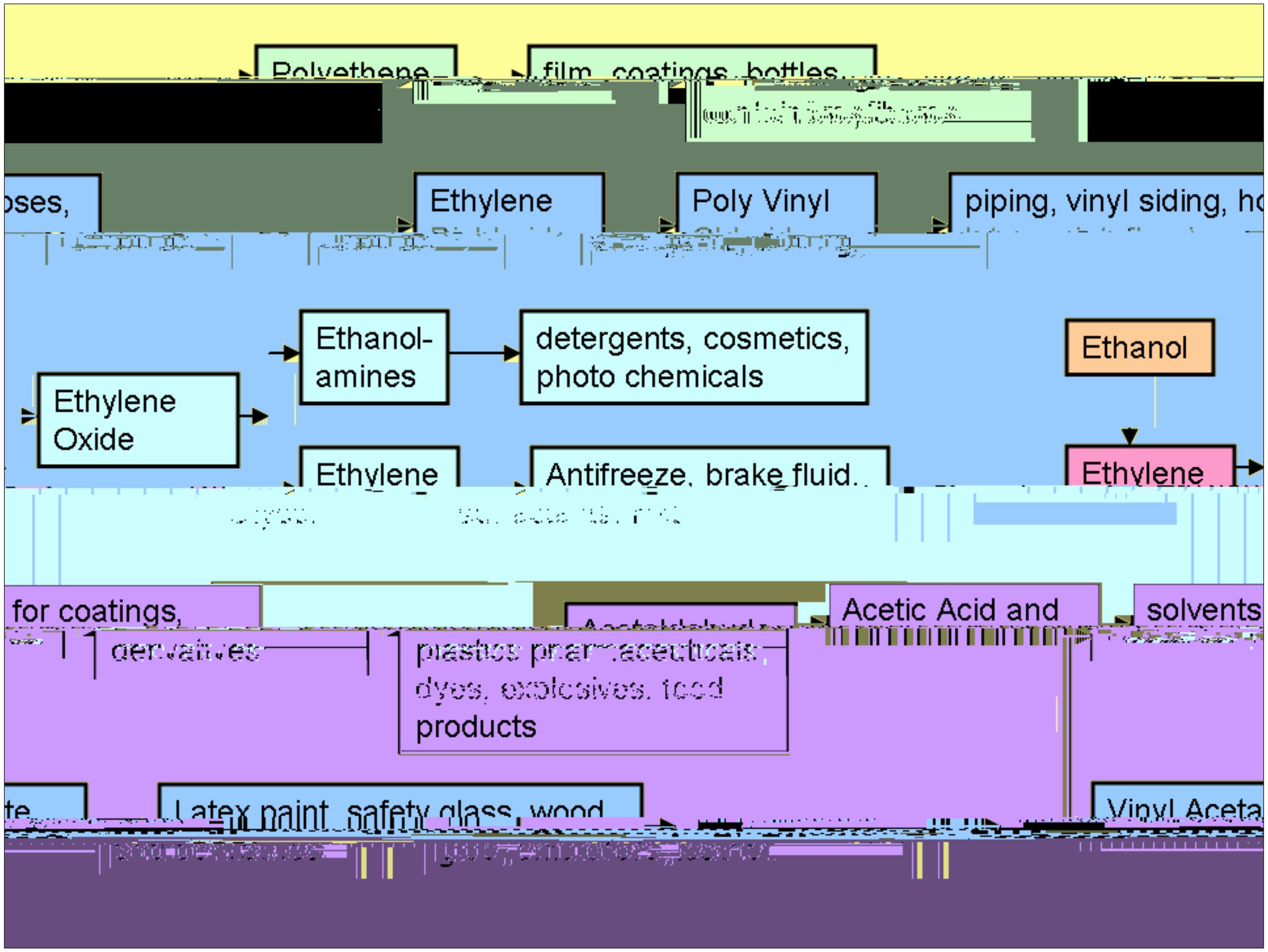
Biomass Feedstock

Biomass Conversion Routes

Chemicals from Fermentation

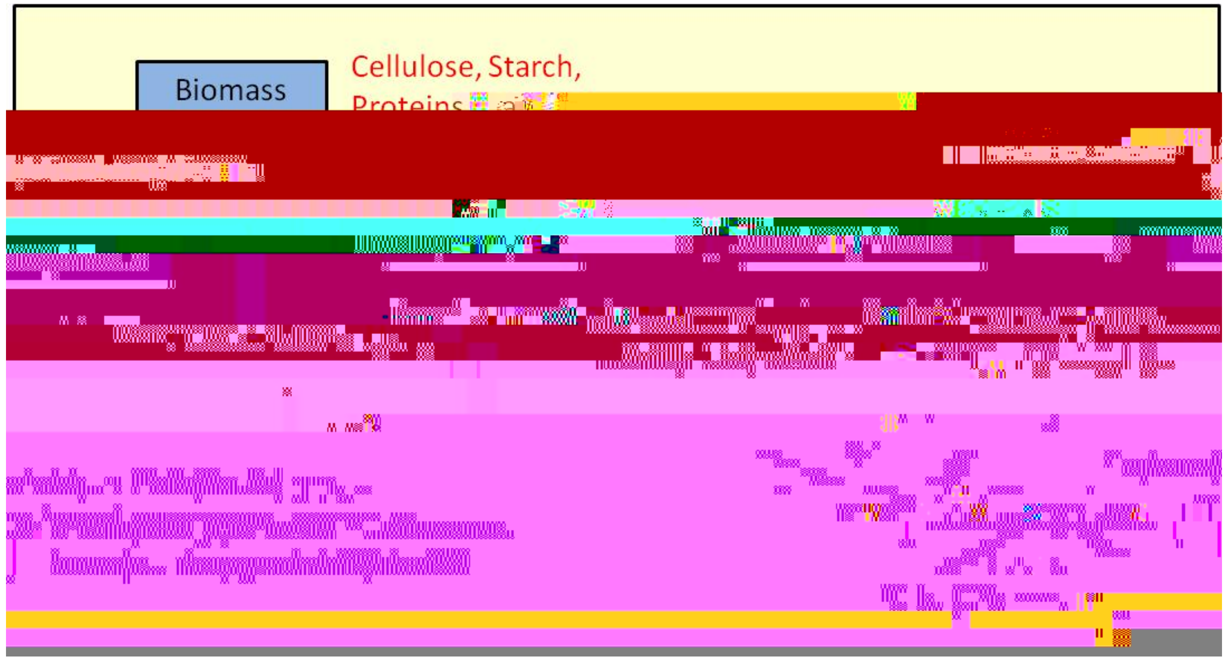


Ethanol Product Chain

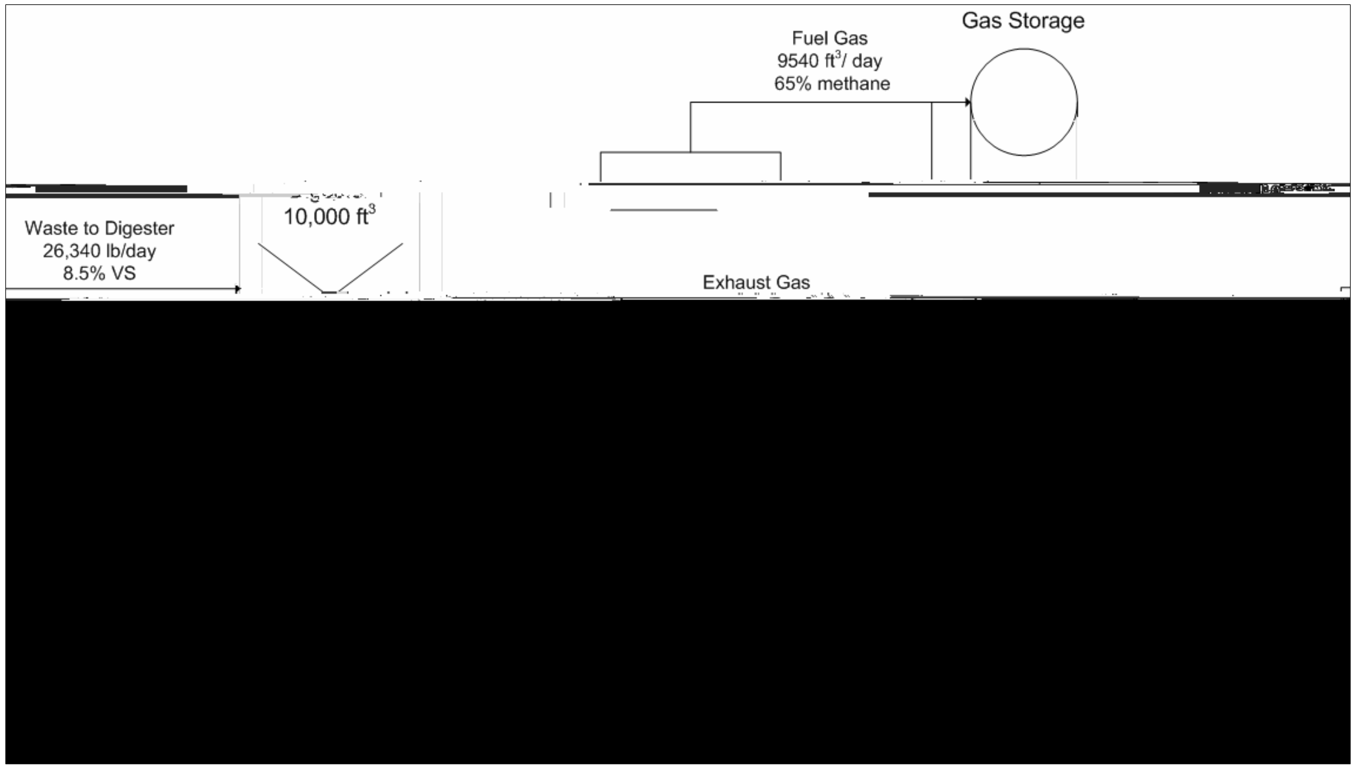


Anaerobic Digestion of Mixed Biomass

- Complex organic molecules are broken down into simple sugars, amino acids, and fatty acids with the addition of hydroxyl groups.
- Volatile fatty acids (e.g., acetic, propionic, butyric, valeric) are formed along with ammonia, carbon dioxide and hydrogen sulfide.
- Simple molecules from acidogenesis are further digested to produce carbon dioxide, hydrogen and organic acids (mainly acetic acid).
- The organic acids are converted to methane, carbon dioxide and water.



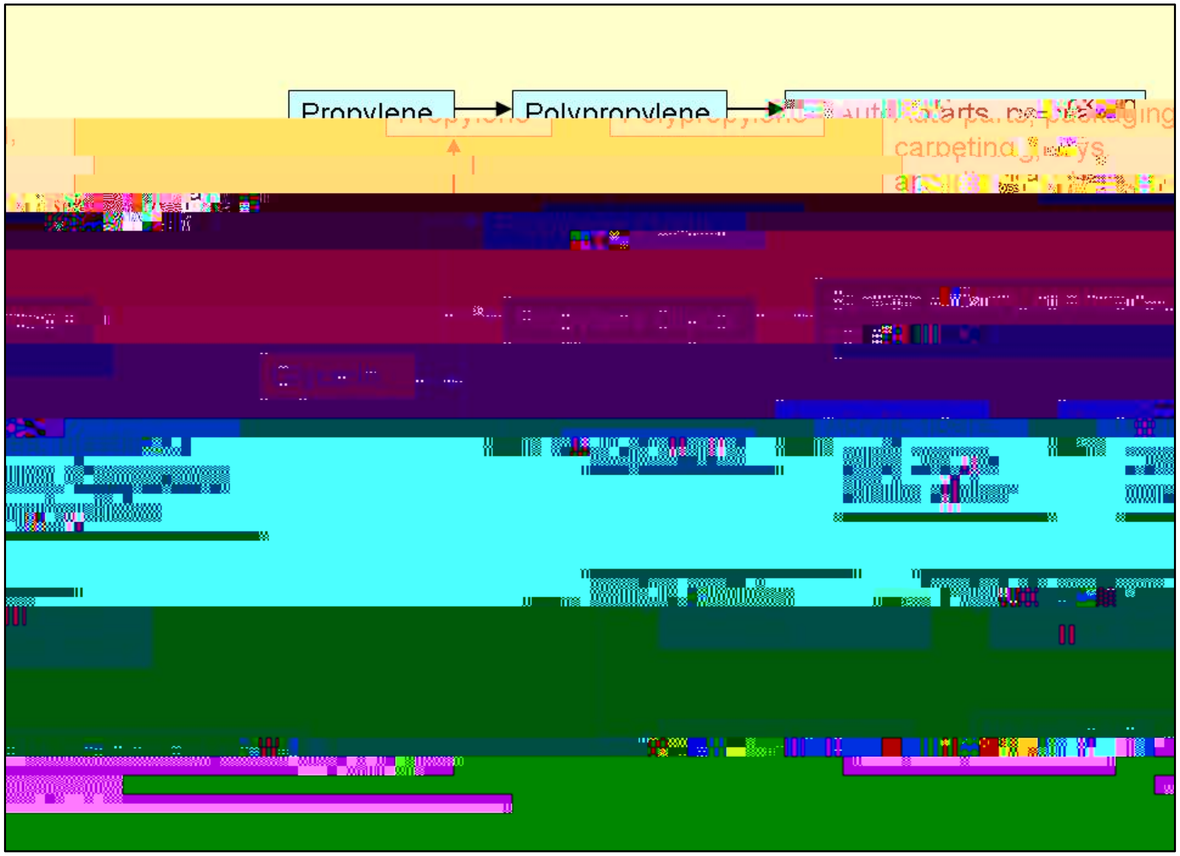
Anaerobic Digestion of Animal Waste



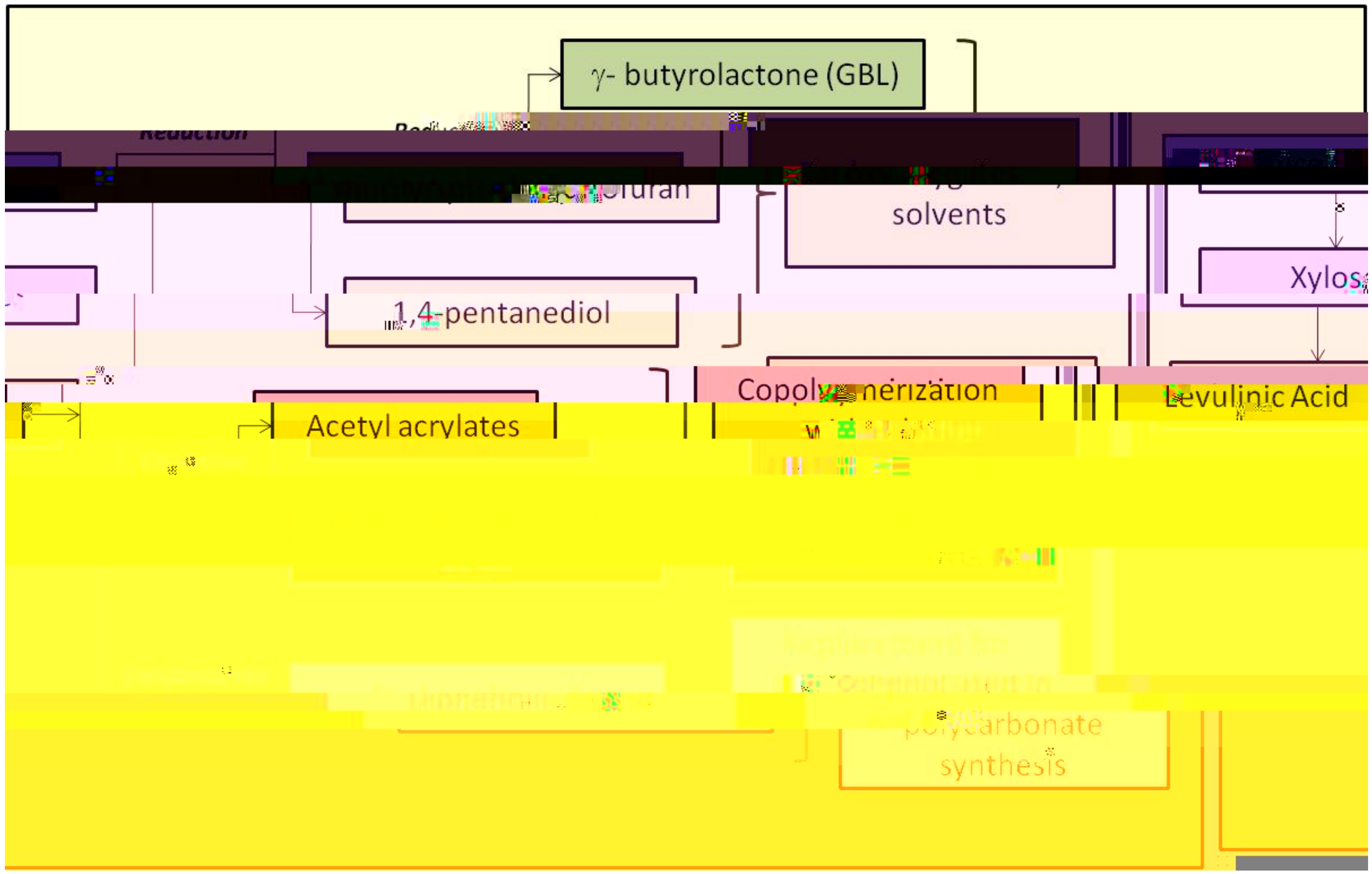
Chemicals from Vegetable oils

Chemicals from Transesterification

Utilization of Glycerol



Chemical Conversion of Biomass to Chemicals – Levulinic Acid



Chemicals from Gasification

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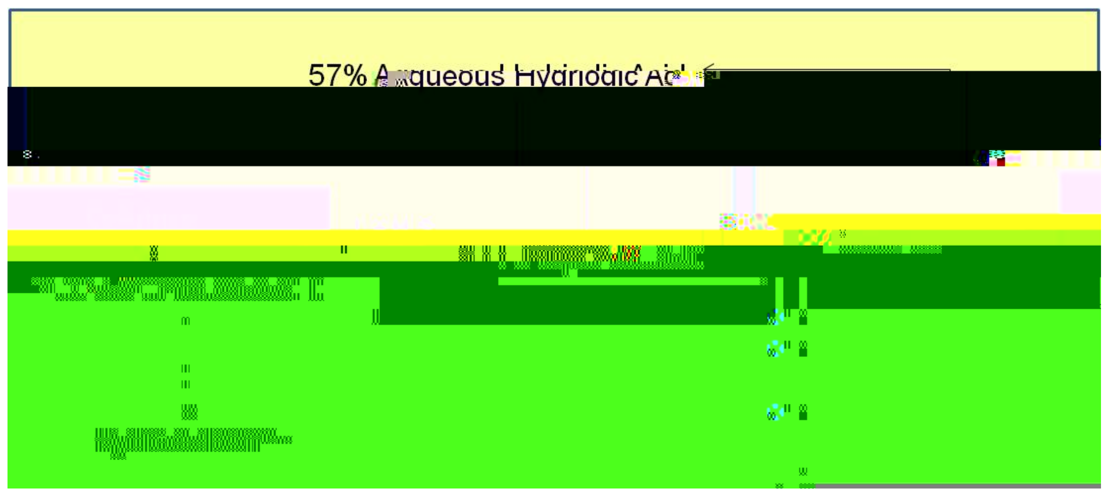
Chemicals from Pyrolysis

Chemicals from Thermal Liquefaction



New Processes in the Chemical Complex